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## PREFACE

The Minister of Science, Innovation and Higher Education has commissioned an evaluation of the Danish National Research Foundation (DNRF). This evaluation will take place during 2013 by an international panel consisting of Dr. Phil. Wilhelm Krull, secretary general of the Volkswagen Stiftung (chair); Dr. Suzanne Fortier president of the National Sciences and Engineering Research Council of Canada (from September 2013, principal and vice-chancellor of McGill University); Dr. Jung-Hoon Chun, director of the Laboratory for Manufacturing and Productivity and a professor of mechanical engineering at the Massachusetts Institute of Technology (MIT); Dr. Barbara König, professor and managing director, Institute of Evolutionary Biology and Environmental Studies, University of Zürich; and Dr. Pär Omling, president of the European Science Foundation (ESF) and vice-president of Science Europe.

The DNRF welcomes this evaluation, and we look forward to receive the panel's conclusions and recommendations. It has been 10 years since the foundation was first evaluated. In 2003, an international evaluation panel chaired by Professor Enric Banda concluded that the CoE initiative had brought genuine improvements to Danish research. Furthermore, the panel noted that about a quarter of the centers had achieved distinction as world leaders in their respective fields. However, the panel also found that more effort was needed with regard to issues of internationalization, research training, and documentation of the societal value of the research ("2. 2003 Evaluation Report and Recommendation").

Following the recommendations of the Banda panel, the DNRF undertook a number of initiatives especially targeted towards increasing the internationalization of Danish research. The international profile of the foundation's flagship program the Centers of Excellence (CoE) was increased, and new international instruments were added. Over the years, the CoE scheme has been revised and developed, but the core values underpinning the activities of DNRF remain the same.

As an input to the current evaluation, the foundation has compiled this self-assessment report that includes statistics and numerical data about the foundation and its activities. Some of these data are available for the whole period of the foundation's existence; some data – especially those concerning center statistics – are only available from 2007 onward. The data presented here are generated from existing data collected from annual reports and evaluation material from the centers. The appendix provides an in-depth presentation of relevant statistics as well as a list of grants given by the foundation.

The Ministry of Science, Innovation and Higher Education has commissioned a bibliometric analysis as part of the evaluation of the foundation. This self-assessment does therefore not include an in-depth bibliometric analysis.

In the main report we present the overall ambition and values of the foundation and its funding activities, and it also includes reflections and discussions about the activities. To a large extent, this part of the report is based on discussions at board meetings as reflected in the minutes of the meetings as well as in a document the board calls the "Experience Catalogue," in which various board members over time have collected their experiences and ideas, making sure that valuable knowledge remains in the boardroom when experienced members step down.

We hope that this self-assessment will provide helpful insight into the foundation, its activities and objectives and hope for good inputs from the evaluation panel to improve further. The foundation will gladly supply the evaluation panel with further information.

The foundation has now existed for more than 20 years. This means that there are quite a substantial number of centers (terminated as well as running), as well as many research results and experiences. The foundation celebrated its 20th anniversary in 2011. For that occasion, the foundation published a booklet summarizing the history, objectives and impact of the foundation, including different stakeholders' views of the foundation and examples of the CoE-instrument ("15.2 20 Years of World-Class Research, 2011").

On behalf of the foundation, April 22, 2013.

Professor Liselotte Højgaard, Chair of the Danish National Research Foundation &

Professor Thomas Sinkjær, Director of the Danish National Research Foundation

## EXECUTIVE SUMMARY

The Danish National Research Foundation (DNRF) is an independent organization committed to funding outstanding research at the highest international level at the frontiers of all research fields. This is primarily done by establishing Centers of Excellence (CoE). Center grants are large and flexible and run for up to 10 years. So far, 88 such centers have been established. Of these 43 are currently active.

The foundation is state funded but independent of the financial budget. It received a start-up capital of 2 billion DKK (267 M euro) in 1991 and an additional 3 billion DKK (400 M euro) was injected in 2008. The foundation enjoys full discretion in managing its funds within its governing legal framework.

Three core values underpin the activities of the foundation: excellence, trust and transparency. The vision of the DNRF is to support research that is potentially groundbreaking, research that changes the state of the art within its field, and research that ultimately may end up making a difference in the way we live and think. The philosophy is that new and unexpected knowledge that transcends existing knowledge barriers emerges when devoted and creative people with high scientific standards work together to explore problems that spark their passion.

Centers of Excellence can be established within all research areas; the quality and potential of a proposed research idea are the criteria that the foundation emphasizes most in its selection processes. Additional criteria concern the persons involved. The proposed center leader is of crucial importance to a center's success. His or her scientific merits and ability to lead and assemble a team of colleagues with the most relevant competences and profiles are also essential. Finally, the envisioned structure of the proposed center and the scientific environment in which it is placed play an important role when we select new centers.

Most centers are trans-disciplinary and comprise younger as well as more senior researchers from several fields and often from many different parts of the world. Led by top people devoted to their research, centers are dynamic, vibrant, yet focused environments in which center members interact and collaborate and new knowledge is generated and transferred.

Centers are seen as individual units or entities with their own distinct identities, but they are established at and co-funded by existing research organizations (primarily universities), where they interact closely with the surroundings. The centers play an important role at the host institutions through education of the next generation and the ability to attract and recruit top researchers and talents from around the world. The centers seem to have "a contagious effect" on their surroundings, and the center model has served as a role model for new initiatives stimulating excellence – locally as well as by other external funders.

The DNRF enjoys a privileged situation, because we deal only with the very best. The foundation distributes large and attractive grants through a selection process that is independent of national and local short-term strategies, and it does not look for immediate applicability of the centers' research efforts. This is possible because the universities and the other public and private funding organizations have laid the groundwork by supporting research with different objectives, on a different scale, and with different means.

The investment in the Centers of Excellence has had a significant effect on Danish research, including a marked impact on patents, innovation and education.

## KEY MESSAGES:

- The Danish National Research Foundation is an independent organization established by the Danish Parliament in 1991. The board of trustees focuses on funding outstanding research in Denmark at the highest international level through the Center of Excellence program and related funding instruments.

### **Funding**

- The DNRF distributes 2% of the public research funds in Denmark.
- Since 1991, the DNRF has supported Danish research institutions with 6.2 billion DKK with an annual distribution of 400 MDKK.
- The DNRF has funded 88 CoE of which 43 are currently active (5.4 billion DKK).
- 12 Niels Bohr Professorships hereof 7 active (267 MDKK).
- The DNRF has co-funded 10 Danish-Chinese centers (total investment 230 MDKK).
- CoE have attracted other external funding at a similar level as the funding from DNRF and host institutions commit themselves by funding the CoE at a level which equals approximately 50% of the funding from DNRF.

### **Output and outcome**

- CoE leaders contributed to 15% of the articles in “top 10” journals by authors from Danish institutions. The “top 10” journals are the 10 publication sources where the centers think it would be most prestigious for them to publish.
- The center leader’s contributions to high impact interdisciplinary journals such as *Nature* and *Science* have increased from approximately 5% of the publications in the two journals by authors from Danish institutions in the mid-1990s to above 25% in 2012. During the same time period the total number of publications from authors at Danish institutions in the two journals has doubled.
- From 2007-2011, 12% of all patent applications and 20% of all granted patents from public research institutions in Denmark came from DNRF centers.
- 50% of all Danish ERC Advanced grants awardees are center leaders or key researchers at a DNRF CoE.
- The DNRF hosts 9% of all enrolled Ph.D. students and 14% of all full-time international enrolled Ph.D. students in Denmark (2010).
- The CoE’s generate international environments with 40% Ph.D’s and 60 % Postdocs from abroad.
- The Niels Bohr professor Dale Mortensen received the Noble Prize in Economics in 2010.

### **Finances**

- The annual return on our investments has been successful. Since the 2008 amendment to the law, the annual return has been 6.8% against the benchmark of 6.6%. In 2012 alone our 4 billion DKK gave a return on investments of 10.7%.

## DNRF IN THE DANISH RESEARCH LANDSCAPE

The Danish research policy system has recently been subject to close inspection. For example, the Royal Swedish Academy of Sciences' report "Fostering Breakthrough Research" ("16.1 Fostering Breakthrough Research: A Comparative Study, The Royal Swedish Academy of Sciences, 2012") makes a comparative study between Sweden, Finland, The Netherlands, Switzerland and Denmark. In terms of high-impact research, Denmark comes out remarkably well in the analysis.

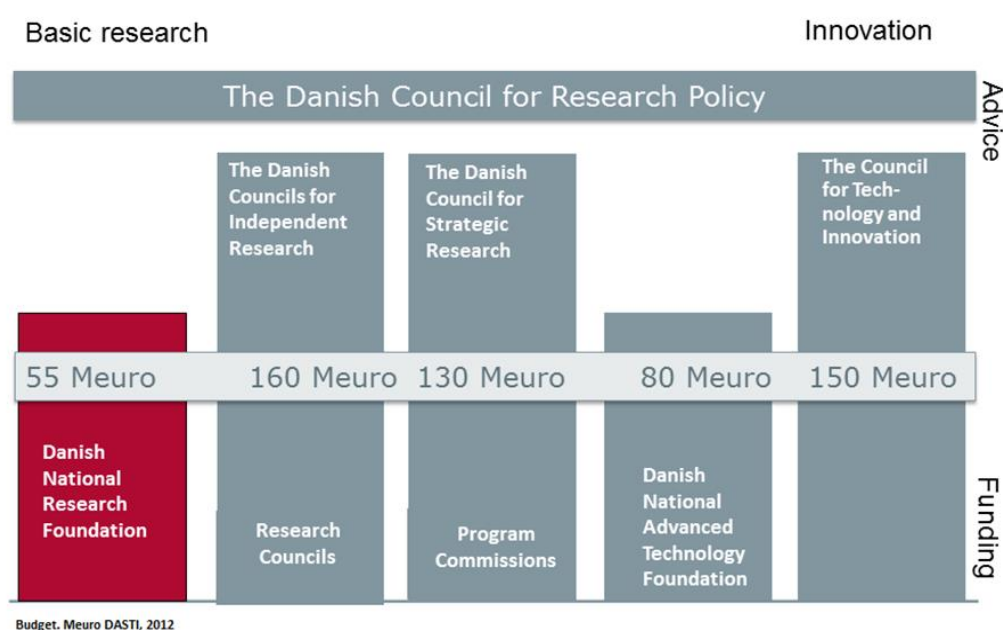
This is consistent with Denmark being called an innovation leader and ranked as number 3 on the *Innovation Union Scoreboard 2013*. When looking at the indicator: Open, excellent and attractive research system, Denmark is placed as second best. ("16.2 Innovation Union Scoreboard, 2013"). Also, the ERAC Peer Review of the Danish Research and Innovation System in 2012 found that the Danish system offers an excellent example of a well-performing research and innovation system, although the review panel presented a number of recommendations for future action on the Danish innovation system.

The Research Barometer for 2012 presents a broad range of indicators which, together, create an overview of the quality and range of Danish research. Indicators for the ability to attract and obtain EU grants show that applications with Danish participants seem to be the most successful of the European countries in relation to demography. The impact of publications is another indicator, and Denmark is reported to rank third out of 38 countries in terms of citations per publications ("16.3 Research Barometer 2012-summary.")

In 2010, the total expenditure on research and development in Denmark amounted to 55 billion DKK, corresponding to 3% of GDP, of which the public sector accounted for 1% (17 billion DKK). ("16.3 Research Barometer 2012-summary"). Part of the remaining 2% of GDP includes substantial funding of research at public research institutions paid by private foundations and charities, placing Denmark with one of the highest percentage in the world of public research funded by private donations. ("16.5 The Danish Council for Research Policy Annual Report, 2007", "16.6 Private fonde – en unik aktør i dansk forskning, DEA, 2012").

The Danish Agency for Science, Technology and Innovation (DASTI) is the central agency for tasks related to research and innovation policy. The agency provides secretariat services to a number of the research funding and advisory committees in Denmark and plays a central role in coordinating and organizing the interaction between key stakeholders and actors in the research system. In addition to the DASTI being the supervising authority of the Danish National Research Foundation, the foundation also enjoys an ongoing dialogue based on trust and mutual interests.

### Main public funding bodies for research and innovation in Denmark



The Danish National Research Foundation is one of several players in the Danish arena for research funding. In addition to the universities and some major private foundations, a number of publicly funded entities, such as the Independent Research Council, the Strategic Research Council, the Advanced Technology Foundation, and the Council for Technology and Innovation, constitute the majority of the Danish research funding system. This funding system may, at first glance, appear complex, but it should be recognized that each of these players, by their own means and mechanisms and with different scales and objectives, supports the development of Danish research. Hence, the system can be seen as complementary, rather than complex.

One of the findings of the report from the Royal Swedish Academy of Sciences is that Danish research policy from 1990-2012 “has succeeded in propelling Danish research from a modest performance into a globally leading position. A key element behind this rise seems to be the resource increase. Rather than being evenly distributed, the boost has been channeled through highly competitive schemes with clearly defined goals.” The Swedish report further speculates that the Danish National Research Foundation has been an important player in raising the international profile of Danish research, stressing that the foundation has been instrumental in assisting Danish universities to direct their research priorities toward academic excellence. The DNRF’s Center of Excellence program has had a positive effect on the ability of the academic leadership at universities to prioritize recruitment at high levels and channel resources toward building more creative and competitive environments.

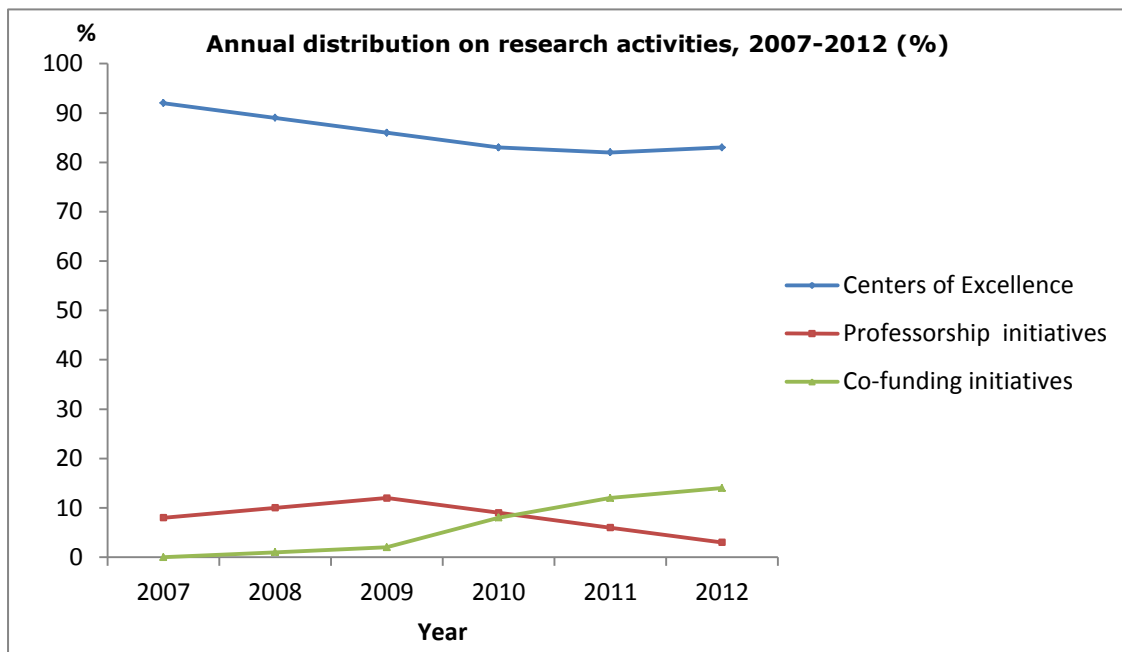
The Danish National Research Foundation is an independent organization established by the Danish Parliament in 1991 with the objective of strengthening Denmark’s ability to develop in terms of research.

The legal framework establishes that the foundation must support excellent world-class research. Supported activities must include key elements of research training and can involve international collaboration and joint funding activities. Grants must be large and must run for a specified number of years. The foundation is obliged to monitor any research activity funded, and it is authorized to distribute 400 MDKK annually. (Please refer to Part C for a further description of the legal framework and for information on the foundation’s finances and funding assets.)

The DNRF can target its activities to funding the very best regardless of discipline, geography, etc., and does not have to choose between various programs and objectives. However, this is only possible because other important actors in the funding system play their roles and carry out their responsibilities. There would be no “excellence” to fund if the universities and research councils did not lay the groundwork.

In order to fulfill its objectives, the foundation has developed a Center of Excellence (CoE) funding instrument that aims to identify and fund outstanding researchers with research ideas that have the potential for breakthroughs that may transform science itself, open up new opportunities, and thus ultimately change the way we live and think. The foundation supports research propelled by desire, curiosity and wonder, research conducted with dedication, focus and passion. So far, a total of 88 Centers of Excellence have been established as a result of seven application rounds. The foundation has supported Danish research with more than 6 billion DKK (~0.8 billion €.)

In addition to the Center of Excellence program, a few other initiatives have been launched with the specific goal of furthering the internationalization of Danish research. These are described in Part B. Because the Center of Excellence program is the primary funding mechanism, the major part of this self-assessment report (Part A) is devoted to describing, assessing and reflecting on this program.



At least 80 percent of the funds are used for the Center of Excellence program. A number of other initiatives have been launched with the specific goal of furthering the internationalization of Danish research. These initiatives include professorship programs and co-funding initiatives.

#### *Core values*

When outlining its strategy in December 2010 ("3.1 DNRF Strategy"), the board defined three core values that characterize the organization and all of its activities. They are:

- *Excellence.* Excellence should pervade all aspects of the organization.
- *Trust.* Trust stimulates creative research. Accordingly, the DNRF's philosophy is that the talented researchers selected to lead Centers of Excellence should have considerable freedom in handling the large and flexible grants at their disposal.
- *Transparency.* Transparency, fairness, and quality are key words in the assessment process. Given the significance of a Center of Excellence grant, it is essential that the scientific community be able to trust the integrity of the foundation and the assessment and selection processes it uses.

The Danish National Research Foundation is devoted to funding outstanding research through large grants that run for long periods.



# PART A

## CENTERS OF EXCELLENCE

# 1 INTRODUCTION

A Center of Excellence grant is a flexible and large grant with a long-term perspective. Centers may receive funding for up to ten years, divided into two grant periods.

Center of Excellence grants are used for funding outstanding researchers in large groups who jointly pursue a set of intriguing, overarching, and ambitious research questions. A Center of Excellence builds a creative research environment and strengthens the exchange of ideas across generations, areas and research environments. A Center of Excellence in the DNRF model is a joint physical community. It is the foundation's experience that a large degree of daily interaction among center members is crucial. However, centers may form partnerships with researchers at other institutions, either in Denmark or abroad.

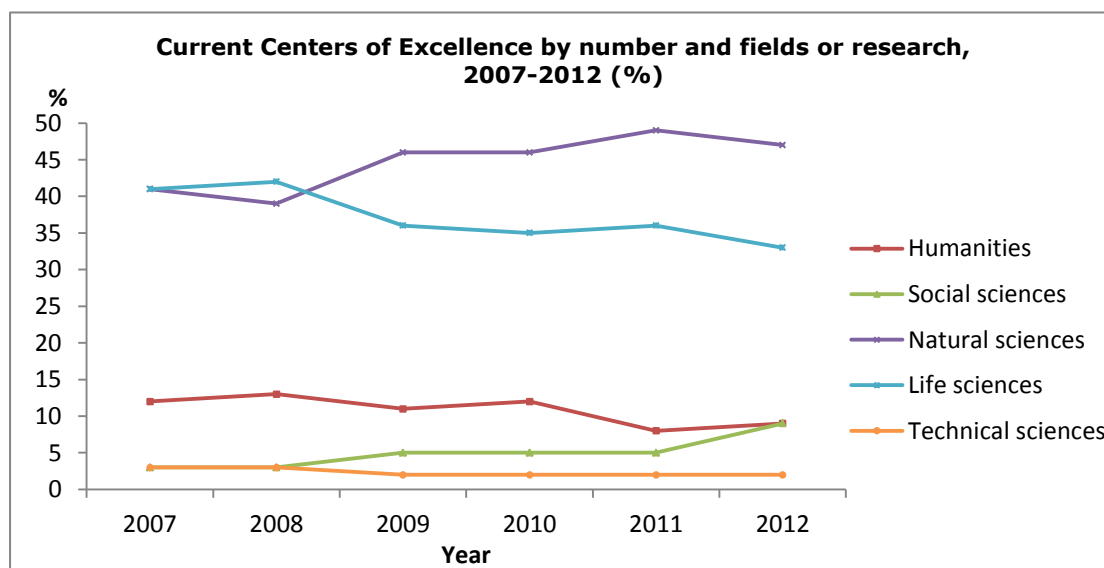
So far, the foundation has established 88 Centers of Excellence. Of these, 43 are currently receiving funding from the DNRF. An overview of all centers funded so far is available in the appendix p. 5-6.

Centers of Excellence are established in so-called application rounds – or competitions. The first application round was in 1992/93. The latest round was the 7<sup>th</sup> round in 2010/11, when eleven new centers were established. Currently, an 8<sup>th</sup> application round has been announced, and a new call for proposals will be launched in June and remain open until November 25, 2013. The new centers from this round will be up and running from January 1, 2015. The next call for new centers – and under the current financial framework the last one – will be announced in mid-2015.

## 1.1 Frontline research

The term “basic research” is included in the Danish name of the foundation (Danmarks Grundforskningsfond), signaling that the foundation supports what may be defined as fundamental research. But the sharp distinction between basic and applied research has become blurred because emerging areas of science and technology often cover substantial elements of both. Instead, the DNRF prefers to say that it supports frontier or frontline research, which we understand as research targeting the frontier of knowledge in an attempt to go beyond.

It is the board's view that the foundation's endeavors should reflect a certain willingness to take risks. Safe and minimally risky endeavors can contribute to good research. However, if we are to achieve cutting-edge and surprising discoveries, we must venture into novel ways of thinking about the scientific approach, method, and hypothesis testing in previously untested collaborations – possibly causing a paradigm shift. Here, elements of unpredictability are important. Much weight should be put on the ambition and potential of the proposed research program. When venturing into funding of challenging research carrying a high degree of risk, the potential of the research is crucial, but the merits and documented results of the applicant are also pivotal. Breakthrough research may result when exceptional ideas are combined with talented researchers who are not yet at the top in their fields.



The majority of the CoEs are in the fields of natural sciences and life sciences (80-85 %). However, many centers are trans-disciplinary and therefore do not fit readily into one category.

Some of the centers funded by the foundation produce results with immediate applicability, while others pursue pure “blue sky” research. What matters is that the research is considered to be truly novel, pushing, exceeding, and going beyond the known research front lines. Hence, center researchers are expected to engage in pondering some of the large, unsolved research questions and address the challenges that intrigue them the most. DNRF’s philosophy is that when excellent people work with problems they are most passionate about, groundbreaking results are more likely to follow. In other words, the foundation welcomes curiosity-driven research – or what might be described as exceptional researchers’ “dream projects.”

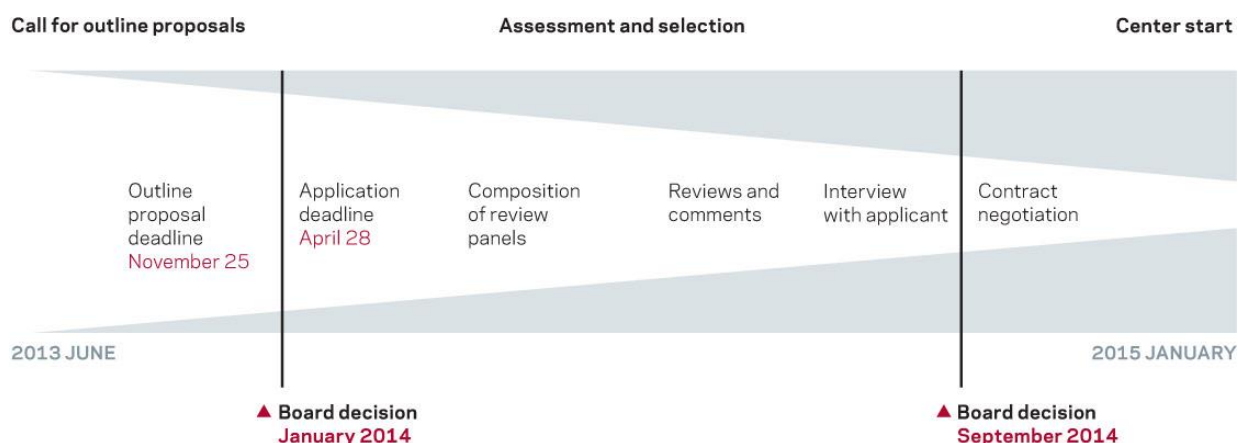
Centers can be established within and across all research areas. As the figure above shows, the majority of the centers lie in the fields of the natural sciences and the life sciences. This is a pattern with several possible explanations, one being that these fields have a long-standing tradition for working in bigger units. Moreover, the breakdown of centers into fields varies considerably from one grant round to the next.

It should be recognized that the vast majority of the centers can be described as trans-disciplinary and, therefore, do not readily fit into one of the five categories (humanities, social sciences, natural sciences, life and technical sciences). The level of inter-disciplinary interaction in some centers even spans all five fields. Many of the other centers involve competences from various disciplines within the same field or across several fields of research

## 2 SELECTION AND ASSESSMENT OF CENTERS

Calls for new centers are announced approximately every two-and-a-half years, and they involve a two-stage application process. In the first stage, prospective center leaders are invited to submit short outline proposals. These proposals are processed by the board alone. In the second stage, selected applicants submit full proposals that are thoroughly scrutinized by a set of international experts in the field in an open review process. Prior to the final selection, the board meets with each selected applicant. An overview of the assessment and selection process illustrating the timeframe of the 8<sup>th</sup> application round is provided in the figure below. The different steps of the assessment process are described in detail below.

### Assessment and selection, 8<sup>th</sup> application round, 2013



The competition is fierce and the overall success rate from submission of outline proposals to establishment of a center has been only 6% in the previous application rounds. 13-20% of the outline proposals have moved on from stage one to stage two and about 30-40 percent of those applications have resulted in new Centers of Excellence. (See appendix p. 26).

### 2.1 Criteria

The same criteria are applied throughout the assessment and selection process. The criteria used in the application rounds rests on four pillars and are formulated as follows:

- **The research idea:** The research idea is ambitious and original and has the potential for real scientific breakthroughs in the relevant research field(s).
- **The center leader:** The proposed center leader has a high standing in the international research community as well as managerial skills.
- **The team:** The center includes high-quality personnel in order to establish a creative and dynamic international research environment that will provide an inspirational training ground for young researchers.
- **The structure/organization:** The focus, structure, and size of the proposed center are such that it sets the stage for scientific ventures that are not feasible within conventional funding from other sources.

### 2.2 Outline proposals

Outline proposals are short documents not exceeding five pages. An outline proposal should not describe the proposed endeavor in detail but provide an *argument* for a grant by addressing questions such as: How will the proposed endeavor redefine the research in its respective field(s)? What kind of new insights and results may it produce? Why should this particular proposed team pursue this research?

The proposal should also include a description of the proposed *research idea*, including its dimension of novelty and potential for groundbreaking results and an argument for its scientific or investigative relevance. And finally, it should include a *strategy* for how the idea and research challenges are met. This can be done, for example, by addressing questions such as: How will the center be organized? Which competences/capacities will be involved? How will a creative and dynamic research environment be established? Which methodologies and approaches will be employed? CVs for the proposed center leader

and core members should also be included. (See “7.1 Applicant’s Guide 8<sup>th</sup> Application Round” for details.)

The board itself, consisting of nine experienced, international researchers, evaluates the outline proposals. In previous application rounds, the foundation has received between 140-200 proposals. All board members assess all proposals by employing a scoring system (ABC). Prior to the meeting, board members are asked to return an evaluation form indicating whether, in their opinion, the proposal: A) should be supported; B) should be conditionally supported, further discussed, clarified, etc.; and C) should be rejected. Each board member is limited to a restricted number of A’s. Before the discussion, an anonymized compilation of the board members’ scores is distributed. Each proposal is discussed thoroughly at the meeting, and the board formulates a reason for each rejected proposal to be communicated to the applicant. It is the board’s experience that this system of scoring is effective as a preliminary processing instrument that, among other things, brings into focus proposals about which there is disagreement. However, this scoring system can in no way replace discussions on the individual proposals in plenum.

As an addition to the ABC scores, a P-score (for Potential) has been added in the 7<sup>th</sup> application round in order to maintain a focus on proposals that can potentially deliver real transformative or groundbreaking research, even though the proposed endeavor may be considered of high risk.

The threshold from stage one to stage two (outline proposal to full proposal) might be considered the most difficult one to pass in the assessment process. The success rate for this transition is 13-20%.

### **2.3 Full proposals**

Successful applicants from the first stage are invited to submit full proposals. Although longer than outline proposals, full proposals are – by comparison to large US funding organizations – rather short documents. As the criteria remain the same throughout the assessment process, the requirements for the proposals are much the same. Hence, a full proposal is an elaboration of the outline proposal, and it may not exceed 15 pages.

Full proposals should consist of a visionary presentation of no more than five pages expanding the overall research idea, including a description of its dimension of novelty and potential for ground-breaking results and an argument for its scientific or investigative relevance and expected impact. It must contain a strategy for addressing the challenges, answering questions such as: How will the center be organized? Which competences/capacities will be involved? How will a strong, creative, and dynamic research environment be established? With which institution(s) will it be affiliated? What are the qualifications of the proposed center leader (scientific as well as managerial skills)? Will specific initiatives be made to attract young and talented researchers? How do the applicants plan to attract international researchers? What sort of international collaboration is envisaged? How will the research activities relate to existing Danish research in this area? Also, a description of the planned research program must be submitted (not exceeding 10 pages). CVs for the proposed center leader and core members should be included in appendices. (See “7.1 Applicant’s Guide 8<sup>th</sup> Application Round” for detail).

### **2.4 Use of external peer review**

External advice is included when processing full proposals. The use of peer review rests on the following core principles:

- Full transparency
- High-quality process; the use of true peers
- Equal treatment of all proposals

Each full proposal is sent to three high-level international experts within the relevant scientific area(s) for external peer review. The foundation strives to compose the group of reviewers for each proposal so that one reviewer is proposed by the applicant, and the overall composition covers the spread of the proposal (often interdisciplinary). With the aim that the proposed research must be able to assert itself internationally, reviewers should at least be full professors or hold similar academic positions. (Nearly all reviewers are full professors.) When possible, gender distribution and geography are taken into account.

Each reviewer is asked to deliver a report of three to five pages according to the Terms of Reference for New Proposals (“7.2 Terms of Reference, New Proposals”). The foundation offers an honorarium of DKK 3.000. Reviewers are not asked to grade or rank the applications but to deliver an assessment based on arguments and reflections.

No expert reviews more than one proposal, and no reviewer is asked to review a proposal from an applicant he or she already reviewed in a previous application round. All proposals compete against each other. There is no up-front allocation of the budget to specific areas or disciplines. In application rounds where all research areas can apply, it is rarely possible to group all proposals. It is the board's view that it would create an unfair situation if some reviewers assess more than one proposal.

Applicants are heard on the proposed composition of review panels before proposals are sent to the reviewers, and applicants may comment on the reviews before the board makes its final decision.

Both the applicant and the reviewers are aware of each other's identity. The board has discussed whether this transparency makes too many invited experts decline the invitation to become a peer reviewer for the DNRF. On average, the DNRF has to ask 8 experts in order to get the 3 needed for the assessment of a proposal. This success rate doesn't seem to deviate from experiences in other funding agencies. Very few (9 out of 790) contacted experts who decline an invitation state the lack of anonymity as their reason.

The board has also discussed whether a transparent process based on non-anonymity might result in too many "cheerleaders" or reviews being devised in such diplomatic formulations that board members to a large extent must read between the lines or pay attention to a particular absence or presence of laudatory adjectives, etc. Moreover, traditions for writing peer reviews differ across the disciplines. Some research areas seem to be focused on commenting on critical issues, while other focus mainly on the positive sides and generally use very complimentary language. This already requires board members to be familiar with the intricacies of the review genre.

For some it may be seen as controversial that applicants are asked to suggest one of the three reviewers. This practice was only initiated in the 6<sup>th</sup> application round but has henceforward been used in all assessments (7<sup>th</sup>, Niels Bohr professors, midterm evaluations). In both the 6<sup>th</sup> and the 7<sup>th</sup> application rounds, the board evaluated the quality of the reviews received with a view to identifying a possible positive bias from reviewers suggested by the applicant. No positive bias was detected.

Other actors are also asked to help identify potential reviewers. The foundation has been advised by the Danish Council for Independent Research (DFF), the European Science Foundation (ESF) and the National Science Foundation (NSF) in the USA. When suggestions from external sources have been exhausted, the secretariat has identified the remaining reviewers. In the 7<sup>th</sup> application round, the secretariat ended up identifying 42% of the reviewers.

## **2.5 Interview with applicants**

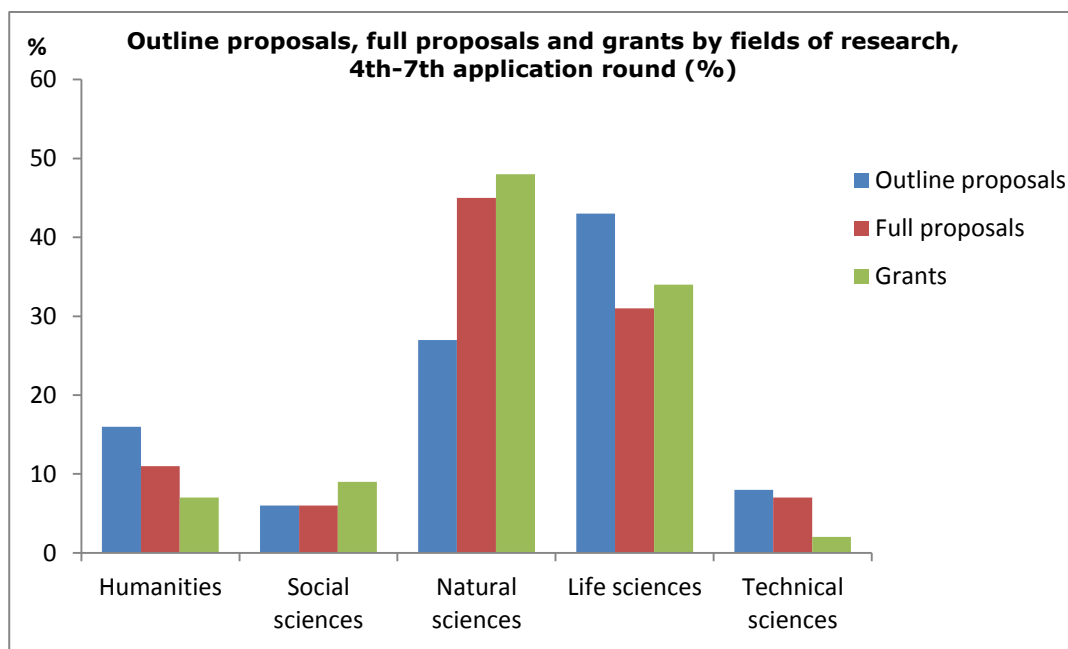
The DNRF conducts a short interview with each applicant (proposed center leader) prior to the final decision. During the interview, the applicant is asked to give a short presentation of the overall research idea and to elaborate on the strategy for realizing the idea. The remaining time is reserved for comments, questions and discussion with board members, who will ask such questions as:

1. How will the research center change the scientific field, and what kind of impact can be expected?
2. What are the great challenges and the corresponding high risk/high gain areas in the field?
3. Why is the proposed team the right one to address these challenges?
4. How will the proposed center leader make sure that the center will constitute a creative and inspiring scientific environment, in particular for its post-docs and Ph.D. students?
5. How will the center relate to similar efforts, nationally and internationally? In particular: Which groups are the main collaborators and/or competitors?

The interview helps board members get an impression of the applicant and the challenges of the research project. It also offers a chance for the board to observe the personal drive of the applicant. To ensure that the interview isn't overemphasized as compared to the actual proposal, each board member is asked to provide an ABCP grade for the submitted proposal *before* the interview.

## 2.6 Distribution on research areas

The Center of Excellence instrument has proved to function especially well relative to the natural sciences and life sciences, while remarkably fewer centers have been established within the humanities, the social sciences and the technical sciences. This pattern is also reflected in the distribution of proposals. There may be several reasons for this pattern, such as poor proposals, misunderstanding of the CoE concept or the board's inability to evaluate proposals consistently across fields.



The figure shows the share of five overall research areas of outline proposals, full proposals and grants. The majority of grants as well as proposals (both stages) lie within the natural sciences and life sciences. The figure also shows how proposals from the humanities, technical sciences and partly the life sciences tend to be less successful in the first stage (outline proposals) of the assessment and selection process.

## 2.7 Reflections

The foundation has consistently received positive feedback on its selection and assessment process from applicants – even from the less successful ones. Nevertheless, the board is continuously discussing the assessment model, analyzing its strengths and weaknesses. The idea of bringing in additional advice when assessing outline proposals was last discussed at the strategy meeting in June 2012. At this meeting, Dr. Steven Wooding from RAND Europe was invited to talk about the strengths and weaknesses of peer review, and he also offered an analysis of the DNRF model. In brief, he found the DNRF process to be very good, and he suggested that the foundation think carefully before adding more layers of peer review or significant additional complexities to the system.

So far, the board has not been able to devise an alternative model that would add positively to the process. When discussing a possible external evaluation in the first stage the board has voiced concerns in regard to the cost (in terms of money as well as time spent), the format of the proposals (five pages), and whether it would impede the funding of the more daring projects. Also, a concern with regard to the general overload internationally of the peer-review system has been raised.

In order to see how the board members' assessment would differ with or without input from external reviewers, an experiment was carried out when assessing proposals for Niels Bohr professorships in 2012. With only 13 proposals the board found it manageable to give preliminary A, B, C, P scores based on the applications only. After reading the reviews from the external experts, board members submitted another set of A, B, C, P scores, which were those used in the processing of the proposals. It turned out that the addition of the peer review changed only one position on the ranking list.

When assessing the full proposals and making the final decision, the board is assisted by experts from relevant fields, and a thorough and transparent peer review process is conducted.

The transparent process may entail that some reviews are not clearly formulated and criticism is suppressed, but in general the board finds that it has received reviews of a high quality and that most reviews provide helpful input. Even in a not-so-transparent process, external reviews may be of varying quality. The board has discussed whether the process would benefit from five external reviews instead of three. It concluded that the resources spent (time and money) and the possible overload of the peer review system does not match the possible improvement of the system.

Applicants are frequently surprised by some of the names external sources have suggested as reviewers of their applications. It is the board's experience that applicants attach much weight to reviewers with a central position in their fields, possessing great subject- or discipline-specific competences.

The interviews are seen as an opportunity to have a short dialogue with all the main applicants, and they function well as an update of the individual applications and also help board members get an impression of the center leader and the research challenges ahead. The board finds that it is reasonable to require that researchers at this level are able to present, briefly and clearly, the primary thoughts behind their research. Potential applicants are strongly encouraged to contact the secretariat during the application phase and information meetings are held at all universities when new calls are launched. When informed that either an outline proposal or a full proposal has been rejected, applicants are invited to contact the director for an elaboration of the reasons provided in the letter. The DNRF receives many inquiries about the application process and most rejected applicants take advantage of the opportunity for a dialogue with the director about the rejection. This may be why the foundation receives few formal complaints from applicants not funded.

Overall, the high degree of transparency is seen as augmenting the quality of the assessment and selection process. Still, the foundation recognizes that a peer review system can never be perfect. Therefore, it continually weighs the pros and cons of an open review process and remains open for feedback. The current law requires open reviews. It is crucial that the board be ensured the greatest possible scope for action so that peer reviews function as an input, but the authority to make decisions rests with the board alone. The foundation has learned that it is important to be aware of the kind of insight the external reviewers can be expected to deliver and what the board can manage by itself.

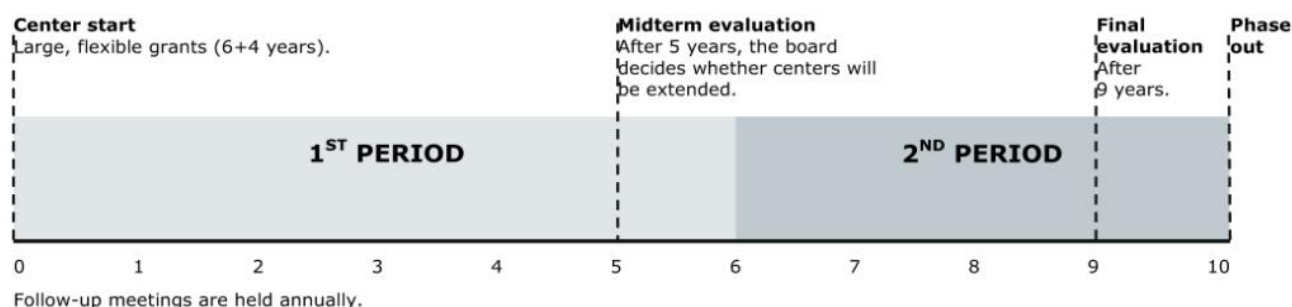


## 3 STRUCTURE OF THE FUNDING MECHANISM

Until 2009, centers were established for a five-year period with the possibility of an additional five years, provided the center received a favorable midterm evaluation and presented an ambitious research plan for the second period.

Starting with the 7<sup>th</sup> round of applications (2011), the DNRF decided to change this structure by extending the first period to six years while maintaining 10 years as the maximum length of a center's grant. By providing more time in the first period the foundation hopes to encourage the centers to take up major new challenges and venture into truly novel and scientifically daring projects that might lead to ground-breaking results. The various stages of a Center of Excellence are addressed in detail below.

### CoE Lifecycle



When the board has decided to fund a new center, the foundation and the center leader initiate negotiations with the host institution regarding co-financing, office and laboratory space, and plans for the center after support from the foundation ends and a formal contract between the foundation, the center leader and the host institution is drawn up (see "5. Standard Center Contract").

### 3.1 Center grants – DNRF funding

A CoE grant is large in terms of money as well as time compared to other Danish research grants. In the last application round, the average grant for a six-year period amounted to 53 million DKK. However, grant sizes vary considerably within the same application round, depending on the center's task and structure.

The grants are very flexible, and the foundation puts a large degree of trust in the center leader's ability to spend the money best. The center leader is charged with fulfilling the research plan. The center leader makes decisions on how to spend the funds and is responsible for following the center budget and for meeting any financial obligations vis-à-vis the host institution. In practice, the center leader decides on whom to hire and dismiss from the center. This freedom and flexibility allow center leaders to act immediately if, for example, they want to buy a new instrument, hire an excellent post-doc or invite a visiting professor, etc. However, the freedom is not unlimited; the foundation does keep an eye on how the grants are spent, and budgets and accounts are thoroughly revised annually.

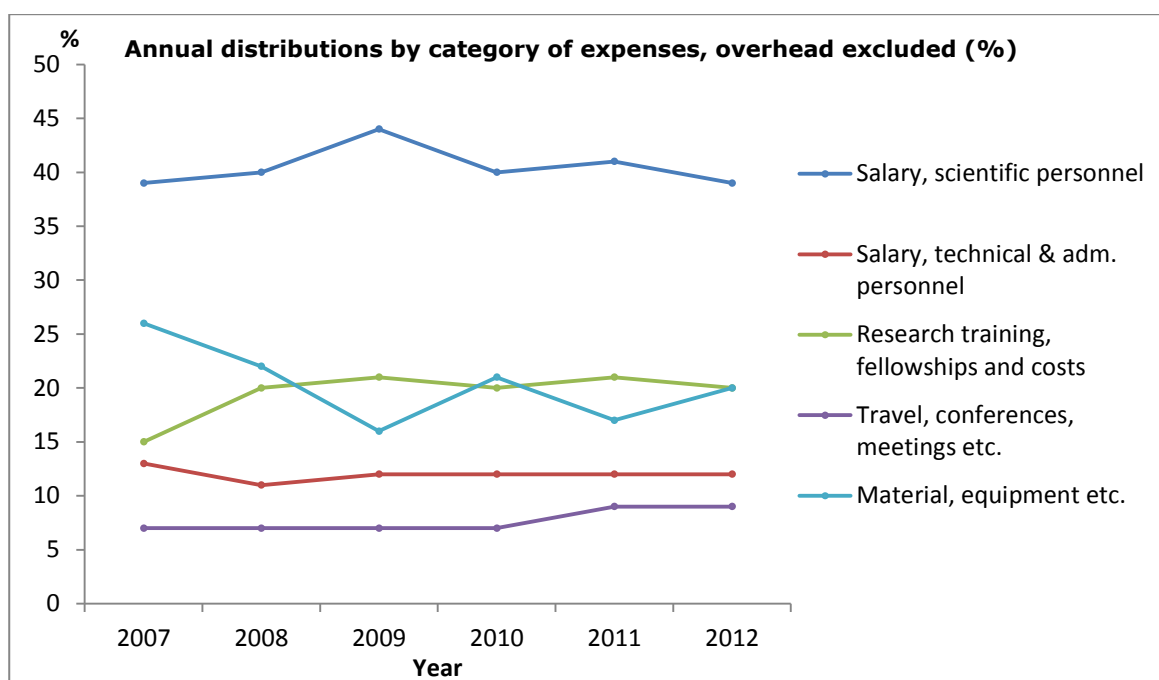
#### Grant size average, Centers of Excellence, current prices

	2004/05 4 <sup>th</sup> appl. Round**)	2006/07 5 <sup>th</sup> appl. round	2008/09 6 <sup>th</sup> appl. round	2011/12 7 <sup>th</sup> appl round.
First grant period, average, MDDK*)	<b>30</b>	<b>44</b>	<b>46</b>	<b>53</b>

\*) First grant periods were five year periods in 4-6<sup>th</sup> application round and six years in the 7<sup>th</sup> application round. Overhead percentage only 20 in 4<sup>th</sup> and 5<sup>th</sup> round but 44 in 6<sup>th</sup> and 7<sup>th</sup>.

\*\*) 2 of the grants of the 4<sup>th</sup> application round did not include an overhead.

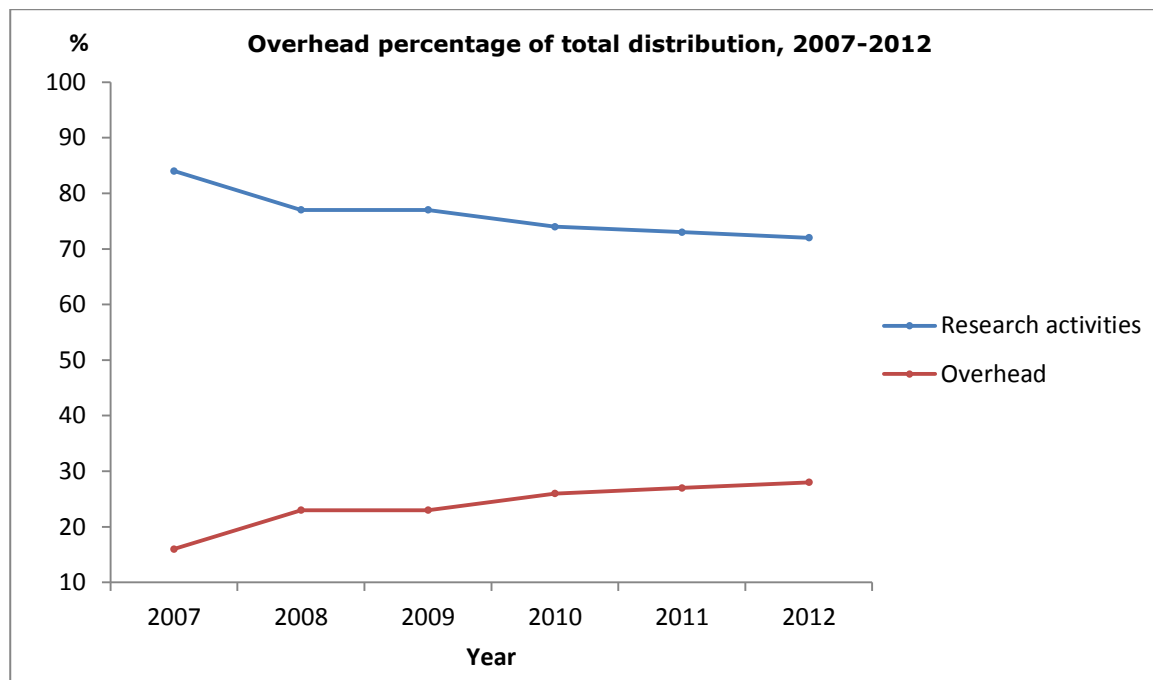
The funding from the DNRF is primarily used for salaries for temporarily hired staff (Ph.D. students and post-docs) and as the "glue" that keeps the center together (equipment, conferences, travels, etc.). The DNRF provides funds for the centers to hire an administrator/coordinator to assist and relieve the center leader of some of the administrative and coordination burdens. The DNRF strongly advises the centers to fill these positions.



The dark blue line primarily includes salaries for post-docs. Few persons in permanent positions are funded by the DNRF. However, the foundation does pay a task bonus to center leaders ranging from 107.000 to 142.000 DKK/yr. These bonuses are included in the blue line.

### 3.2 Overhead

The grant from the DNRF includes an overhead contribution to the host institution(s). Prior to 2008, the overhead rate was 20% of a grant; in 2008, this rate was augmented to 44%. This development appears in the chart below.



The figure shows how overhead's share of the total annual distributions has increased after the change in 2008, when overhead rates rose from 20% to 44%.

### 3.3 Host institutions' co-funding of centers

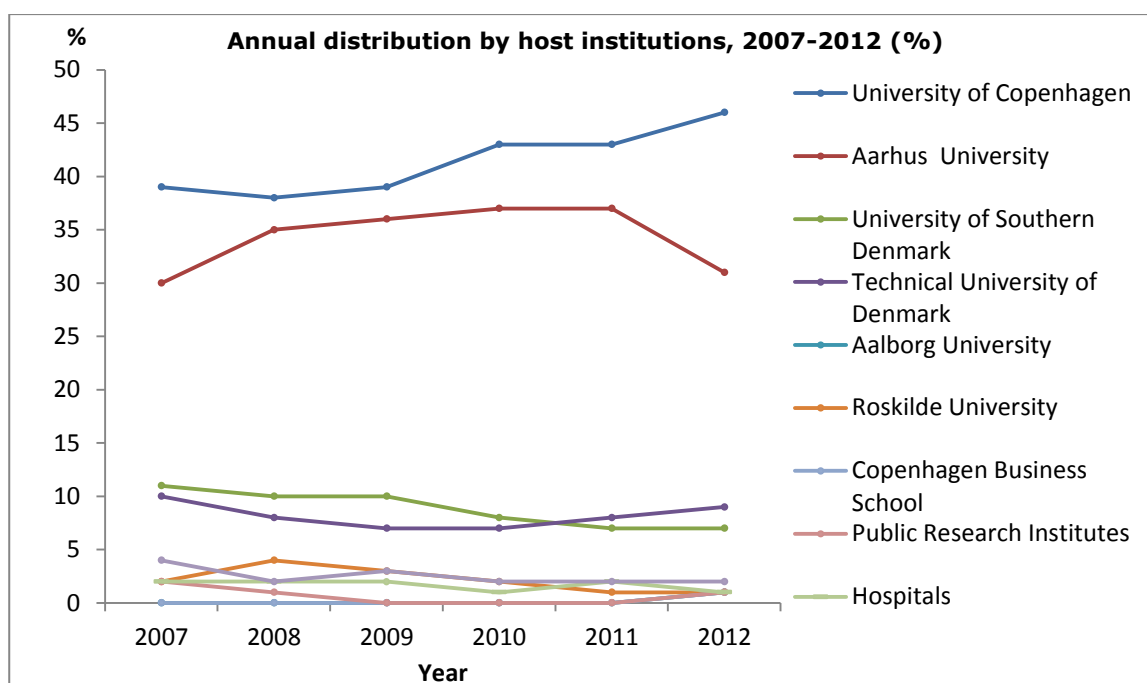
The host institutions are requested to co-fund the centers. This is mainly done by providing salaries for permanent staff. Co-funding from the host institutions is essential to the centers and accounted for 20%

of the total center budget for centers established in the 7<sup>th</sup>. application round. Contributions from the host institutions have decreased by almost a third from the 5<sup>th</sup> application round to the 6<sup>th</sup> and 7<sup>th</sup> rounds (see table below).

Very clear agreements regarding co-funding and later embedment of center activities are made with the host institutions right from the outset. These agreements include not only salaries for current staff members in permanent positions but may also include a commitment from the host institution of opening new positions within the center's area after close down.

The contract with the host institution also includes an appendix specifying how much space in terms of offices, laboratories and meeting facilities the centers will have as a minimum. This is an appendix that many centers have come to value over time, as restructuring of university departments and relocation in general are likely to happen over a ten-year period. With this appendix the foundation is well equipped to look after the center's best interest and to protect its investment in the center.

Centers are established at existing organizations, most frequently at universities. Some are hosted by hospitals or public research institutes, and only two have been hosted by non-public research organizations. More than 90% of the centers are hosted by the four biggest universities in Denmark. The University of Copenhagen and Aarhus University have been particularly successful in obtaining CoE grants.



The figure shows how the foundation's annual distributions are divided by host institutions, with more than 90% of the means distributed to the 4 largest institutions.

### 3.4 External funding

Additional funding from other external sources is substantial and has grown over the 10 years of funding from the DNRF.

#### Centers of Excellence by source of finance – first CoE grant period (%)

	<b>2004/05 4<sup>th</sup> appl. round</b>	<b>2006/07 5<sup>th</sup> appl. round</b>	<b>2008/09 6<sup>th</sup> appl. round</b>	<b>2011/12 7<sup>th</sup> appl. round</b>
<b>DNRF</b>	36	36	40	40
<b>Host institution</b>	28	28	20	20
<b>External funding</b>	36	36	40	40

The table shows the composition of the centers' funding during the first grant periods. The contribution from host institutions is declining. This can only to some extent be explained by the fact that host institutions' contributions no longer include expenses for rent. These expenses are now covered by the increased overhead.

Throughout the first grant period many centers have successfully attracted funding from other sources, and centers typically grow because of this funding. External funding includes funding from the Independent Research Councils (often for post-docs affiliated with the centers) and the Strategic Research Council or the Advanced Technology Foundation (if an idea or result from a center has a potential for commercialization). Private foundations also frequently support individual center members, instruments or a strand of the research within the center. It is worth noting that Denmark has the highest level of private funding for research in the world adjusted for population. ("16.5 The Danish Council for Research Policy, Annual Report 2007", "16.6 Private fonde – en unik aktør i dansk forskning, DEA 2012"). Many centers are successful in obtaining EU and other international grants. Researchers from DNRF Centers of Excellence have been awarded 17 of the 27 ERC advanced grants so far awarded to Danish researchers. Ten of the 40 ERC starting grants have been awarded to researchers associated or previously associated with a CoE. It is the foundation's impression that the prestige and quality associated with being awarded the status of a CoE is an important factor in helping the centers attract additional funding.

The ability to attract external funding varies across the disciplines. The two tables below show how much external funding centers are able to attract in the social sciences and humanities and in life sciences, natural sciences and technical sciences.

#### External funding compared to the grant from DNRF for CoEs within humanities and social sciences

<b>Year</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>
<b>DNRF (MDKK)</b>	4.6	5.4	4.6	5.0	6.5
<b>External funding (MDKK)</b>	1.1	2.0	2.4	2.0	3.4
<b>External funding %</b>	24	38	52	41	52

External funding to CoEs within humanities and social sciences equals in 2011 approximately 50% of the grant they receive from DNRF. The external funding has tripled in absolute numbers and doubled relative to the support from DNRF since 2007.

#### External funding compared to the grant from DNRF for CoEs within life sciences, natural sciences and technical sciences

<b>Year</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>
<b>DNRF (MDKK)</b>	6.0	8.7	6.9	8.6	7.8
<b>External funding (MDKK)</b>	6.1	7.9	8.9	9.5	9.8
<b>External funding %</b>	102	91	129	110	125

The external funding to COE's within natural sciences, life sciences and the technical sciences double the total funding available as compared to the grant received from the DNRF

### 3.5 Evaluation and monitoring

Centers are evaluated by international evaluation panels twice during the ten-year grant period. A mid-term evaluation is conducted after 5 years (previously 3½) and a final evaluation after 9 years. The foundation is continuously monitoring the center's performance through annual reports and annual follow-up meetings during which the foundation visits the center. These activities are described in detail below.

### 3.5.1 Midterm evaluation

With grant periods of five years, midterm evaluations are carried out after 3½ years for centers established in application rounds 1-6. For centers from the 7<sup>th</sup> application round and beyond, midterm evaluations will be conducted after five years.

For their evaluation, centers will be asked to submit a self-evaluation and an application for a second funding period. An international review panel evaluates the center and the review process includes a site visit to the center by the panel. When assessing the research quality the panels focus on three aspects: the choice of problem concerned, method/originality, and results. The review panels assess the publication activities, with an emphasis on the quality of the outlets in which research has been published, as well as what conferences, seminars, etc. have been held and initiated. In addition, factors such as organization, leadership, researcher education/training, and internationalization are taken into account to the extent that they are relevant. (See "10.1 Guidelines for Self-Evaluation Reports").

The panel spends a whole day visiting the center and the next day in the DNRF office drafting their evaluation report. As when assessing full proposals the centers are allowed to suggest one of the members of the review panel. (This counts for centers from the 5<sup>th</sup> application round and beyond). Centers are heard on the composition of the panel before the evaluation is initiated, and they have an opportunity to comment on the review report before the board decides whether or not to extend the center for a second grant period. The extension/prolongation rate has so far ranged between 55-93%. It should be noted that the CoEs may opt out from being extended. The foundation takes great care to secure the embedment of Ph.D. students and post-docs into the host institution in case centers are not prolonged or are suddenly closed owing to center leaders exiting before the expiration of the grant. For an overview of numbers of CoEs not receiving funding for the full 10 years, see the table below.

#### Centers of Excellence not receiving funding for the full 10 years

	Number of CoEs	Embedment as a result of center leader's exit before termination of contract	Embedment as a result of midterm evaluation
1992/93	23	0	7
1997/98	9	1	4
2001/02	12	2	1
2004/05	16	2	1
2006/07	8	1	0
2009/10	9	0	*
2011/12	11	0	*
<b>TOTAL</b>	<b>88</b>	<b>6</b>	<b>13</b>

The table above shows the number of CoEs that has been embedded owing either to the center leader's exit or to an unfavorable midterm evaluation.

In the course of the foundation's first midterm evaluation, it decided to let eight broadly assembled panels evaluate all 23 centers, while a model with specific panels for each center has been predominant in later midterm evaluations. Broader panels are less vulnerable to suspicion of bias or desires to further their own research area in the evaluation process, but they do not have the same capacity to perform in depth analysis of the research as more narrow panels have. Narrow panels, on the contrary, have – not least owing to the principle of complementarity that usually directs the assembling – the capacity to cover the subject matter both broadly and in depth. However, narrow panels are vulnerable to suspicion of bias and the desire to further their own area. The foundation avoids overlap between panel members from the original evaluation panel and the midterm evaluation panel, considering that 1) such panels would actually have to take their own original assessment into account, 2) it can be difficult to find the original reviews for all centers, and 3) there could be an unfortunate difference between the reviewers' original view of the applications in question, leading to a situation in which centers are treated unequally.

### **3.5.2 Final evaluation**

The evaluation of the 10-year centers is conducted about a year before the contract expires. This evaluation considers the research results given the period of time elapsed and the significance of the centers' performance (See "11.1 Guidelines for Self-Evaluation Reports"). Evaluations are carried out by three international experts individually selected for each center, and each reviewer submits an evaluation report. The final evaluation enjoys great legitimacy throughout the research community, and it is the foundation's impression that it influences the researcher's potential to obtain future funding. The board invites center leaders to give a presentation and subsequently take part in a discussion with the board about their experiences in being part of/running a DNRF center for 10 years.

### **3.5.3 Continuous monitoring**

Besides evaluating the centers after five and nine years, the foundation is continuously monitoring the performance of the centers. Each year in March, the centers submit annual accounts and reports for the previous year (See "9.1 Guidelines for Annual Reports and Appendices"). The annual reports consist of a short text in which research-related developments and results as well as changes in the center's organization are accounted for. In addition, the reports also include appendices that contain information on collaborative relations, dissemination and applicability, external financing, and changes in the center's size and organization, including the extent of foreign co-workers. In this way there is a great deal of convergence between the center's annual report and the data collected in connection with evaluations.

### **3.5.4 Annual follow-up meetings**

The foundation takes a keen interest in the development of the centers. The chair, one or two board members, the director and a research adviser visit each center annually at follow-up meetings. The meeting is divided into an open and a closed session. During the open session, all center members can participate. The dean and/or head of the department usually participate. In the closed session the DNRF representatives meet with a smaller group of center members (e.g., core members, PIs, the center coordinator). Normally the dean and/or head of the department also participate in this session, at which issues regarding the host institution or financial or administrative matters are addressed. The meetings also provide a possibility for an exclusive meeting between the center leader and the DNRF.

The centers prepare the agenda for follow-up meetings based on the foundation's standard agenda (See "8.1 Standard Agenda for Follow-up Meetings"). The points that the foundation generally wishes to discuss at follow-up meetings are the research, collaboration, external financing, dissemination and utilization of results, internationalization, researcher education/training, finances, any administrative issues, the center leader's appraisal of the center as a whole, and interaction with the host institution and the foundation, including any questions about embedment, etc. Over the course of a ten-year period the foundation conducts 3-4 separate meetings with the groups of Ph.D. students and post-docs/visiting researchers at the individual centers.

From year to year, specific topics are put on the agenda and discussed with all centers. In 2012, research integrity was such a topic, and the discussions with all centers led to the identification of some simple best-practice advice. In 2013, collaboration with an emphasis on non-academia collaboration is another special topic.

Minutes are recorded from the meetings, and board members who have attended a meeting will brief the board at subsequent board meetings. In case the board raises concerns or wants to further discuss a specific issue, the director will communicate this concern back to the center.

### **3.5.5 Dialogue with the centers**

Throughout the year, the foundation has a continuous dialogue with the center. A research adviser is appointed as a contact person for each center; this person maintains the continuous dialogue with the center.

The foundation issues the newsletter "DG\*Info" 3-4 times a year, addressing topics such as: new funding possibilities, new guidelines, news from the foundation – especially with regard to hot topics in the research policy debate, etc. The newsletter features a guest editorial by one of the DNRF grant holders. Currently, this newsletter is only sent to DNRF grant holders as well as present and former board members ("DG\*Info vol. 1-15"). The idea is that it should serve as an intimate channel for sharing relevant news and information within the "DNRF family."

The idea of creating a special, common DNRF identity is also cultivated at the annual meetings, at which all center leaders are expected to participate and where they have the opportunity to introduce themselves to each other and form networks. The meetings address different topics from year to year. Research management was chosen as the topic of the meeting in 2012. In 2011, the foundation's 20<sup>th</sup> anniversary was celebrated, and the Center of Excellence funding mechanism was the theme of the day. Before that, internationalization had been addressed. According to the topic, the group of attendees is expanded, and other relevant stakeholders from the research arena may be invited.

### **3.6 Reflections**

Placing centers at existing research institutions has proved to work very well. This provides an opportunity to use and exploit already existing infrastructure and facilities and thereby have the centers up and running soon after the contracts are signed. It also has a spillover effect to the host institutions in terms of educational activities and ongoing interaction with other research groups. Of the 43 currently running centers, 39 are located at a Danish university. Judging from the universities websites and similar media, it appears the centers have a positive branding effect on the universities, and that the universities benefit from the results and impact of the centers not only in international rankings but also when part of the basic funding for the universities is distributed.

Taking into account that the center grant covers a limited period (up to ten years), the location at universities makes it easier to embed and integrate the center activities at the universities when the DNRF grant expires. This is a process further facilitated by the contracts. By addressing how research activities within the center's research area are continued when funding from the DNRF expires, embedment issues are less dramatic. The DNRF is willing to extend the grant period by 6-12 months if it facilitates the embedment efforts. Nevertheless, centers are certainly hunting for new funding possibilities when the expiration date comes close, and many centers might advocate the idea of a third funding period.

The discussion of a possible third funding period surfaces frequently. So far, the foundation has found it important to maintain that center grants are large and long term but not permanent. The grants should make it possible to take up new and ambitious research questions – also such big endeavors that demand a considerable amount of time and resources. However, by limiting the funding periods, a certain dynamic and freshening is possible, allowing new questions to be addressed and new people to participate.

The size of the DNRF center grants has varied over time. The first grants were very large and left huge gaps with little focus on embedment when the DNRF funding expired. Acknowledging this problem, the foundation took the initiative to make co-funding and agreements with the host institutions part of the formal contract from 2001 onwards. The issue of embedment was pointed out as a concern in the last evaluation of the foundation in 2003 (See "2. 2003 Evaluation Report and Recommendations"). Having already identified the issue, the foundation appreciated the advice from the 2003 evaluation report and is pleased to observe that since the 2001-initiative the previous issues with embedment have been almost eliminated.

The board finds that the grant size in the fourth application round was too small. A more adequate level has been reached from the 5<sup>th</sup> application round and beyond.

With the increase of the overhead rate from 20% in the mid-1990s to 44% in 2008, the foundation has as part of the contract negotiation put more focus on the expectation of the basic facilities at the universities.

Centers succeed to a high degree in attracting additional funding from other external sources. This is probably because the centers create dynamic and generous intellectual environments attracting new and excellent people and ideas worth funding.

The board expects that the change of the structure from a 5+5 model to a 6+4 model will improve the possibility for centers to venture into truly novel and scientifically daring projects that might lead to groundbreaking results. However, some risk of failure may be associated with such ventures, and perhaps it can be expected that fewer centers will be continued after the first 6 years as compared to the previous 5+5 model. The board's decision to not extend a center normally considers on-going commitments, and so the phase-out may run for a couple of years.

When assessing centers in the midterm evaluation, the board wants to continue centers that not only have been extremely successful in their first grant period but also are expected to continue to be very successful and to continue to pursue new questions and results.

The board values the close and running dialogue it has with the centers and thinks that this direct contact and knowledge of each individual center is one of the strengths of the format of the CoE instrument. Although it demands a lot of time and effort from board members, the board is very pleased with the follow-up meeting system, which provides an opportunity to give advice or make adjustments if things go awry and at the same time gives an insight into how the funding mechanism works and is best applied in different environments.

The follow-up meetings are of value not only to the foundation but also to the centers. They get advice from experienced board members, and they can use these follow-up meetings as an occasion to produce a status report and to formulate and present their grand objectives. Also, follow-up meetings engage the entire center and thereby strengthen the center's identity and cohesiveness.



## 4 ORGANIZATION OF THE CENTERS

Centers are established as relative autonomous units at the host institutions. The center leader is the authority on the implementation of the grant according to the research plan. This gives considerable flexibility for the organizational structure of the center and a higher freedom and independence than most of the surroundings. Even so, most centers are well integrated into the host-departments and interact with the surroundings. For example, they conduct courses for undergraduate students and host international conferences, etc. Many center members are faculty members who only devote part of their time to center activities. The foundation encourages centers to interact with their surroundings. In particular, the foundation expects research and new results from the center to spill over to the host environment and that knowledge generated in the centers will be transferred to the next generation of students. Hence, center members are expected to actively participate in educational activities.

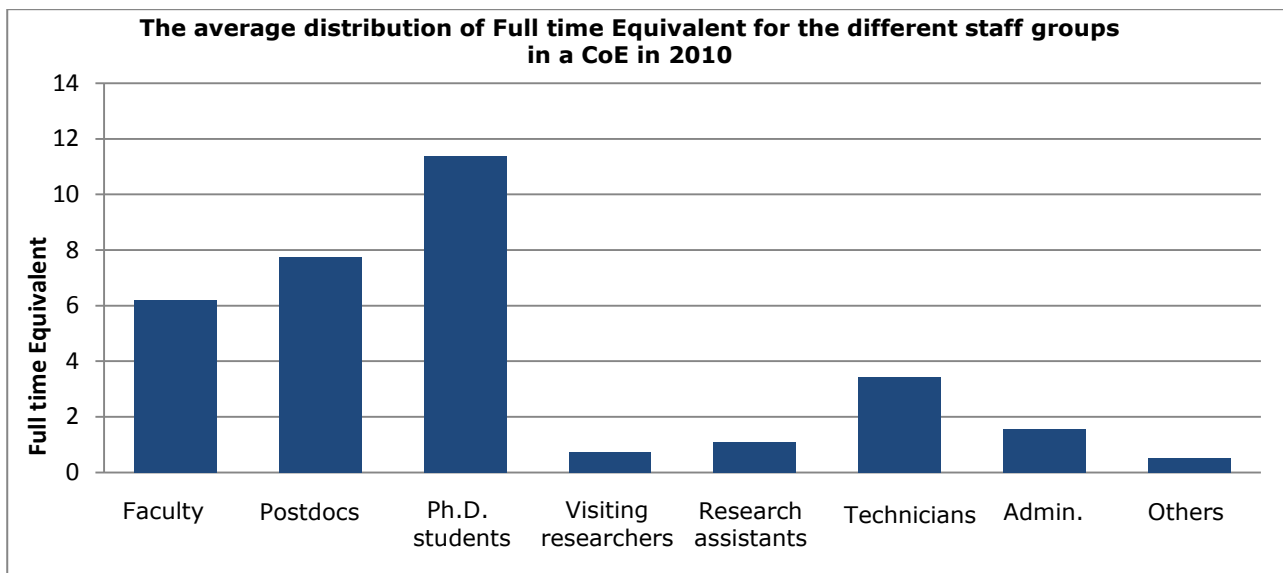
The foundation expects the centers to develop what could be called a certain center identity. This is not a question of fancy logos and merchandise (although both are welcome) but more about generating their own identities and cultures. Successful centers are characterized by being vibrant and focused environments, where interaction between center members across generations, research areas and nationalities is easy. Joint physical facilities encourage such interaction and are therefore expected unless special circumstances justify otherwise. The same can be said for the way the center is managed and organized, e.g., by having regular Monday meetings, Friday seminars, journal clubs, Ph.D. clubs and annual retreats or other activities for center members to meet regularly and discuss research topics as well as the grand objectives.

### 4.1 The people in the centers

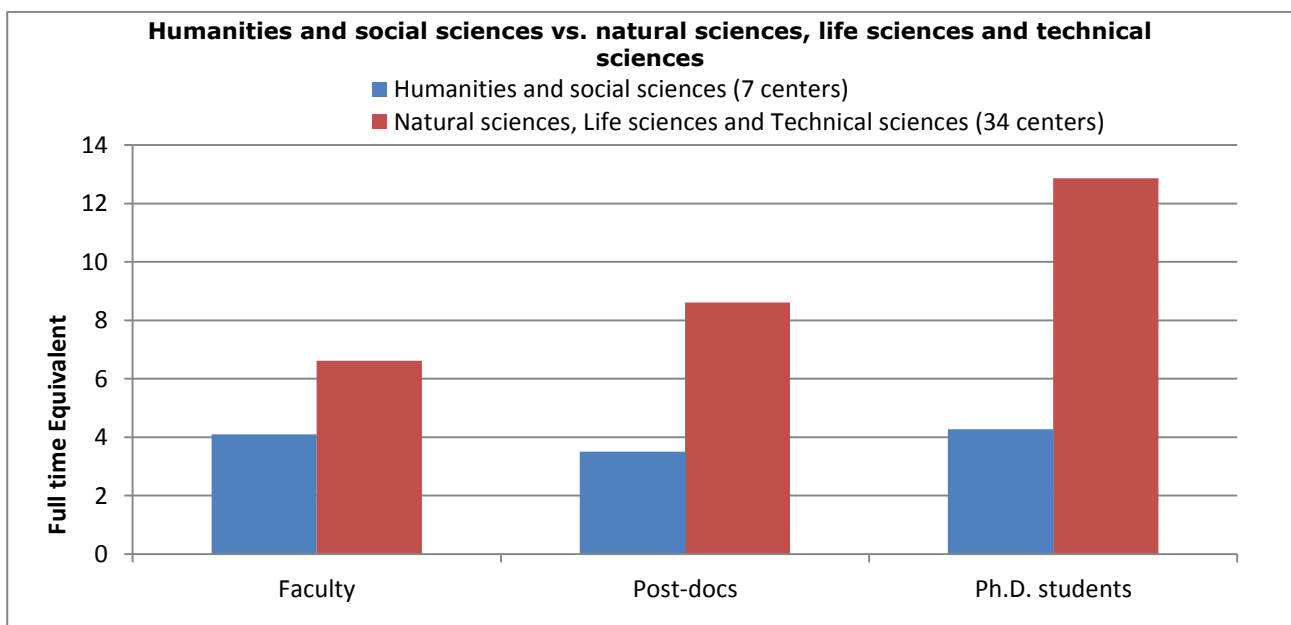
The centers differ in size and organization, depending on their subject and scope. Some centers have big laboratories and instruments and a need for many Ph.D. students and lab technicians, etc., while others by nature are smaller and don't require as many resources. Some centers become rather large during the grant period, employing more than 60 people divided into several research teams, while others have fewer than 15 members. Some centers set up formal advisory boards, while others do not.

Nevertheless, there are some common characteristics about how centers are organized. The center leader is the director of the center. In some of the larger centers, the research takes place in subgroups headed by senior PIs. At such large centers, a management board consisting of senior PIs is often established. At the annual follow-up meeting the foundation assess the cohesion and explores whether the center has clear grand objectives, or if the center acts more as an umbrella for a number of independent research laboratories?

Most of the centers consist of a rather small group of faculty, a larger group of post-docs and an even more numerous group of Ph.D. students. Also, administrative and technical staff members are part of the centers. The figure below shows the distribution of different staff groups in 2010.



On average, the ratio between faculty members and Ph.D. students is 1:2. However, within the humanities and the social sciences, the relation is 1:1.



For the humanities and social sciences it is seen that the ratio faculty/Ph.D. is approx. 1:1, unlike in the natural sciences, life sciences and technical sciences where the ratio is 1:2. "Part of this is explained by the fact that more Ph.D. grants are available within the latter than the former.

The composition of staff members may change throughout a center's lifetime. The table below shows how centers evolve over time.

**Development for the different staff groups in a CoE through a 10-year period**

FtE for:	Year					
	1	3	5	7	9	10
No. of centers	9	7	15	10	10	8
Faculty members	4.9	7.0	6.4	7.2	6.6	7.9
Post-docs	7.7	11.5	7.8	6.2	5.1	5.7
Ph.D. students	11.1	16.9	10.4	12.4	9.3	10.3
Visit. researchers	1.2	0.2	0.5	1.3	1.0	2.1
Research assist.	0.7	0.7	1.5	0.7	1.1	1.4
TAP	1.7	4.5	3.2	5.1	4.7	6.3
Administration	1.6	1.8	1.3	1.4	1.7	1.6
Others	0.1	0.3	1.0	0.5	0.3	0.1

Year 1 is the average of 6<sup>th</sup> round's centers. Year 3 is the average of 5<sup>th</sup> round's centers. Year 5 is the average of 4<sup>th</sup> round's centers. Year 7, 9 and 10 is the average of 3<sup>rd</sup> round's centers. FtE: Full time equivalent.

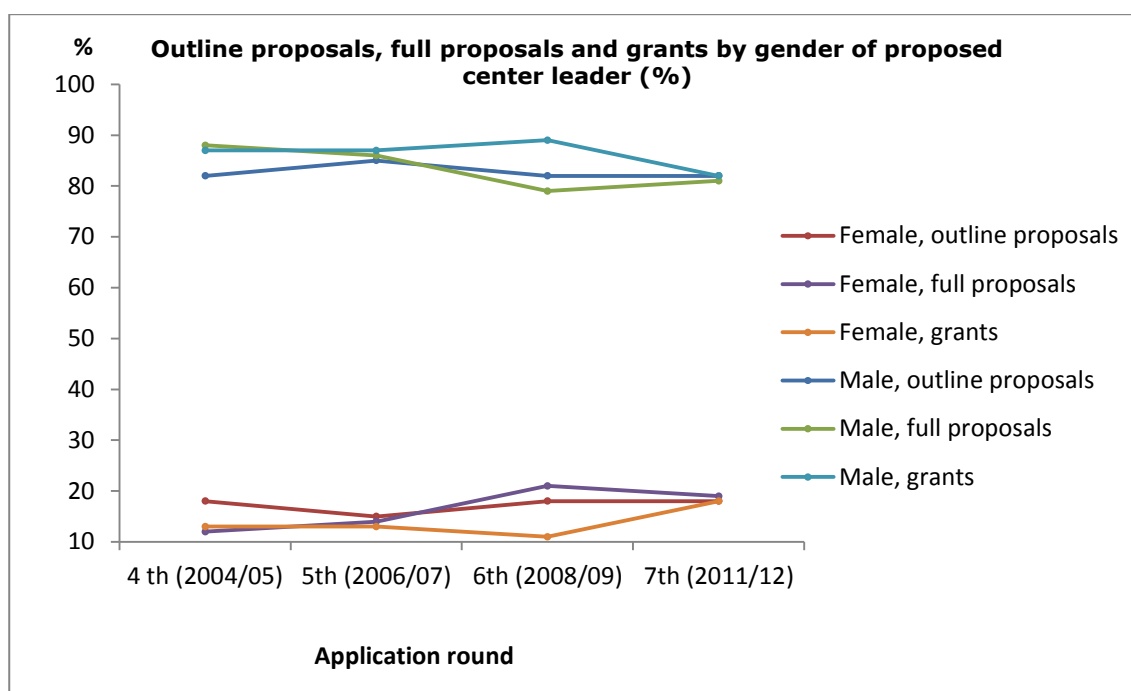
Assuming that the centers in the application rounds 3, 4 and 5 have similar behavior over time with respect to development in staff groups the table suggests that centers grow during the 10 years and that the foundation's strategy in terms of embedment and opening of new positions as agreed in the contracts is working. In the center contract, the host institution commits itself to new faculty positions with an average of one per center during the first five years and one during the last five years. This is shown in the table. The Center of Excellence funding instrument appears to have a strong effect on TAP positions. This is probably due to the fact that large laboratories are built up over the 10-year period.

## 4.2 The center leader

When assessing proposals for new centers, the foundation places a great deal of emphasis on the people – especially the imminent center leader – behind the proposal. The foundation has adopted the saying, *People, not projects*. And the proposed center leader must convince the board that he or she is not only an excellent and outstanding researcher but also a visionary leader capable of fostering a creative and dynamic research environment, someone who can build the right team and inspire others to deliver their best performance.

### 4.2.1 Gender

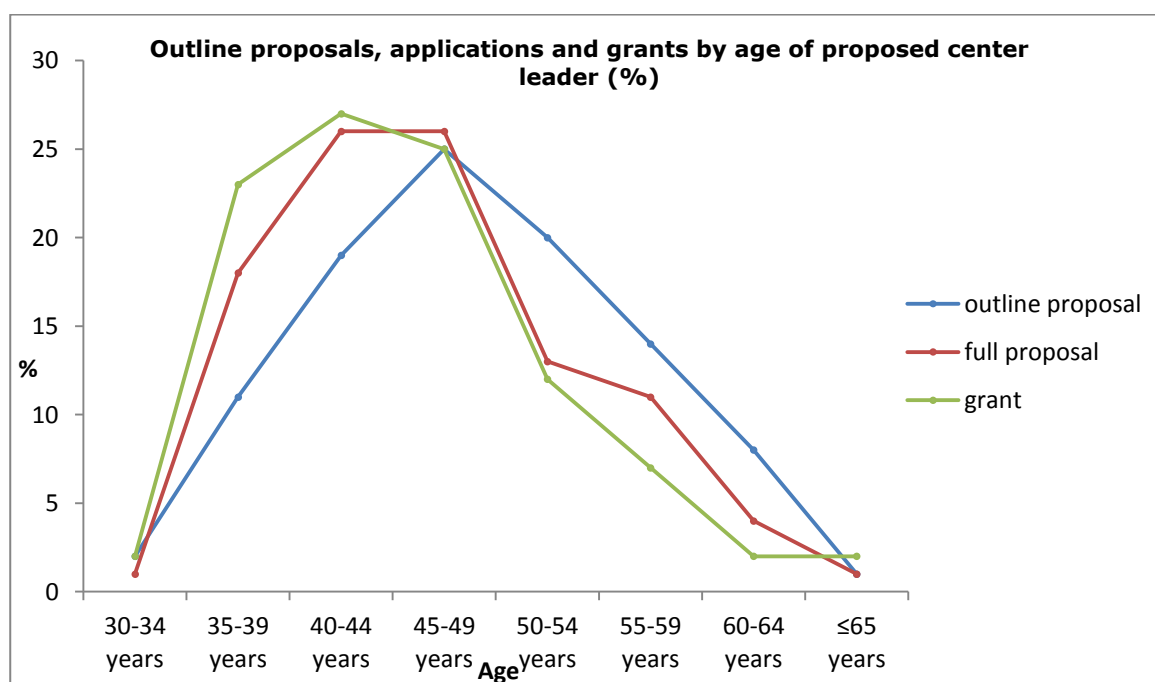
Among the center leaders, 85% are men. This matches an unfortunate but well-known pattern in Danish research environments where only 16% of all professorships at Danish universities in 2011 were held by female researchers (See "16.4 Køn og forskning i det Frie Forskningsråd, DFF, 2013"). The board welcomes excellent proposals that may lead to new centers led by women. The table below shows the gender distribution of outline proposals, full proposals and grants in the last four application rounds.



The number of outline proposals headed by female researchers remains stable at around 17% during the four application rounds, whereas the number of outline proposals headed by women that the board has invited to submit a full application has increased from rounds 4/5 to rounds 6/7.

#### 4.2.2 Age

The foundation does not apply any age criteria. However, because a center is likely to be funded for 10 years, the center leader should from the start expect his or her scientific career to flourish for at least another 10 years. Looking at the actual age distribution of selected center leaders so far, the average age for a center leader is about 45 years at the center's start, compared to an average age of 48 for the PI in the outline proposal.



The figure shows the age of the proposed center leader behind outline proposals (blue), full proposals (red) and new center leaders at the start of the center (green). Younger proposed center leaders seem to be more successful; this could indicate that originality and bold ideas are more common among younger people. The chart is based on data from the 4<sup>th</sup> to the 7<sup>th</sup> application rounds.

#### 4.2.3 Managing a center

The board finds that research management is of pivotal significance. As stated above, the center leader needs to be not just an outstanding researcher but also a visionary leader. The questions constituting the basis for scientific inquiry are becoming increasingly complex and are placing rapidly growing demands on the scientific community for interdisciplinary collaboration. Consequently, research groups are more than ever composed of people with different backgrounds. Achieving exceptional results in a Center of Excellence rests on good leadership, but managing a center is a challenge for the majority of researchers.

Since 2007 the foundation has offered tailor-made courses in research management for center leaders. The courses offer inspiration and advice on how best to handle difficult situations and how to develop a strategic approach to management; they provide a forum for center leaders to exchange experiences and inspire one another. Research management is also a recurring theme for annual meetings between center leaders and the board. Besides the courses on research management, additional seminars on outreach and communication are arranged for the center leaders. The courses are well attended and appreciated by the center leaders.

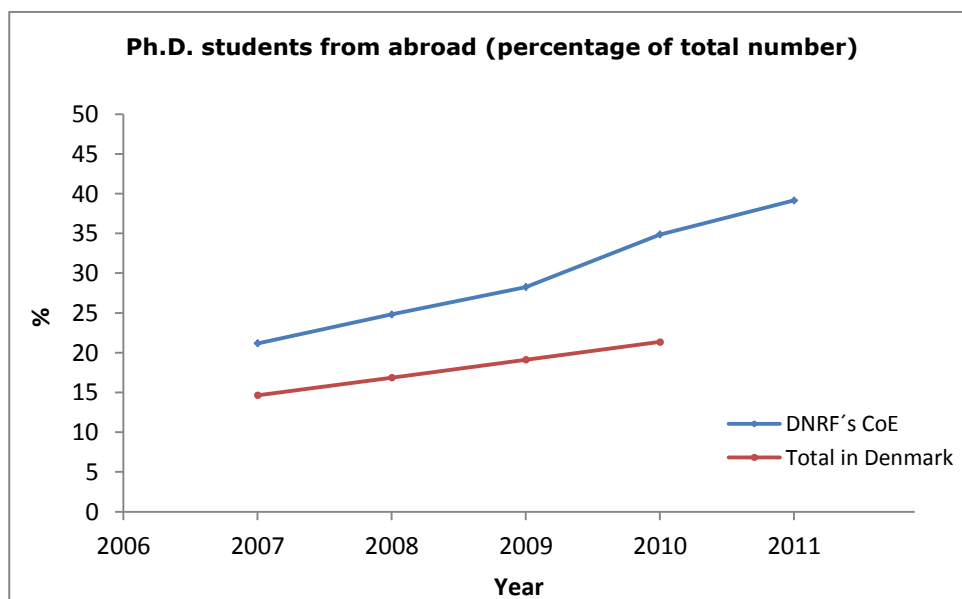
When heading a center, leaders find that many organizational burdens and administrative tasks are added to their workload. Many of these tasks are necessary, but the foundation strongly advises center leaders to hire a center coordinator or get some administrative assistance. An administrative assistant may not be able to take over all of the organizational issues, and most center leaders come to realize that they spend more hours acting as a director than doing actual research.

#### 4.3 Research training

Centers are dynamic, creative, and internationally oriented research environments, and therefore they provide an optimal setting for training the next generation of first-rate researchers. The foundation considers it highly important that research training and the seedbed play a key role in the centers.

In total, 649 Ph.D. students were affiliated with a DNRF CoE in 2011, funded partly by CoEs and partly by additional funding attracted to CoEs. This corresponds to 8% of all Ph.D. students in Denmark. This is quite an impressive amount, considering that the DNRF only allocates approximately 2% of all public research funds

A large proportion (35%) of the Ph.D. students is recruited from abroad. This indicates how attractive the centers are regarded by international students. It is the foundation's experience that foreign Ph.D. students are a real boon for the centers. Their commitment and desire to be at these centers provide a great inspiration to other center members.



The number of foreign Ph.D. students in the centers exceeds the national average.

#### **4.3.1 Meetings with the Ph.D. students**

Approximately every second year, during the follow-up meetings, the DNRF holds separate meetings with the Ph.D. students, discussing issues such as: What defines Ph.D. life in a CoE? And what are the students' future career plans? ("8.2 Questions for Ph.D. Students at Follow-up Meetings"). In general, Ph.D. students seem happy and motivated with their own research, and most feel that they have very good conditions with easy access to their supervisors, data, knowledge exchange, publications, etc. Depending on the research area some feel pressed for time owing to extensive fieldwork, experiments, etc., and some feel the teaching burden is overwhelming. The teaching obligation varies among the centers; some Ph.D. students teach too much and feel they are exploited as cheap labor, while others don't teach at all. Most Ph.D. candidates agree that teaching experience is a plus on their CVs. At many centers the Ph.D. students are not too satisfied with the number of relevant Ph.D. courses. One thing often wished for is better career counseling from the university. Such advice is most often provided by senior center colleagues. The DNRF has communicated these views from the group of Ph.D. students to their center leaders and to relevant stakeholders, such as Universities Denmark.

#### **4.3.2 Where do the Ph.D. graduates go?**

Asked about their future career plans, more than half of the students wish to continue within academia. This matches information gained from midterm evaluations and final evaluations where the centers are asked to provide information on where their students have gone after finalizing their Ph.D.s.

Among the Ph.D. graduates who are trained at a center, 230 (68%) continued in universities or the public sector compared to a national average of 63%. Looking at the group that stayed in academia, 61% remained in Denmark, while the rest went abroad. An overview of where the Ph.D.s have continued their careers is shown in the appendix p. 29-30.

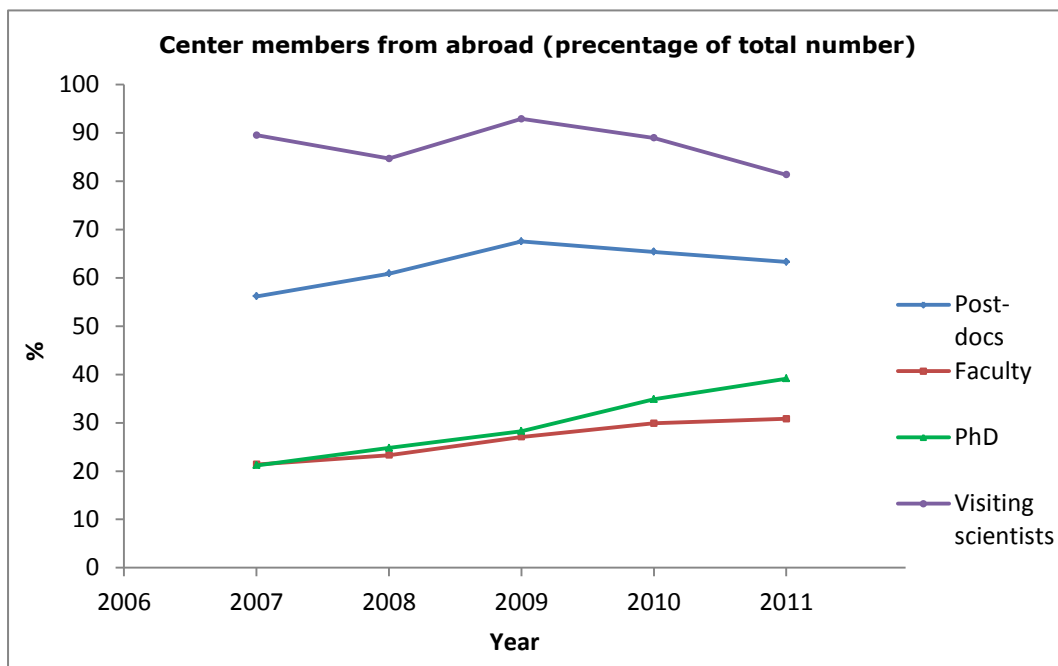
#### **4.3.3. Post-docs**

Post-docs constitute another important group of center members. In 2011 a total of 463 post-docs were affiliated with the centers, corresponding to more than 15% of all post-docs in Denmark that year. More than 60% of these were recruited from abroad. As with the Ph.D. students, foreign post-docs also create a good dynamic and are seen as a source of inspiration at the centers. The DNRF also holds separate meetings with the post-docs when visiting the centers ("8.2 Questions for Post-docs at Follow-up Meetings"). Asked about their future career plans, many said that they would like to stay in Denmark, but there are few permanent positions open and most continue to new positions abroad after leaving. Based on data from midterm evaluations and final evaluations we see that most of the post-docs continue their careers in academia after leaving the centers.

About a third of the post-docs have remained at Danish universities, while the rest have gone abroad, chiefly to the US, Germany, the UK and Sweden. A list showing where post-docs formerly affiliated with a DNRF center have continued their careers is provided in the appendix (See appendix p. 27-28).

#### **4.4. Internationalization**

Centers of Excellence attract a larger number of foreign researchers than the national average. As shown above, the centers are highly capable of attracting Ph.D. students and post-docs from around the world. Quite a large number of center leaders and faculty staff are also recruited from abroad.



Centers are to a large degree very international environments. Approximately a third of faculty members (professors, associated professors) were foreigners in 2011. More than 60% of all post-docs and almost 40 % of the Ph.D. students were from abroad.

#### 4.5. Collaborations

With the goal of establishing themselves as major international players in their fields, the Centers of Excellence are necessarily oriented toward the international research community and hence they collaborate extensively with researchers abroad.

In 2011, the centers collaborated with 1,619 researchers at foreign institutions and with 47 foreign companies.



The map shows the locations of the 1,619 researchers at foreign institutions that CoE's collaborated with in 2011.

The map shows the approximately 1,600 collaborations between centers and foreign universities and centers and foreign industries in 2011. The dots represent many kinds of collaboration. Some are formalized to a considerable extent, in which groups at foreign universities are actual members of the DNRF

centers; other collaborations include joint Ph.D. programs, exchange of Ph.D. students or joint projects reflected in co-authored papers, etc.

#### **4.6 Reflections**

We believe that the large degree of freedom, the flexibility and the autonomy are key factors of the centers' success. Centers should demonstrate a clear center identity in harmony with the host institution.

The center grants should be large, but not necessarily of the same size. There are different modes of organization and different needs for resources, depending on discipline and objectives. However, it is important that grants be of a size that makes it possible to create an environment with critical mass for excellent research and research education.

By expecting so much from the center leader – both with regard to the ability to deliver new knowledge and to create a strong research environment – the foundation may worry that leading a large organization such as a Center of Excellence may harm the center leader's scientific impact. There is no doubt, becoming a center leader adds to the workload of most researchers. The research management courses have been set up in order to supply center leaders with some tools and, at the same time, to provide a platform for them to address some of the challenges they share. The board pays a lot of attention to how new centers organize themselves, and even in the application phase, prospective center leaders are encouraged to think about a management structure that will facilitate the creation of a strong environment. Center grants also cover administrative staff, and center leaders are advised to specify the competences of a potential center coordinator: Should this person have specific insight into the research area? Or does the center leader need someone who can deal more with administrative matters. However, no administrative or management set-up can exempt the center leader from managerial tasks. In addition, it is difficult to imagine a successful center not being led by an outstanding researcher.

The centers function as hubs for exceptional research. They attract people from around the world: both for positions as Ph.D. students or post-docs/faculty and as collaborators. The passion and commitment that drive a person who is willing to leave a safe environment and travel around the world to pursue his or her research interest in a Danish Center of Excellence may be very "contagious" and may contribute to the creation of a thriving and dynamic research environment.

Many of the Ph.D. students will not continue their careers at the centers – at least not immediately after getting their degrees. But they will continue to act as ambassadors and to find networking opportunities for the center, regardless of whether the Ph.D. candidate pursues a career in industry or in academia, either in Denmark or abroad. This applies even more to post-docs.

The centers are, to a large degree, international environments. Approximately a third of faculty members (see appendix p. 33) were foreigners in 2011. More than 60% of all post-docs and almost 40% of Ph.D. students were from abroad. In addition, the centers collaborate extensively with other research centers around the world, creating a vibrant international atmosphere. The ability to recruit researchers from abroad might be regarded as an indication that a center is pursuing excellent and exciting research. Other researchers in a given field are the first and the best to assess the results and potential of a research center. Moreover, people's readiness to move great distances to participate is in itself an expression of the interest the center sparks in the world around it. The same can be said for collaborations with partners abroad at research institutions with a global reputation.

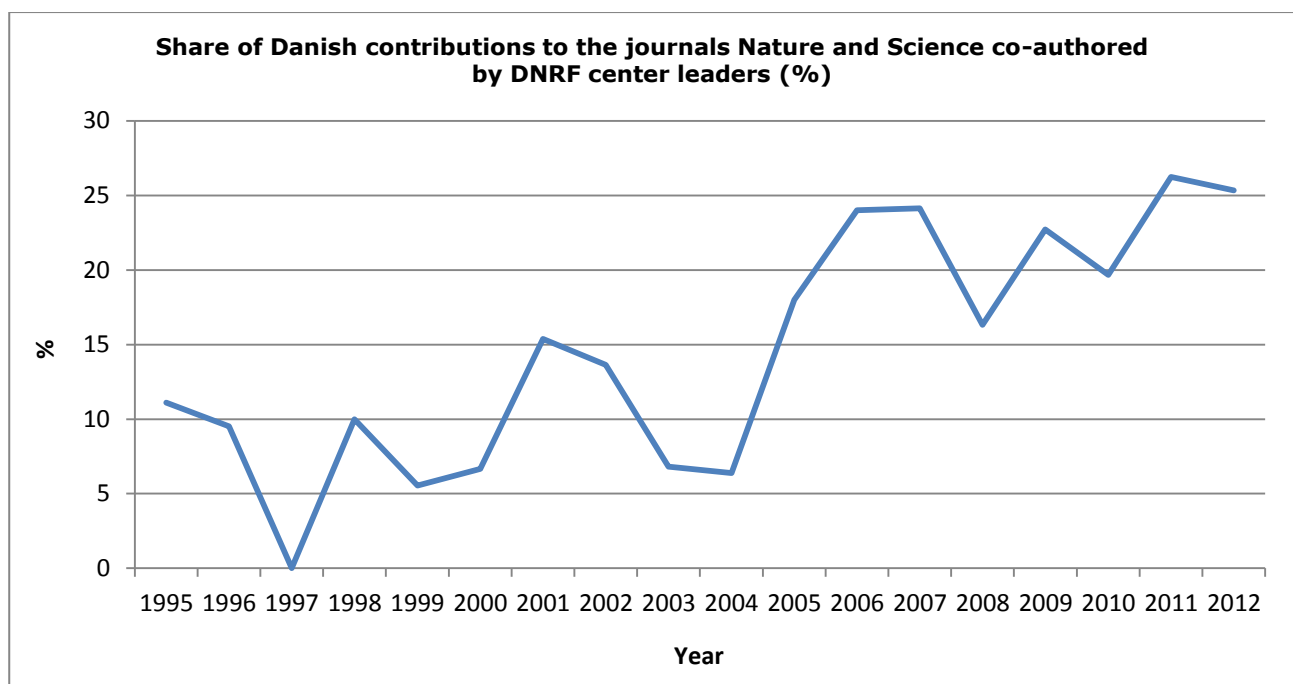


## 5 RESEARCH QUALITY AND IMPACT OF CENTERS OF EXCELLENCE

Assessing research quality and impact is notoriously difficult. As illustrated below the foundation has experimented with simple bibliometric studies and analyses trying to demonstrate a DNRF CoE's effect. However, in-depth biometric analysis has not been pursued and the foundation awaits with interest the outcome of the bibliometric analysis of Danish research that the Ministry of Science, Innovation and Higher Education has commissioned as part of this evaluation of the foundation.

One rather simple analysis the foundation has carried out concerns the number of articles authored or coauthored by center leaders and published in prestigious journals such as *Nature* and *Science* compared with all Danish articles in these journals.

The figure below shows that the share of Danish contributions to the journals *Nature* and *Science* (in %) that are co-authored by DNRF center leaders has increased from about 5% in the mid-1990s to more than 20% at the end of the first decade of the 2000s. During the same period, the total number of *Nature* and *Science* publications from Danish research institutions has more than doubled.



The figure shows that the share of contributions from researchers affiliated with Danish institutions to the journals *Nature* and *Science* (in %) that are co-authored by DNRF center leaders has increased from about 5% in the mid-1990s to about 25% in 2012. During the same period, the total number of *Nature* and *Science* publications from Danish research institutions has more than doubled. The publications involved cover the period from the year when each of the centers started to one year after the funding period ended for each center.

The DNRF greatly relies on peer reviews when conducting midterm and final evaluations. The continuous monitoring and interaction with the centers provide the board with a constant feel for the quality of the centers. The follow-up meetings have in some cases informed the board that changes were needed in a center, and if such changes aren't implemented as requested, the foundation has renegotiated the contract and asked for a revised research plan.

### 5.1 Peer-reviewed assessments

In the 2009 midterm evaluation of the 16 centers from the fourth application round, 14 centers were extended. As part of this evaluation process the peer reviewers of the 14 successful centers were asked to assess whether the center they had evaluated ranked in the top 5, 10, 20% or below globally within their respective research fields. Five of the centers were ranked in the top 5 globally, while all the other centers were ranked in the top 10. The reviewers' ranking of CoEs is shown in the table below:

	<b>CoEs</b>	<b>CoEs %</b>
Top 5%	5	36
Top 10%	9	64
Top 20%	0	0
Below top 20%	0	0
<b>Total</b>	<b>14</b>	<b>100</b>

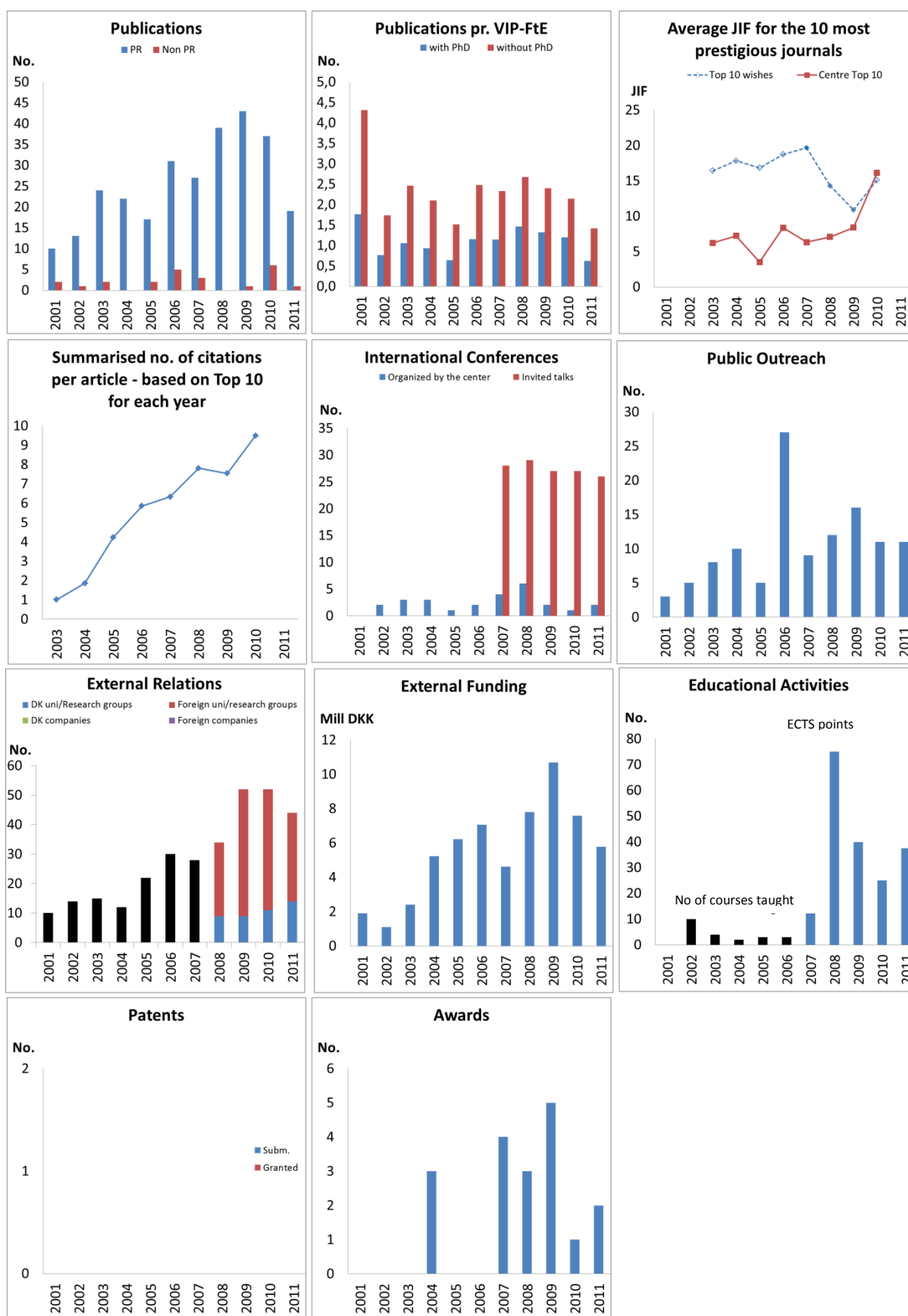
This assessment confirms and further qualifies a finding of the international panel that evaluated the foundation in 2003. That panel concluded, based on an assessment of the first 16 centers that had completed a 10-year grant period, that about a quarter of the centers had achieved distinction as world leaders in their respective fields.

### 5.2 Continuous monitoring, diverse indicators

The data collected with the annual reports form the basis of an analytical instrument that provides an overview of each center's development over time as well as the center instrument's overall effect. At the annual follow-up meetings, the foundation shares these data with the center leaders in order to understand the reality behind the data and to ensure a proper interpretation of the data collected.

As part of the annual reporting, centers have to submit a full publication list that includes all authors dating to the centers' start. In addition, centers are asked to list the 10 most prestigious publication channels within their research areas as an indication of where the centers find it most prestigious for them to publish. The secretariat then compares the Journal Impact Factor of the top 10 publication sources listed with the 10 papers from the center that have been published in journals with the highest impact. The foundation uses this as an indication of the ambition and actual performance of the center and how it develops over time.

As an example, data collected from the annual reports of one CoE are provided below. In addition to this data sheet, data on the composition of the staff groupings of each center have also been compiled.



Data collected as part of the annual reporting. In 2007 the foundation revised the structure for the requested data. This is reflected in the figure for external relations, international conferences, and educational activity

### 5.3 Prizes and awards

Prizes, awards and grants may be seen as another indication of the quality of the research. In Denmark, the EliteForsk prize is a prestigious recognition awarded to excellent researchers younger than 45 years. The first prizes were awarded in 2007, and so far, DNRF key researchers have received more than half of all EliteForsk prizes (20 out of 36 prizes).

Center leaders have also received numerous other prestigious national and international academic prizes and recognitions.

The European Research Council (ERC) and the DNRF share some of the same values and ambitions. ERC grants are awarded following a fierce competition and thorough assessment and selection procedures. To date, Denmark has received a total of 40 starting grants, 10 of which have been awarded to researchers associated with DNRF Centers of Excellence.

So far, 29 Danish researchers have been awarded prestigious ERC advanced grants. Seventeen of these grant holders received their ERC advanced grant after they became affiliated with a DNRF Center of Excellence. An additional two ERC advanced grants are held by two DNRF grantees of the Sino-Danish research centers.

#### ERC Advanced Grants

	2008	2009	2010	2011	2012
DNRF CoE	1	2	3	5	1
DNRF post CoE	1	1	1		2
DNRF other				2	
Others (Non-DNRF)	2			2	6
<b>TOTAL Denmark</b>	<b>4</b>	<b>3</b>	<b>4</b>	<b>9</b>	<b>9</b>

Statistics from the last ERC competitions show that Denmark is within the top three countries for attracting ERC grants when adjusted for population. For advanced grants, Denmark is number 2.

### 5.4 Impact on graduate and undergraduate education

Over their lifetime, centers engage to an increasing extent in educational activities at the host institutions, both at the graduate and the undergraduate level. Some centers have established completely new master's degree programs; some have developed new Ph.D. courses; and most centers host summer schools on a regular basis. But the centers also contribute to teaching at the undergraduate level. At many centers, the contact with first and second year students is seen as an opportunity to recruit new students to the center. The foundation strongly encourages the centers to participate in teaching obligations at the host institutions and do not normally accept senior staff to be released entirely from teaching obligations. However, senior staff may share some of the teaching with post-docs from the center, who may spend up to 20% of their time on teaching.

### 5.5 Value and commercialization

In 2010 every sixth patent application submitted from a public research institution came from a DNRF Center of Excellence. By comparison, DNRF allocates approximately 2% of all public research funds.

The high number of patent applications indicates a substantial potential for applications, even though the foundation does not make this a criterion when selecting new centers. In this process, the foundation solely considers scientific quality. In 2011 far more patent applications were submitted from public research institutions, the DNRF centers accounting for 14%, indicating that CoEs bring forward more new ideas for potential use than would be expected.

**Patent applications submitted, 2007-2011**

	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>
<b>Public research institutions</b>	131	128	129	122	171
<b>DNRF's share (number)</b>	17	13	11	19	24
<b>DNRF's share (%)</b>	13	10	9	16	14

Both international and national statistics use patent applications, patents and spin-outs as indicators of commercialization. The relevance and quality of these indicators may be discussed. Information about the research communities' collaborations and partnerships, even the more informal ones, might also contribute to an increased understanding and so might actual case examples.

**Patents granted, 2007-2011**

	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>
<b>Public research institutions</b>	13	11	16	13	45
<b>DNRF's share (number)</b>	6	1	2	4	7
<b>DNRF's share (%)</b>	46	9	13	31	16

Quite an impressive number of spin-outs emerge from the Centers of Excellence. When asked about this, people behind these new companies are highly united in their explanations of their success. They often find that their competitive edge is due to having based their business on original and groundbreaking basic research. They are not just good at what they do. They have made a scientific breakthrough and have translated this knowledge into practice.

**Spin-out companies, 2007-2011**

	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>
<b>Public research institutions</b>	9	12	7	11	7
<b>DNRF's share (number)</b>	2	1	2	1	1
<b>DNRF's share (%)</b>	22	8	29	9	14

All of these numbers exceed what might be expected when taking into account how big a share of the Danish public research funding that is channeled through the DNRF. In an effort to try to understand what lies behind some of the numbers, the foundation created a publication called "Curiosity Pays Off," in which the foundation has collected examples from eight of the centers ("15.1 Nysgerrighed betaler sig"). These examples confirm that the combination of selection criteria focusing on the ability and courage to pursue new and big ideas and the freedom and flexibility offered by a center grant produces results that make a difference.

**5.6 Outreach**

The DNRF encourages the centers to engage with the society at large through various outreach activities. The DNRF has a clear division of labor with the centers when it comes to communicating research findings from the centers. The foundation finds that such communication is best done by the researchers involved in the research, often with the help of local communications departments. The foundation has launched a series of communication seminars for center leaders in which they meet with stakeholders from the media, etc., and, at the same time, have the opportunity to learn from each other. The first seminar was held in 2011 and focused on bringing researchers and journalists together. This seminar also focused on issue management and provided good advice on how to act when gaining exposure in the media. This seminar was followed by a workshop in the DR (public service broadcaster) in which a number of journalists (TV and radio) met with some of the center leaders in order to explore possible stories, series, etc. Another communication seminar was held in April 2013, this time focusing on strategic com-

munication. This seminar was planned in conjunction with videnskab.dk, which is a popular science news service.

Research communication has been chosen as a special topic for discussion at follow-up meetings, and in their annual reports, the centers are asked to submit information on their outreach activities. Also, the foundation allows minor parts of the center grants to be used for the co-financing of TV productions, etc.

Many of the center leaders are exceptionally good at communicating their research, and many have been awarded prizes for outstanding research communication. One of the most prestigious communication prizes in Denmark is the Rosenkjærprisen, which is awarded by the DR. This prize was established in 1963. Three center leaders or core members have received this prize since 2006. Since 2004, the Ministry of Science, Innovation and Higher Education has also awarded a communication prize. Five of the nine prizes awarded so far have been to center leaders/center members.

## **5.7 Reflections**

The combination of input from international peers, the close contact and interaction between the foundation and the centers, and the data collected annually provides the board with a very good idea of the quality and impact of the research in the centers on a regular basis.

The foundation is confident that excellent research has emerged from the Centers of Excellence and that the centers have enriched and strengthened Danish research. Publications in high impact journals/books, and prizes, awards, international collaborations, commercialization activities and the ability to attract talent and top researchers from abroad are all indicators of the prestige and recognition the centers enjoy.

The universities are clearly proud to be hosting CoEs, since this is perceived as a mark of quality. The CoEs have strengthened the universities' ability to prioritize recruitment at a high level and prioritize resources for building more creative and competitive research environments. The Center of Excellence concept has inspired new efforts, both by other public and private funders or in elite programs at the universities. This indicates not only that the DNRF is convinced of the qualities of this program but that its qualities are also recognized by the people and institutions that interact with the centers.

The impact of the centers is not just measured in terms of research output. Educational activities at both the undergraduate and the graduate level are important outcome of the centers and they provide important benefits for the host institutions.

The impact on society at large is also quite significant. Even though research activities are not chosen to solve specific social challenges, researchers are generally dedicated to and absorbed by the world around them – and they want to apply their knowledge. Hence, many centers are visible actors in the society at large, engaging and interacting with a broader public and putting their research findings to use for policy makers and the broader public.

The commercialization and application of research findings are yet other ways to assess the quality of the centers' research. The research conducted at the centers leads to cooperation with companies, patents, and the establishment of new spin-offs to a surprisingly higher degree than expected by the foundation. This shows the importance of the DNRF's philosophy of trusting preeminent researchers to tackle the research issues that most ignite their interest.

# PART B

## OTHER FUNDING MECHANISMS

## 6 INTERNATIONALIZATION INSTRUMENTS

The foundation has only a few other funding instruments besides the Center of Excellence program. In its strategy ("3.1 DNRF Strategy") the board has decided that new instruments should be launched if and when the foundation sees an opportunity to address a particular challenge to Danish research. Excellence shall remain the overall criterion for assessing any new instrument, and the various instruments must be clearly defined without compromising the Center of Excellence concept.

One of the recommendations from the evaluation in 2003 concerned the level of internationalization. The 2003 evaluation panel found that the objective of internationalizing Danish science was achieved unevenly in the centers. The panel recommended that the Danish system needed to develop imaginative ways of attracting more foreign researchers and research students and encouraging more Danish scientists to gain experience abroad.

Since 2003 the international outlook has increased not only in the Danish research sector but in society in general. Various actors (universities, political systems, etc.) have implemented initiatives and regulations that have enhanced the level of internationalization, and the situation today differs somewhat from the situation ten years ago.

Today, centers are, to a large degree, international environments. Approximately a third of faculty members were foreigners in 2011. More than 60% of all post-docs and almost 40% of the Ph.D. students were from abroad. Hence, the centers are major contributors to the internationalization of Danish research.

In total, the foundation has spent 620 MDKK on internationalization initiatives since 2006. If international recruitment within the Center of Excellence program (international post-docs and Ph.D. students) is included, the internationalization costs amount to approximately 1 billion DKK.

Some challenges do, however, remain, and in order to further contribute to the internationalization of Danish research, the foundation has developed initiatives to boost cooperation and interaction with creative research communities abroad. This set of initiatives can be categorized as either recruitment initiatives or joint collaboration initiatives, although there is naturally some overlap between the two groups since they share a common overall objective. Each of these internationalization initiatives is presented below.

### 6.1 Recruitment activities

The recruitment activities can be divided into two groups: A) the professor programs aimed at recruiting top researchers to Denmark and B) talent recruitment.

#### 6.1.1 Professor programs

The foundation has launched three professor programs that share overlapping objectives. In 2005, the Niels Bohr Visiting Professorships were initiated with the purpose of promoting the internationalization and competitiveness of Danish research by attracting top international researchers for repeated stays to existing research centers in Denmark; 100 MDKK was distributed among six grants on the order of 11-21 MDKK each and the initiative ran in the period 2006-2011 ("12.3 Overview of Niels Bohr Professorships"). Most of the six Niels Bohr Visiting Professors stayed in Denmark for six months each year. In 2010, Niels Bohr professor Dale Mortensen received the Nobel Prize in Economics.

In addition to this program, the DNRF professor program was launched and ran between 2007 and 2012. The objective of this program was to enrich Danish research by attracting elite international researchers (Danish or foreigners) from abroad to permanent positions in Denmark on favorable terms. The support for this program amounts to 63 MDKK shared among three grants ("13.2 Overview of DNRF Professorships").

In 2011 the latest professor program, the Niels Bohr Professorships, was launched. This program can be seen as a merging of the two previous programs. A total of six new professorships have been established, and the new Niels Bohr professors will be spending between 50 and 100% of their time in Denmark over the next five years. This program has been open to top researchers from abroad (Danish or foreigners). From the outset they have all been offered a permanent position at a university in Denmark. This offer of embedment was secured in advance. The support for this program amounts to 167 MDKK ("12.3 Overview of Niels Bohr Professorships").



### **6.1.2 International talent recruitment program**

Realizing that competition for the best international research talents is fierce, the foundation embarked on a special talent recruitment initiative in 2007. The purpose of this initiative was to give the centers the opportunity to develop and test new recruiting measures. Many initiatives have resulted from the talent-recruitment effort, but two programs, the MOBIL program and the Brahe program, stand out as examples of new and original efforts to make research stays in Denmark attractive to foreign scientists.

The MOBIL program is a collaboration between five DNRF centers at Aarhus University involving a targeted effort to attract especially talented students within the area of molecular and chemical biosciences to a research education at one of the centers.

The Brahe program consists of the Sophie and Tycho Brahe Prize Fellowship in Astrophysics, which is awarded once annually to an independent and autonomous research project within the Dark Cosmology Center's (DARK) overall research area. The fellowship includes a two-year stay at DARK, and the following one to two years are spent at and financed by the foreign collaborative partner, making a stay at DARK particularly interesting to a foreign top post-doc who eventually wants to continue a career in his or her own country.

The international talent recruitment initiative has not been continued, since most of these activities have now been integrated into the centers' general recruitment strategies. The support for this program amounted to 31 MDKK.

## **6.2 Joint funding**

The foundation has set up collaborative and joint funding with a number of large foundations and organizations from various research-intensive nations. Together with the Max Planck Society, the foundation co-funded a Center for Geomicrobiology between 2007-2012 (support amounts to 24 MDKK). This center was awarded a Center of Excellence grant in the 7<sup>th</sup> application round and is now funded by the DNRF.

### **6.2.1 Danish-Chinese research centers**

In collaboration with the National Natural Science Foundation of China (NSFC), the DNRF has established a joint program that funds Danish-Chinese research centers. This cooperative effort was established in 2005 and, since 2008, has given rise to 10 Danish-Chinese research centers. The centers are established within four research areas: two centers in cancer research, established in 2008 and 2009; three centers in nanotechnology in 2009; two centers in renewable energy in 2010; and three centers in the field of information and communication technology (ICT) in 2011 ("14.2 Overview of Danish-Chinese Centers").

The idea behind the program is to establish new contact between leading researchers from China and Denmark. The program aims to launch initiatives that support cooperative efforts that result in excellent Danish-Chinese research.

The DNRF offers 10-15 M DKK to the Danish research center over a period of three years. The Chinese counterparts are supported by the NSFC. The centers have the possibility of extension into a second funding period. The current agreement with the NSFC runs until 2018, at which time the DNRF will have spent approximately 230 MDKK on this initiative.

### **6.2.2 Collaboration with the NSF**

Since 2010, the DNRF has collaborated with the National Science Foundation (NSF) in the United States on what is now known as the Graduate Research Opportunities Worldwide (GROW) (formerly known as the Nordic Research opportunity, NRO). The program allows recipients of graduate research fellowships at the Ph.D. level to carry out a research visit at a DNRF Center of Excellence for a period of 2-12 months. The DNRF spends approximately 1 MDKK a year on this initiative.

### **6.2.3 Collaboration with the CNRS**

The DNRF entered an agreement with the French National Center for Scientific Research (CNRS) in 2008, and in 2011, the agreement was extended for another four years.

The purpose of this agreement is to develop and strengthen scientific cooperation between Danish Centers of Excellence and CNRS laboratories and institutes. The program is intended to accommodate greater mobility between Danish and French research institutes and to promote the exchange of scientists between the cooperating parties, thereby creating opportunities, especially for younger researchers. Approximately 0.3 MDKK is spent annually.

#### **6.2.4 Collaboration with India**

As the latest addition, the foundation launched a new program in 2012 in order to facilitate and stimulate research collaboration with Indian researchers. The foundation does not work with a specific counterpart in India. The program will make it possible for DNRF Centers of Excellence across all disciplines and with different connections with researchers in India to take advantage of the initiative and enforce a bottom-up approach in defining collaborative activities. The DNRF supports the Danish-side activities only. The Indian partner must fund activities on the Indian side. Currently, three projects have been funded in collaboration with the Chennai Mathematical Institute (CMI), the Tata Institute of Fundamental Research (TIFR) and the Physical Research Laboratory (PRL). So far, the DNRF's support amounts to 12 MDKK.

#### **6.3 Reflections**

The Center of Excellence program remains the core activity of the foundation, and today the CoE program alone contributes significantly to the internationalization of Danish research. Following the recommendations of the evaluation panel in 2003 the foundation initiated a number of other initiatives specifically targeted at increasing the internationalization of Danish research at multiple levels. Such additional plans can be initiated if and when the foundation wants to address specific challenges or new opportunities for Danish research. However, they do not necessarily have permanent status but are evaluated, revised, included in other initiatives or terminated, thereby making room for new initiatives.

The foundation experimented with new ways of recruiting foreign talent (Ph.D. and post-docs) in the international talent recruitment program of 2007. Many interesting experiences were gained from this program, and some of the program's activities have been integrated into the activities of several centers as well as some of the universities' recruitment strategies; hence, the program has not been continued. However, international talent recruitment continues to be supported within the CoE scheme and through the mobility schemes co-funded with the NSF and the CNRS.

Attracting top researchers from abroad remains a challenge for Danish research. Danish salaries do not compare with those at some top universities around the world. With its professor schemes the DNRF has tried to create an attractive package for outstanding foreign researchers. The aim was to create a scheme that would lead to a long-lasting effect on Danish research communities. This is not necessarily best done by "adopting" a foreigner full time. Close relationships and collaborations can be obtained through repeated visits over a long period. The foundation realizes that internationally recognized senior researchers may benefit Danish research. Often, they are more mobile and able to come for longer stays, and they are very successful in attracting highly skilled young scientists from abroad to Denmark.

The DNRF was truly a first mover when launching its first professor initiatives and addressing this challenge of recruiting top researchers. Today, some of the private foundations have also initiated programs aimed at attracting top talents from abroad. Examples of these include the Villum Foundation's 'VKR chair' and the Novo Nordisk Foundation's Laureate Research Grants.

The DNRF was also a first mover when it established the Danish-Chinese research centers and provided an opportunity for close collaboration between excellent Danish and Chinese researchers at a crucial time, when many wanted to encourage collaboration with China as a new and strong research nation.

The new initiative with India is another attempt at exploring and encouraging new opportunities.

Ideally, the foundation would like to have a few well-defined instruments that support each other, underpin the CoE program and meet the needs of the centers. Once the foundation has gained more experience with the current Niels Bohr professorships and the Indian collaboration, the board will consider whether it should merge its various international funding instruments into only two: 1) the Niels Bohr professorship program and 2) a research collaboration program based on the principles in the Indian instrument but open to all countries of interest to the CoEs.

# PART C

## FINANCES AND LEGAL FRAME- WORK

## 7 FINANCES

On its establishment in 1991, the foundation received start-up capital of 2 billion DKK. Following a legislative amendment in 2008, the foundation received an additional 3 billion DKK, allowing a distribution of annual grants totaling an average of 400 MDKK.

The foundation's activities do not depend on annual finance bills. The foundation enjoys full discretion to manage its funds within the given legal framework, the Ministerial Order on the management of the foundation's assets.

As of March 31, 2013, the foundation's total assets amounted to 4.0 billion DKK, and the yearly return on investment since the 2008 amendment to the law has been 6.8% against the benchmark of 6.6%.

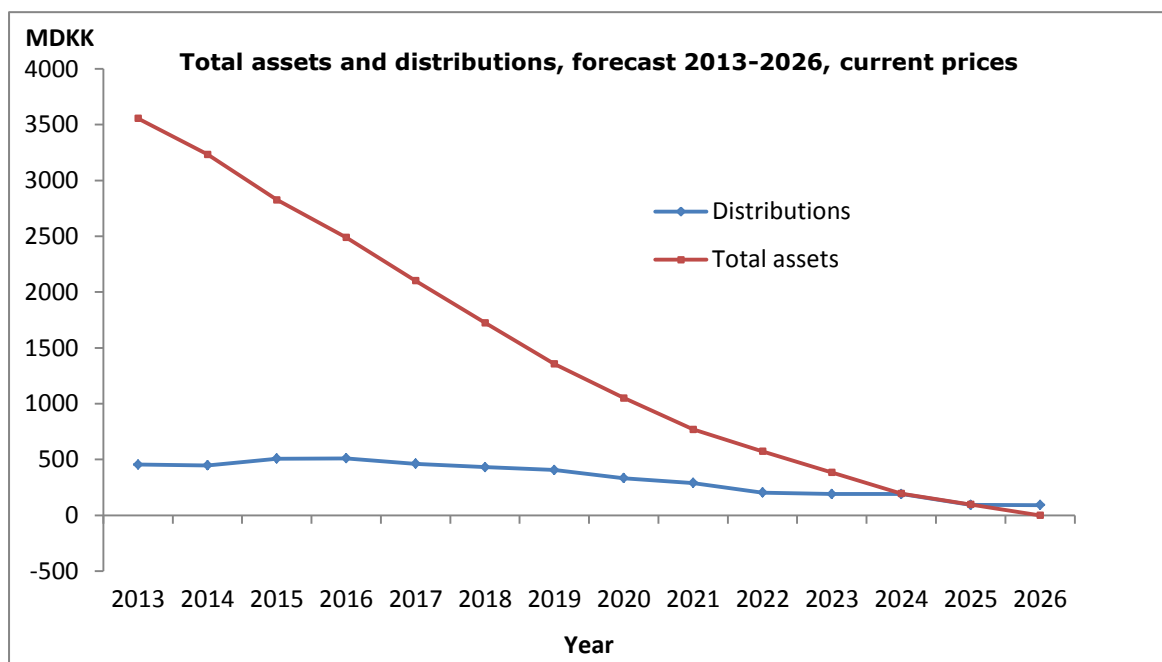
### 7.1 1998-2008

The legislative amendment in 1998 entitled the foundation to add equities to its investment portfolio and to draw down its capital. At the same time, minimum requirements for the value of the total assets were established. A subsequent legislative amendment in 2003 opened up an opportunity for the foundation to spend all of its remaining capital, which would therefore be expected to be depleted by the end of 2013. Accordingly, throughout the period from 1998 to 2008, the foundation had a very limited investment horizon and had to undertake investment transactions in a relatively conservative fashion. The foundation's annual return in 1998-2008 was 4.7% against an annual benchmark of 4.7%.

### 7.2 2008-2012

At the end of June 2008, the foundation received 3 billion DKK, and the life of the foundation was extended from 2013 to 2026. The considerably longer investment horizon necessitated the formulation of a more balanced investment strategy.

It was a condition pursuant from the legislative amendment in 2008 that the foundation was capable of distributing grants of up to 400 million DKK a year, up to and including 2017, when the final 10-year centers would be launched. After that time, grants would be phased out toward the end of 2026. It should be added that the foundation is committed to ensuring that funds will be available for distribution up to and including 2026.



Total assets and distributions. The announcement of the 9<sup>th</sup> application round in the summer 2015 will be the last initiative based on the current capital base.

### 7.3 Investment strategy

The day-to-day management of portfolios is handled outside the foundation's organization. The foundation makes use of external recommendations for its investment strategy.

The foundation has not decided on a particular risk level, but has defined – as a choice between alternative models - how high an allocation to equities the foundation would like to have. In the context of total portfolio return and risk, the asset mix is by far the most significant factor.

Based on the strategic allocation of the portfolio, historical risk developments, and expected returns for the different asset classes, a number of risk metrics are currently calculated. By applying portfolio risk p.a., expected return p.a. and value at risk (the maximum loss within one year with a probability of 2.5%) supplemented by annual and triennial stress tests, the foundation regularly assesses whether the risk is acceptable.

The foundation's total assets are allocated into the following asset classes:

Asset allocation	Percentage distribution	Portfolio manager
Global equities, Exchange Traded Fund	30%	Deutsche Bank, passive man.
Global equities, Danske Invest	0.6%	Danske Capital, passive man.
Emerg. Markets equities, Danske Invest	4.4%	Danske Capital, active manag.
Danish bonds	35%	Nykredit, active management
Global inflation-linked bonds	20%	Danske Capital, active manag.
European corporate bonds	10%	Danske Capital, active manag.
Short term bonds, cash	0%	Danske Capital
In total	100%	

Since 2008, the foundation has generally adhered to investing 35% in global equities and 65% in fixed-income products. Thus, the overall investment strategy is balanced, containing both equities and bonds in order to ensure a robust and resilient portfolio that is able to perform in very different financial environments. The strategy involving a combination of both equities and bonds ensures a beneficial diversification of risk in the portfolio.

The investment universe is made up of a relatively limited number of asset types, since simplicity and transparency are key elements in the overall investment philosophy. Owing to the foundation's objective of maintaining the actual value of the portfolio, investments in real assets, equities, and inflation-linked bonds represent a significant proportion of the portfolio. Moreover, equities are expected to generate a higher return in the longer run, and this will underpin the return potential and thus the pattern of the distribution of funds. Nominal bonds have a more predictable cash flow and are suitable for ensuring substantial elements of distributions. Danish government and mortgage bonds are the safest and most stabilizing element, while European corporate investment grade bonds are likely to generate a higher return against a slightly higher risk.

The foundation does not work with an actual reserve. The objective of the foundation is to fund exceptional research, and savings therefore do not fall within the scope of this objective. It should further be noted that it will be difficult for the foundation to increase its distributions in the short term if the return on investment exceeds the expected return. As illustrated by the annual report for 2005, a setback involves a risk of subsequent periods characterized by unintended under-distributions. If returns actually turn out to be poorer than projected, the foundation can reduce its level of grants in the 8<sup>th</sup> or 9<sup>th</sup> application round when the level is determined in 2014 and 2016.

### 7.4 External assessment of the foundation's investment strategy

In October 2012 it was decided to invite the Stockholm-based consultancy firm Wassum for a second opinion of the foundation's investment strategy. The purpose of the external assessment was to get an analysis of the foundation's current investment strategy, including the return on investment for 2008-12 and to receive recommendations for the years to come.

The report "Performance evaluation for the period (2008-2012) and an evaluation of the Foundation's current investment strategy - Recommendations for new asset classes" begins with the following statement in the executive summary:

"In general we think the execution of the investment strategy of the Danish National Research Foundation (the Foundation) has been prudent and executed in a conservative manner."

"The performance of the Foundation's total investment portfolio during the period July 2008 to September 2012 has been 6.3% p.a. net of fees. This is 0.2% better than benchmark. In other words, the active management of the portfolio has compensated for the cost and generated an additional value of 0.2% p.a. The overall results are satisfactory given the very challenging period we have been through in the investment markets." ("3.3 Mandate of the Executive Board with respect to the management of the foundation's assets").

Due to the fact that the total assets are originally transferred from the government, the annual accounts must be audited by the Auditor General as well as by a state-authorized public accountant. The cooperation with the auditors has always been very constructive.

## **7.5 Reflections**

The fact that the foundation has its own funding and is independent of annual financial bills is crucial. This independency allows for long term planning and funding of research endeavors that run for up to ten years. The independency is also important when funding curiosity driven research that not necessarily matches current strategic focus areas.

Having its own funds requires a prudent investment strategy. A recent external evaluation concluded that the overall investment strategy with respect to portfolio return, risk and expenses is satisfactory.

Since the capital injection of DKK 3 billion in the summer 2008, the average annual return of the foundation has been 6.8% against a benchmark of 6.6% (5.5% return according to law). It was a tough start for the portfolio in 2008 with a global stock market crash – the global market was down with 25%.

In the years to come, Centers of Excellence activities are funded mainly by drawing down the foundation's capital. Obviously, an early capital injection followed by increased return on investment could deal with this capital reduction. It should be further noted that a setback involves a risk of subsequent periods characterized by unintended under distributions just as it is difficult for the foundation to increase its distributions in the short term.

## 8 LEGAL FRAMEWORK

The foundation is regulated by law. The legal basis of the foundation was last revised in 2008. The legal framework comprises:

- "4.1 Consolidated Act on the Danish National Research Foundation, No. 833"
- "4.2 Royal Decree on the Charter of the Danish National Research Foundation, No. 944", "4.3 The Rules of Procedure of the Board of Trustees of The Danish National Research Foundation"
- "Ministerial Order No. 154 of February 2010" (only available in Danish) on the management of the foundations assets.

The legal framework establishes that the foundation must support excellent world-class research. By agreement with existing research institutions and for a specified number of years, the foundation may establish centers at or across institutions, after which the foundation's commitment will cease. Thus, the foundation's grants are required to be large. The foundation must normally distribute the funds in open competition on the basis of applications from research institutions and researchers. Supported activities must include key elements of research training. Furthermore, the foundation can undertake initiatives in cooperation with and wholly or partially financed by other public or private councils, foundations or companies, including public or private councils, institutions, foundations or companies abroad. The foundation is obliged to monitor any research activity funded by the foundation, and it is allowed to distribute 400 MDKK annually.

### 8.1 Reflections

When the legal basis of the foundation was formulated in 1991 it was based on the following objectives 1) to ensure grant recipients were good researchers as well as good research leaders, 2) to ensure the grant recipients would have considerable freedom and time in spending the means at their disposal and 3) to provide large grants. The board feels these values were visionary and also today should maintain to be core in the legal basis of the foundation.

## 9 MANAGEMENT OF THE FOUNDATION

### 9.1 The board

The foundation is managed by a Board of Trustees, whose members must have insight into research at a high international level and into financial matters. The chairman and the members are appointed by the Minister for Science, Innovation and Higher Education in their personal capacity. The minister appoints the chairman and one other member directly, while a number of organizations nominate candidates for the rest of the seats. Two members are nominated by the Danish Council for Independent Research. The Danish Council for Strategic Research, the Danish Rectors', the Joint Committee of Directors at Government Research Institutes, the Royal Danish Academy of Sciences and Letters and the Danish Academy of Technical Sciences all nominate one each ("4.1 Consolidated Act on the Danish National Research Foundation, No. 833" and "4.2 Royal Decree on the Charter of the Danish National Research Foundation, No. 944"). The board meets six times annually. Board members participate in a number of follow-up meetings in addition to the regular board meetings.

Since the foundation's beginning, the board has had an international perspective. In the early days, this international perspective was secured by appointing Danish professors from American universities and, later on, by appointing foreigners, especially from the Nordic countries. Since March 2010, all board meetings have been conducted in English, allowing inclusion of board members who do not master the Danish language. Extracts of minutes of board meetings, recommendations, etc. have been available in English since that date.

The board consists of four to five international members. It is the board's view that such a composition allows for sound and unbiased input from fresh eyes while it also ensures a necessary knowledge and understanding of the Danish system.

### 9.2 The secretariat

The secretariat is headed by a director with a scientific background and a deep insight into research at a high international level, adding credibility and facilitating dialogue with the researchers at the centers. In addition to the director, the secretariat comprises a vice director, 1 senior adviser, 4 research advisers, 1 accountant, 1 secretary and 1-2 student assistants. External consultants are used in matters of asset management, legal advice, ICT, graphic design, etc. It is a small organization that demands skilled employees with broad competences.

#### Administrative expenses compared with distributions and number of grants, current prices

	2007	2008	2009	2010	2011	2012
<b>Adm. expenses, DKK 1,000</b>	8.8	10.1	11.3	11.1	12.2	11.6
<b>Distributions, MDKK</b>	243	321	275	387	359	391
<b>Grants, number as of December 31</b>	51	49	61	61	58	64
<b>Adm. expenses/ Distributions, %</b>	3.6	3.1	4.1	2.9	3.4	3.0
<b>Adm. expenses/ Grants, 1,000 DKK</b>	173	206	185	182	210	181

The table compares the administrative expenses with distributions and number of grants. Administrative expenses relative to distributions are close to 3% taken into account that 2009 distributions were restricted to 275 MDKK. Calculated relative to numbers of grants the administrative expenses are fairly constant."

### 9.3 Reflections

It is of outmost importance to have an independent Board of Trustees with high integrity and knowledge on how to identify researchers that are "better than good." The board finds that having approximately 50% of the board members coming from abroad helps the board in identifying excellence at an international level. The balance between Danish and foreign board members at approximately 50/50% also ensures that a good knowledge of the Danish research system is present within the board. The board covers a broad spectrum of research fields and finds that this is conducive to the work of the foundation.



The board considers that the balance between in-house and external advisers allows for a lean and efficient administration. It is the foundation's view that a director with a scientific background ensures a high degree of credibility in the scientific community.

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