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SUCCESS Work Package 1

Benchmarking Successful Models of Collaboration

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Eds. Finn Hansson,
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Mette Mønsted &
Torsten Fransson

April 2009

SUCCESS

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SUCCESS

ACKNOWLEDGEMENTS

This report, referred to as Work Package 1 (WP1), concludes a process that started in the spring of 2008 as part of the EU-sponsored pilot project SUCCESS. It builds on an extensive literature review and empirical survey on research and innovation collaboration projects within the fields of sustainable energy and climate in several countries. The combined and coherent efforts from a large number of academic and industrial contributors made it possible to conduct a benchmark analysis of various forms of collaborations and to reach a set of findings which hopefully will be helpful in future efforts to support and facilitate collaborations in the EU.

During the process a large number of researchers and practitioners have contributed significantly to developing the building blocks of this report. Furthermore, the researchers from ESADE and Copenhagen Business School contributed with in-depth literature reviews on innovation networks, managerial challenges of collaborations, exploration and exploitation of knowledge and other relevant themes of WP1. Also, researchers from The Technical University of Denmark contributed with a review of national systems of innovation, and the Energy research Centre of the Netherlands contributed with governance and innovation process analysis.

Parallel with the literature review a large empirical survey was conducted on more than 60 collaboration projects throughout the EU. This work involved all partners and was finalized by Copenhagen Business School during the summer 2008. The survey led to a number of case analyses which are also part of this report.

Together, the literature review and the empirical survey allowed us to conduct a benchmark analysis of existing collaboration projects – not in order to identify one, winning model but to demonstrate the variety and complexity of collaborations and the need for supportive frameworks that take into account the dynamics of research and innovation oriented collaboration projects. The contributors would like to express their sincere thanks to the EU for the financial support which made this study possible inside the SUCCESS project.

SUMMARY

In this report the key findings of an extensive literature review and an empirical survey of collaboration projects within the fields of sustainable energy and climate change are presented. The main objectives of the report is 1) to develop an analytical framework of innovation systems and to identify important managerial and organisational challenges pertinent to collaboration projects linking actors from within the Triangle of Knowledge (Innovation, Education and Research) and 2) to report on major collaboration patterns and on the basis hereof identify the most important types of collaborations known by the partners of SUCCESS.

To this end, we have put together a report in three parts:

Part one is based on a state-of-the-art literature review, an empirical survey of more than 60 existing collaboration projects within the fields of sustainable energy and climate change, and three cases studies. The purpose of part one is to develop an analytical framework suited for understanding the complexity characterising different types of collaboration projects. The aim, therefore, is not simply to construct one specific model to be applied in future collaborations. Rather, the aim is to map and in the end provide a framework for understanding the wide range of different collaboration projects which becomes still more important in order to accelerate innovation within the field of sustainable energy and climate change. Focus in part one is put on the managerial and organisational challenges facing collaboration projects and networks.

In part two we shift focus from the meso-level of analysis to a macro-level of analysis. The purpose is to demonstrate that any collaboration project of the kind we refer to in this report is framed by larger innovation systems. The aim of part two is to present some important results from the perspective of innovation systems and to ensure that the more in-depth analysis in part one is put into a context of national and regional policy which also has important impact on the success of collaboration projects.

Finally, in part three, we will summarise the key findings of the report. Focus is put on how to understand the basic forms of collaborations and to highlight the most important challenges of building successful collaboration networks within sustainable energy and climate change.

KEY FINDINGS

Collaboration projects within the fields of sustainable energy and climate change are very diverse making it difficult if not impossible to build one model that fits all types of collaborations.

Collaborations are generally characterised by integrating a managerial and an innovation-oriented mode of organising. The difficulty of making this integration work depends very much on the size, scope and purpose of a given collaboration project. Thus, large, open and heterogeneous projects/networks may experience a high degree of innovation or potential for innovation while small, closed and homogenous projects may be relatively easier to manage and less open to innovation. In practice, however, the picture is more complex: When we analyse actual collaboration projects it becomes clear that collaborations are very dynamic and continuously faced with the challenge of balancing between risk-reducing, managerial decision-making and innovation-oriented dimensions of collaborative engagement. When looking further into the managerial aspects of creating successful collaboration projects it becomes clear that understanding and handling a number of managerial dilemmas are crucial to delivering innovative results through collaboration projects and networks. Among such dilemmas we find the unity/diversity dilemma to be fundamental: In order to create trust and a common ground for diverse partners in a collaboration project a sense of unity is needed. However,

the very motive for engaging in collaborations is to become exposed to a diverse knowledge-base and to be part of a dynamic exchange of ideas and competencies. Therefore, creating a sense of trust and unity while maintaining a sufficient degree of diversity are equally important. Successfully managed collaborations are often characterised by a division of labour between management of and management in collaborations. These levels of management are important in order to both define the purpose, basic structure and scope of a collaboration project (i.e. management of) while maintaining a continuous focus on balancing interests, building trust, handling dilemmas, ensuring deliveries in due time etc. (i.e. management in). If managers of collaborations understand the dilemmatic character of collaborations and the different levels of decision-making and intervention, the rate of success of collaboration projects are likely to increase. The reason for this is that creating a productive tension between risk-reducing management and innovation is what constitutes the dilemmas facing managers. The division between management in/management of collaborations is a way to ensure that all important management issues are dealt with making it more probable that dilemmas will be turned into mutually reinforcing and productive tensions.

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INTRODUCTION

0.1 BACKGROUND AND PURPOSE OF SUCCESS WORK PACKAGE 1

Within the knowledge triangle of education, research and innovation the pilot project SUCCESS is intended to establish efficient and effective structures of collaboration in large distributed consortia in Europe featuring new governance schemes thereby maximising the efficient use of available resources and an increase in turning R&D results into commercial opportunities. The field of sustainable energy and climate change will be the underlying subject.[1]

The partners involved are a comprehensive group of institutions in the knowledge triangle in the field of sustainable energy and climate change as well as establishments dealing with knowledge transfer, business administration, governance structures and innovation management.

The overall objective of establishing effective and efficient structures of collaboration in large distributed consortia in Europe has a number of partial objectives, namely 1) to improve the link between research and innovation thereby strengthening Europe's capability to transfer results of collaborative research programmes into commercially competitive products; 2) to strengthen the education in the field of research, innovation, and entrepreneurship within the field of sustainable energy and climate change and 3) to develop models of management of innovation to handle the level of complexity of geographically dispersed and complex network relations.

As a consequence of these overall objectives, a number of specific goals have been identified which the pilot project is intended to fulfill:

- Identification of success criteria of existing collaborations in the knowledge triangle related to energy and climate through a comprehensive benchmark process
- Identification of obstacles and the underlying mechanisms avoiding successful collaboration
- Identification of ways to overcome or circumvent such obstacles
- Identification of applicability and limitations of different approaches with respect to collaboration in the knowledge triangle related to sustainable energy and climate
- Identification of best practices concerning education, research and technology transfer in the area of energy systems and development of innovation entrepreneurship courses
- Establishment of interdisciplinarity by bringing together the actors of the knowledge triangle in the field of climate and energy, both in the technical and socio-economic areas, with experts in the field of knowledge management, innovation transfer and governance structures
- Internal dissemination, i.e. generation of a collaborative network in the field of sustainable energy and climate based on the identified and verified structures within the pilot project SUCCESS.
- External dissemination of the developed models to the European Union and the parallel pilot projects.

The network established in the pilot project will, in a later step and potentially within the future European Institute of Technology (EIT), form relevant partnerships that can contribute to research, education and innovation in the area of sustainable energy and climate issues.

0.1.1 SHORT OUTLINE OF THE ACTIVITIES OF SUCCESS

The duration of the pilot project is limited to 24 months. As stressed in the section above the main goal of the pilot project will be to identify new - or improve existing - models of cooperation and governance of integrated partnership in the knowledge triangle of education, research and innovation in the

1 *Pilot projects for cooperation between European Institutes of Technology – Supporting integrated innovation networks. SUCCESS Searching Unprecedented Cooperations on Climate and Energy to ensure Sustainability, p23.*

field of integrated sustainable energy supply and climate change bringing together the main stakeholders in Europe in the most creative, effective and efficient way.

The project is structured into 5 work packages. In work package 1 a benchmarking of past and ongoing collaborations has been carried out including the latest tools incorporated within FP7 like Technology Platforms. This benchmarking process will serve as a baseline for work package 2 which focuses on elaborating new and improved models of governance structures for integrated partnerships with the final goal of strengthen the links between education, research and innovation. Work package 3 will implement and test some of the critical components and models which have been elaborated in WP2 using up to three examples. The success of the changes will be assessed using the degree of three dimensional integration of the collaboration under consideration prior to and after the implementation of the new models. Work package 4 will take care of the internal and external dissemination of the results gained in the pilot project SUCCESS. Hence it will also pave the way for a follow-on network working on the challenges of sustainable energy and climate change after the pilot project has been finished - with improved capability for innovation. Finally work package 5 will care for the overall coordination of the project. It will be organised according to the present knowledge of management structures but it is also supposed to benefit from the results gained in course of the pilot project SUCCESS.

0.1.2 WORK PACKAGE 1

The purpose of work package 1 has been to establish benchmark criteria for analyzing and evaluating various types of collaborations in a regional, national and international perspective with the goal of identifying strengths and failures of the different models employed in different countries. WP1 concentrates on analysis of innovations in the energy and climate control area and how these are brought to the market. All core partners have contributed significantly to the work package, and have conducted detailed discussions and interviews with many of the network partners, mainly from the industrial and public sectors, to analyze various types of collaboration projects involving key actors from the Knowledge Triangle of education, research and innovation.

Accordingly, WP1 set out to deliver the following output:

- Clarification of the analytical framework of innovation systems and detail plans and criteria for the analyses.
- Report on major collaboration patterns so far known to the partners and identification of the most important or typical ones to analyze.
- Detailed analysis of the most important existing regional, national, EU and intercontinental growth and innovation models, both on the education, research and business sides.[2] This is not fully developed in WP1 but is pursued through three case studies which will be an important part of bridging WP1 with WP2 where the detailed case analysis will be more thoroughly conducted.

2 *Ibid, p28*

PART ONE: IN SEARCH OF COLLABORATIVE MODELS

1.1 METHODOLOGY

In order to achieve the desired output of WP1 two parallel analysis processes were initiated: 1) A survey of past and ongoing collaboration projects within the EU and 2) a literature review covering areas such as innovation networks, collaboration in and management of networks, knowledge transfer, national innovation systems as well as a number of papers discussing the challenges of benchmarking the performance of collaboration projects and network systems.

The survey was constructed with the purpose of developing empirical input to the WP1 benchmarking process. Thus, the survey gathered data from 66 successful collaboration projects based on the knowledge of the partners in Energy and Climate. All projects involve in various forms and degrees partners from the Knowledge Triangle of education, research and innovation. The questionnaire used was completed in 12 countries throughout the EU. The primary focus of the questionnaire was issues such as motivation to collaborate, organisational forms of collaboration, managerial approach/structure and challenges pertinent to collaboration projects in the field of sustainable energy and climate change.

The purpose of the literature review was to introduce state-of-the-art research findings and on the basis of this develop an analytical framework suited for analysing the empirical input from the survey. As a result hereof, the literature review provided a set of core issues which then was used as tentative benchmark criteria in the empirical analysis.

Consequently, the benchmark analysis was not conducted in a typical manner where a set of relatively identical processes are compared resulting in the finding of one "winning model". Instead, the benchmark analysis employed in WP1 set out to use the findings from the literature review as success criteria or important issues to be handled when organising and managing various types of collaboration projects. In this sense, the review of the scientific literature resulted in a set of findings which were then used as benchmarks against which the survey findings are evaluated and analysed.

The outcome of this approach was not an identification of a single, winning model. Instead, the outcome was an identification of a variety of successful collaboration models or best practices which together constitute a diverse set of success criteria. The diversity of success criteria allows us to evaluate the highly heterogeneous portfolio of successful collaboration projects characterising the field of energy and climate. This, we believe, has resulted in valuable insight that will be useful for understanding and dealing with a variety of best practices and not for the implementation of one best practice in a highly diverse field.

In all, the methodological approach has allowed the analysis to understand and conceptualize a variety of collaboration models as well as keeping the specific context of sustainable energy and climate change in focus and at the same time point towards the need for developing a variety of models that will suit different types of successful collaboration projects.

In the following chapter we will present the key findings of the literature review before moving on to the empirical analysis.

1.2 CHARACTERISTICS OF COLLABORATIVE NETWORK MODELS

The following chapter aims at summarising the discussion on collaborative networks as discussed in the reviewed literature which is presented in appendices to this report (appendix 3.1 – 3.6.).

The question on governance of networks has today assumed a key role as more and more research programs are depending on large scale network collaborations. The criteria for evaluating the optimal organizing of a network can be divided into two important categories, each facing a number of important challenges. Management of network and management in network constitute together the governance system of the network and are of course closely connected but represent simultaneously a very important division of labour in the whole network system. Each type of management has to find solutions to specific challenges raised by the function of the network and its participants. This is what the following pages will describe in more detail. However, first introduce the basic reasons for why organisations collaborate, what their motives are for collaborating and what primary obstacles we see in many collaboration projects.

1.2.1 WHY COLLABORATE?

Collaboration in R&D is discussed in the literature on strategy and innovation as a key strategy for knowledge based firms to secure a competitive advantage by controlling complementary knowledge flows into the innovation process. Research collaboration has a number of advantages in relation to this end. The higher speed of collaborative knowledge production, the opportunity to match complementary knowledge and an increased commercialization potential are just a few beneficial characteristics of university-industry collaboration. However, the utilization hereof is contingent on a current development of the governance models and internal structures of the integrated networks that connect universities and industry partners. In the SUCCESS pilot study, R&D collaboration projects are the key drivers for collaborating in different local, regional and international networks. The collaborations differ considerably in terms of size, members and time span, but all of them are characterised by combining different types of research organizations, public research organizations, private firms and universities in researching front-end challenges on sustainable energy projects. This is primarily done in order to enhance the performance in the knowledge triangle of innovation, education and research.

Recently, the research on collaboration in R&D has moved beyond the traditional focus on private companies as a consequence of the fact that key players in R&D today interact with public research institutions and universities as well as private firms. However, as most of the empirical and theoretical studies of research collaboration by tradition are related to collaboration between private firms, we will start by listing up the key findings from this research.

1.2.2 MOTIVES FOR COLLABORATION

The rise in the interest in collaboration in the field of R&D is first of all a result of the growth in the knowledge-based economy and intense global competition. These general drivers behind motivation to collaborate need to be specified in order to produce useable knowledge on how and why collaboration in R&D occur. A very visible hindrance in private companies, and to some degree also in public research organizations, is the organisational boundaries. The very fact that opening the boundaries of the R&D unit in a firm to others, to outsiders, in order to collaborate contradicts the high level of security as well as policies to secure IPR's which are typical to many R&D departments. Therefore, in relation to a traditional understanding of innovation, collaboration normally has to be about definable or codified types of knowledge.

This was more or less the basic logic of inter-firm collaboration in innovation until recently when this view was challenged by the perspective of open innovation. Open innovation centres around the idea of willingness by the firm to use a wide range of resources, external as well as internal, in the process of innovation. The paradigm of open innovation has become very important in order to understand the recent growth in R&D collaboration between firms as well as between firms and public research organizations and universities. Open innovation makes it much easier to set up systems of collaboration, because the approach is no longer exclusively on exchange of well-defined or codified units of knowledge but, quite the opposite, on expectations of accessing future, cutting-edge knowledge and knowledge resources. Open innovation implies a much more positive attitude towards collaborating on integrated knowledge production and exchange over a longer time span and existing boundaries need to open up to new levels of integration and cross-fertilisation in the knowledge production. An important driver in the process towards open innovation is the increasing need for complex knowledge outside the individual firm, as each firm cannot maintain expertise on all involved issues. But also the new pattern is supported by the increasing demand for rapid testing and implementation of new ideas and solutions and the increasing acknowledgement hereof by R&D actors in firms, public research organisations and universities.

1.2.3 BARRIERS TO COLLABORATION

The increasing demand for collaboration in R&D makes it necessary to take a closer look into the different roles of knowledge exchange or transfer in the collaboration. The transfer can be knowledge in the form of mutual complementary assets or as sharing in novel ways, demanding knowledge mobility as well as stability in the collaboration network.

A barrier very often mentioned in collaborations is the interest by especially private firms to protect their core knowledge from outsiders. The use of legal constructions such as contracts can partly solve the problem, but even the most specified and detailed contract will never be able to cover all dimensions in the search of new knowledge in a field. In relation to this, a more general barrier is how routines and mind sets in the organization is geared toward the kind of dynamic changes and adaptations necessary to absorb, create and exchange new knowledge in a collaboration. These capabilities have individual as well as organizational dimensions. The concept of 'absorptive capacity' discusses explicitly these barriers in the organization. Organizations without absorptive capacity will experience a reduced ability to recognize, absorb and assimilate new (outside) knowledge. Private firms and public organizations may differ in how they organize their ability to absorb new knowledge. However, a common challenge is the question of how to formulate a strategy toward openness to outside collaboration and accordingly, organize internally to support the strategy.

From network theory, we learn that the ability of an organization to learn and absorb knowledge depends very much on how the boundaries of the organization function and especially what specific kind of network relation is at stake. We can distinguish between a network based on weak ties (open to the surrounding) or strong ties (closed to the outside). Furthermore, we know that building trust in network collaboration is a product of continuity of and experience with inter-organisational relationships.

An important distinction when we want to understand the operation of different network-based collaborations is that of exploitation and exploration in knowledge creation. In collaborations between different organizational units, companies and universities, the balance between interests in exploiting existing knowledge or explore new knowledge can take many forms and becomes itself a barrier to collaboration. The latent conflict between short run exploitation and long run concerns to explore can take the form of a conflict between visible gains to individual knowledge at the prize of the growth of collective knowledge. Often these conflicts or dilemmas will become a hindrance to full-scale involvement in collaborating with partners. Network collaborations with weak ties and partners with different levels of knowledge will tend to explore new knowledge resources in the collaboration while collaborations characterised by strong ties tend to be oriented toward exploitation and the exchange of complementary knowledge in a division of labour.

It has often been assumed that a basic motive for collaboration in R&D is the interest of participating organizations to learn from others, to exploit the knowledge from partners through organizational learning processes. A recent study questions this motivation by demonstrating, that most often collaborative alliances are based on a strategy to continuously access knowledge from partners rather than to acquire and incorporate in own organization processes of learning. Following this argument, collaboration motivation takes the form of a strategy of search for complementary knowledge by partners which emphasizes the advantages of maintaining collaboration with diverse partners rather than striving for homogeneity and predictability.

1.2.4 DIFFERENT TYPES OF COLLABORATION AND NETWORK MODELS

Existing literature and studies of collaborative networks in the field of innovation, education and research clarify that networks hold many different characteristic, and that these characteristics make the different forms of networks suited for very different purposes and functions. There is no network-model that fits all collaborative purposes and thus there is no main model to apply in all situations where collaboration is asked for. Still, a generic purpose for building an innovation network is to benefit from the inter-organization links that connects people and knowledge from diverse fields. The form of a given collaborative network is often dependent on the motivation of the organizations that participate, or dependent on various contextual factors specific to the partners or their disciplinary background. For example, members of a given collaboration may be reluctant to engage in a large collaborative project due to previous experiences with partners that do not deliver the promised services or knowledge in time. Thus, they prefer to work in small scale collaborations with a clear management structure where they, in a swift manner, can get acquainted with partners and build trustful relationships that make them feel in control with the collaborative processes.

Yet small networks will only provide access to a limited amount of new knowledge making the core challenge to be settling for the right size and character of the network. Yet, in spite of the fact that previous experiences as well as factors intrinsic to a given project or partner organization may affect the form of a given collaboration, it is possible to outline some overall factors that describe any given collaborative network. The core factors that affect the design of the collaborative project and the way it is carried out are the size of the collaborative network measured by number of active participants and the proximity of partners in relation to geographical and disciplinary scope. Table 1 shows the strong relations in small and close collaborations, whereas the weak ties of the larger and more dispersed network makes management more complex.

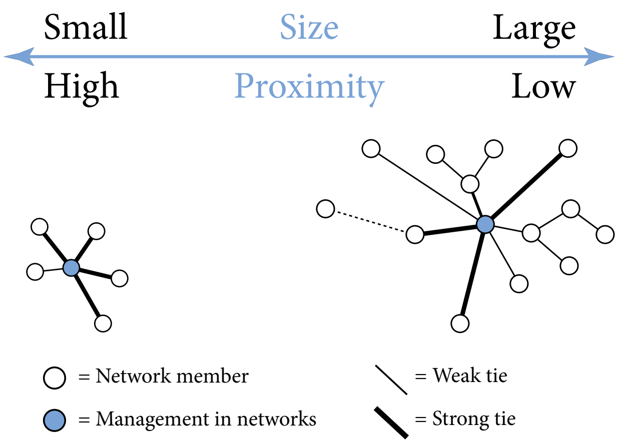


Table 1: Core Characteristics of Networks

As shown throughout the literature review of the SUCCESS project these factors are described in many studies of network models and are often used to group different collaborative projects. The different forms of collaborations have different strengths and weaknesses and it is important to be aware of this when networks are designed. Being aware of the strength and weaknesses may help to make the best possible match between the aim and the form of the collaborative project.

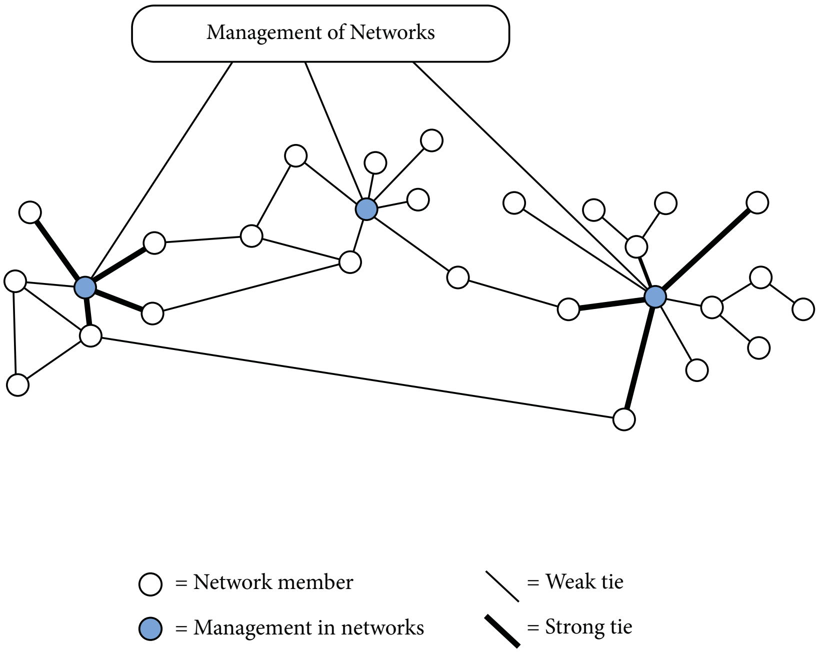
The large scale and very diverse networks are especially well suited for projects with the aim of searching for new knowledge, exploring new collaborative opportunities, or creating associations. Joining employees from many different organizations and with diverse backgrounds may serve the purpose of elucidating new knowledge and facilitating relations between employees that would not have made contact otherwise. Organising a project as a large-scale network may be beneficial in the early stages of research projects where activities such as getting familiar with knowledge and abilities of partners, searching for valuable knowledge and making connections are vital. However, large-scale networks need cross-unit coordination activities to keep the network parts together. This solicits strong management, and clear structures of the network. But it also stresses the importance of mutual dependencies keeping motivations across cross-unit collaborations intact at the practitioner's (researcher's) level.

Later on, when connections are made between members of the network and the project goes into the next phase it is often argued to be beneficial to work towards a tighter structure in the network. Especially if complex or tacit knowledge is to be transferred between partners, the relation need to be tight and trustful relations need to evolve. This may happen either through repeated collaboration or because network members trust the organizations behind the collaboration. In general, a relation that is characterised by mutual trust between partners will provide a better foundation for knowledge sharing as the partners can be confident that knowledge will not leak to third parties and the receiver will handle the knowledge with due respect. A trustful relation may also reduce the need for rules and regulations as the partners respect each other's requests. In table 2 the strength and weaknesses of the different network models are illustrated. The table portrays the archetypes and mix of factors that confer challenges as well as opportunities which often characterise networks.

We may see networks as being either large and loose in structure or small and tightly knitted. Even though many studies are based on this binary classification of network models this continuum entails both the archetypes, but it also describes all the different forms inherent to this spectrum as a continuum of network forms. The best possible size of a network and level of proximity between partners in a network depends on a number of factors. It is not possible to make a general and conclusive list of these factors as some will be idiosyncratic to the project. Nevertheless, a number of core factors are of special importance due to their effect on the activities of the network. For members

Table 2: Different Network Models: Strengths and Weaknesses

	STRENGTH	WEAKNESS
LARGE SCALE NETWORKS	• Knowledge search is eased as the pool of knowledge to search from is more diverse • Exploration activities are eased	• Easier for partners to violate an obligation to provide resources • Governance challenges • Hard to get rid of non-performers
SMALL SCALE NETWORKS	• Easier to build trust • Knowledge transfer between partners is eased • Exploitation activities are eased	• Partner knowledge may be redundant • Difficult to ensure a diverse pool of knowledge



MANAGEMENT OF NETWORKS:
Integration at different levels
Changes in the surroundings
Competence alignment
Creating engagement
Decision structure
Incentive structure
Legal unit
Shared facilities
Up-scaling

MANAGEMENT IN NETWORKS:
Core or marginal activities
Integration of different kinds of activities
Time frame
Vertical and/or horizontal integration

Table 3: Dimensions of Organising Networks

in a given network or managers that are responsible for activities in this network it is vital to go through evaluations of the following factors or questions, as the answers will have an impact on the size and diversity of the project:

- Does the project involve diversity in activities? In the present setting, this question could be rephrased as: does the project involve both research, innovation and education activities; i.e., are all of the parts in the Knowledge Triangle activated? If so, the project might need to be big in scope and number of partners with very different competencies must be involved.
- Are the activities core or marginal to the partners? Core activities may need to be better protected and partners will probably prefer to do these activities in close network groups where knowledge can be protected. Are the activities marginal to other activities of the partner firms it may not be that necessary to protect them and the partners may even want third parties to join the project in order to inspire and bring new knowledge to the scene. Some very basic, early stage research may in this phase be called marginal, as they are not yet core business, and thus exploration is still important for good results.
- Is the project vertically and/or horizontally integrated? A horizontal project involves partners from the same kind of organizations, such as university departments. If the project aims at creating new basic knowledge about a specific kind of energy technology, a high degree of horizontal integration is needed in order to get highly specialized researchers gathered in the same project. If the project on the other hand aims at commercialising research results, partners from different phases of the research process and more development oriented phases need to be included and the project will thus be more vertically integrated. This is a kind of "extended division of labour" between organizations to create a mutual dependency.
- What is the time frame of the project? The time perspective is a core determinant of the design of a given network. Is the core aim to come up with solutions to well defined problems in a relatively short period of time the project may not need to be large in scale. A network that, on the other hand is planned to run for a longer period may include different kinds of activities. The extend of interaction will often be greater in a long term project and more importantly it may vary over time.

These themes or questions are important to address

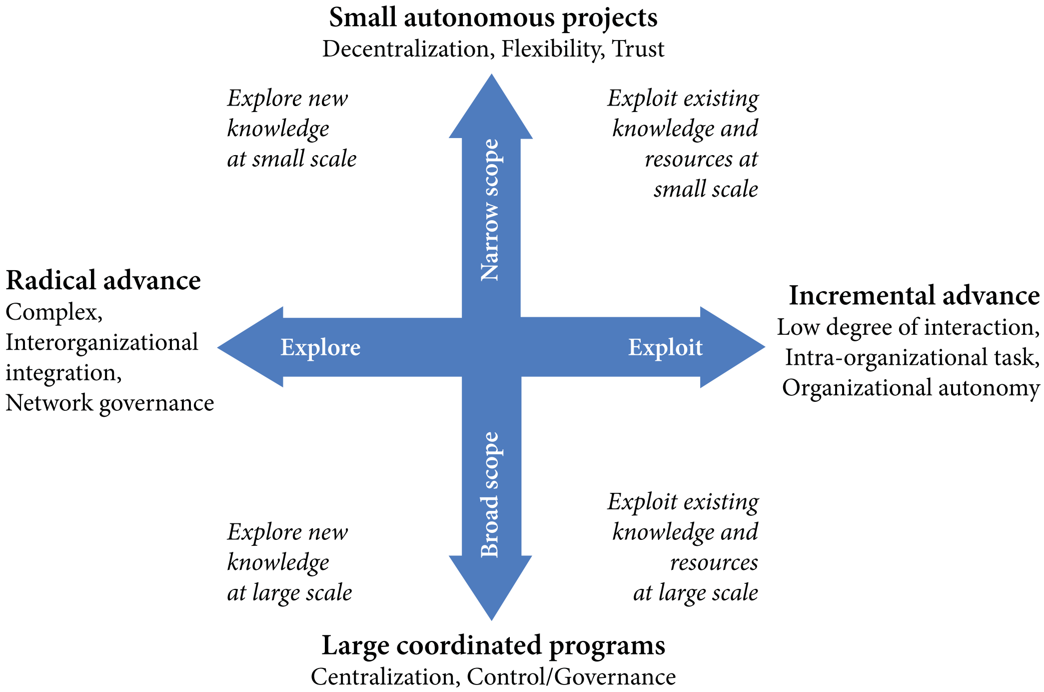


Table 4: Scope and Purpose of Collaboration Projects

when dealing with how to design a specific network, where for example network purpose has to be aligned with network form. Still, it is also important to remember that networks do never operate in a vacuum; a number of other actors and groups will relate to the network and different networks are often overlapping. Considering this makes it important to add another model to the ones outlined above. Instead of describing the issues that affect the design and management in networks, we must add a description of management of networks. The difference is more than semantic as it puts focus on the difference between coordinating people and processes that are set up to fulfill a specific goal and coordinating the interaction between different groups and actors. Or formulated from the point of view of the single projects, the management in networks will have responsibilities primarily toward facilitating specific projects while the management of networks have obligations to secure the functioning of the whole network system, including defining and securing the boundaries of the network. This may be illustrated as follows:

All of the dimensions help to identify different types of challenges and each dimension affect the level of complexity of the management of and in networks. Understanding the basic characteristics and inherent dynamics of any given collaboration is crucial in order to create a creative tension between network actors and the overall goals of the network or collaboration project. An important aspect hereof is to understand the diversity of network constituents while bridging this diversity by defining mutual goals, working with integrative mechanisms, building a clear governance structure etc. As illustrated in the model above, these dimensions should mix into a balanced relation between management of and management in networks.

How exactly to combine various types of management activities depends very much on what type of collaboration managers face. In the model below we outline some of the most common purposes characterising most collaboration projects. Having a clear understanding of the purpose, scope and structure of a collaboration is the first step in dealing with organisational and managerial challenges.

1.2.5 MANAGERIAL DILEMMAS

When studying the issue of management in large and diverse collaborations it becomes clear that there is not one single managerial model that fits all. Still, a number of factors determine which managerial model that support a given project the best.

A core finding from the literature reviews of this project is that the decisions and action taken on management issues of collaboration is often based on a number of dilemmas. First of all there is the unity/diversity tension. This relates to the fact that in fragmented settings, such as networks, it is difficult to generate common institutions and maintain the desired diversity at the same time.

> *In situations where two (or more) organizations depend on the other's resources they will take advantage of their complementarity only if they are capable of using in concert the resources that they bring together. In other words, diversity provides the resources and unity ensures the capacity to use them.*

This represents the core of the paradox of unity and diversity in a network context. The degree of unity and diversity will of course vary within a continuum of circumstances, but there must always be a minimum of diversity resulting from the autonomy of the organizations and a minimum of unity resulting from commitment to the network.

This dilemma is further emphasized by the fact that research projects are almost always characterised by autonomy/control dilemmas. Researchers need autonomy in their work processes and network managers need to pursue some degree of control over the work processes. This managerial dilemma pertinent to internal R&D management becomes even more outspoken when research is done in collaboration across firm boundaries.

> *Research is a process of creativity and researchers are most often motivated by a high degree of autonomy and freedom of choice in the work processes. This often creates conflict with the corporate wish for managerial control of the R&D activities.*

In this context control can be defined as the exercise of authority through a hierarchical structure that limits or channels behavior. In inter-organizational R&D we witness both an autonomy-control tension at the functional level (researchers ask for autonomy, managers need control) and the inter-firm level (one partner demands autonomy, another partner ask for insights and control, and vice versa).

Identifying the dimensions along which the coordinating units unite the network and support diversity is a central task in the governance of networks, independently of what will be the optimum balance between unity and diversity for each network type. Even the least diverse of networks must cope with the diversity introduced by uniting autonomous entities with diverse organizational characteristics, and must unite members along some dimension. Achieving the successful mix is the overall purpose of governing the whole network.

Another central dilemma to the kind of collaborative projects we deal with in this study relates to finding the right level of openness between partners in the collaborative process. It is widely acknowledged that innovation networks help a partner to gain new knowledge at a higher speed and thus be more innovative. Yet, scholars have shown that even though openness in the R&D process does enhance innovation it does so at a decreasing rate, meaning that beyond some limit increased search for knowledge through external sources will become negative. It seems that the tendency to ask for more openness in some phases of the R&D process or at specific times is faced with a quest for more closeness or protection at other times.

This can be framed as the knowledge-sharing/ knowledge-expropriation dilemma. What is referred to is a tension occurring when a focal partner firm has to adopt a variety of practices to facilitate the transfer of knowledge in the collaborative project, but in doing so may increase the likelihood that knowledge which is beyond the scope of the collaboration, and difficult to legally protect, is expropriated by the other partner. Thus, a need for protection is engendered.

This situation resembles the 'paradox of openness' describing the concurring needs of many knowledge intensive firms to be both open to many external knowledge sources and to put up the shutters to protect their knowledge in order to appropriate the value of it. These are seemingly contradictory actions, but none the less a prevalent situation in many collaborating organizations.

In order to handle the dilemma of being open and protective at the same time, managers need to adopt specific knowledge management practices, designed to handle the need for 'openness' or open channels between the partners in a very deliberate way. For example, managers must be clear on whether to design communication channels that are high in bandwidth or not.

Communication bandwidth refers to the degree of intensity in the communication. By way of example, high bandwidth means that interaction between a focal firm and its partner need to facilitate a high degree of rich context, high effect and high transparency in the communication. This can be attained by providing opportunities for physical demonstrations, immediate redundancy and rephrasing the information in own context, high clarity in the information, rich contextual clues, high interactivity and clear emphasis. High bandwidth is needed if knowledge is tacit and problem solving complex, whereas low bandwidth is sufficient if knowledge is easily codified. This finding is closely related to the work of social network scholars who have revealed that complex and highly codified knowledge is hard to transfer and that this kind of knowledge need to be frequently compared to the 'template' from which is replicated in order to be successfully received. This means that close interaction is needed between partners.

The fact that limits to openness do exist is apparent; a given organization would not have any knowledge to build on in the future if all channels were constantly open. What is important in the context of this somewhat dilemmatic situation is to remember that a higher degree of openness may be beneficial in more that one way. An open attitude towards external knowledge sources may as well promote a better employment of the internal resources of the organization for example by facilitating a higher degree of internal knowledge sharing between researchers of the sub group, e.g. university department. A by-product of collaborative activities may thus be that employees of the sub units of the focal firm are being better acquainted and therefore become more skilled in sharing knowledge.

Again it should be stressed, that it is important to distinguish between management of and management in networks. By focusing on these two levels and connecting the responsibilities with the right managerial level (either in or of the network), many challenges become easier to handle by separating the managerial decisions taken on a day to day basis from the overall design decisions.

Having said this, there is no doubt that the traditional way in which management is conceived and practiced emphasizing predictability and control is challenged by innovation oriented collaborations.

The challenges facing managers tend to be characterized by combining traditional managements issues with socially complex challenges that quite often emerge as dilemmas. Thus, as already argued, a managerial dilemma rises when mana-

gerial control needs to be combined with engaging a diverse range of relatively independent collaboration partners.

In practice, therefore, we see that collaboration projects places managers somewhere between two extremes namely between a managerial and an innovation oriented regime. This is one of the reasons why managing collaborations is also about understanding and facing dilemmas than simply about planning and executing linear processes. In other words, the emergent, non-linear character of collaboration projects confronts partner organisations with challenges that point beyond the traditional mode of managerial decision-making.

While collaboration projects may challenge the execution and control centered focus of "traditional" management there is little doubt that the interests of collaboration partners by no means become to leave management out of the picture. Quite the contrary, management in and of networks is still crucial for success in collaboration projects. The challenge therefore is to design the right type of collaboration network aligning purpose and size and to identify and define the role of management in and of the network. Having identified a number of dimensions including some key managerial dilemmas we will now turn to analysing the empirical survey of collaborative projects in the area. This chapter will outline the findings reported in appendix 5.2 and provide a summary of the key findings characterising more than 60 collaboration projects surveyed. After having summarized the key findings we will present a conclusion where we relate the key findings to the dimensions identified in the literature review. This will, however, not be a test of the findings on all dimensions for two reasons: The survey material is far from solid enough to do such a comparison and, more important, the dimensions from the literature study cannot be encompassed by one theory or set of variables. The literature review stress very clearly that network analysis at the present state of the art is able to highlight some general dimensions (such as exploitation vs. exploration) but without taking into account the context dependency of the survey findings. Bearing this in mind, we will comment on the results seen from the literature but not in the form of confirmation.

1.3 COLLABORATIVE PROJECTS IN CLIMATE AND ENERGY RESEARCH – EMPIRICAL FINDINGS

1.3.1 INTRODUCTION

In this chapter we put focus on the key findings of the empirical survey analysis[3]. As already clarified, the empirical focus is the field of climate and energy research. This field is in specific need of more efficient collaborative models that can facilitate knowledge sharing and thereby ease the development of new sustainable energy technologies. By analysing existing projects and processes in this field, we are able to derive new and improved models of governance structures for integrated partnerships in order to improve the innovation processes. The final goal is to work towards recommendations on the process of strengthening relations within the Knowledge Triangle of education, innovation and research in the European Union.

1.3.2 DATA AND METHOD

As shown in table 4 below, data was collected from projects done in a number of countries and as the figures show, this includes almost all SUCCESS member countries. As we will not do a benchmark analysis between countries, but rather between project types, the unequal number of projects from each country is not seen as a challenge to the project as such.

A total of 66 questionnaires have been completed.

3 This chapter summarize the findings presented in Appendix 5.2, Facts and Figures on Collaborative Projects in Climate and Energy Research by Knudsen, Line Gry, Finn Hansson & Mette Mønsted. The appendix contain a number of charts which are not included in this chapter.

COUNTRY	Belgium*	Denmark	Finland	France	Germany	Italy	Norway*	Poland	Portugal	Spain	Sweden	The Netherlands	United Kingdom*
NUMBER OF INTERVIEWS	1	7	5	7	8	3	6	0	6	2	8	12	1

Table 5: number of interviews done in each country

* = not member of the SUCCESS project

The aim of the questionnaire has been to collect data about present collaborative projects and thereby delineate best possible ways of organizing and managing collaborators. The projects vary a lot in regards to size, age and aim, yet they are all located in the knowledge triangle of research, education and innovation, with a varying weight on any of the three kinds of activities. The overall aim of most of the projects is collaborative research of some kind.

All projects are done in the field of climate and energy research involving many different technological sub fields. Thus, areas such as wind energy, wave energy, hydrogen energy, and sun cells (photovoltaic cells) are highly represented, as well as projects on bio fuel cell and biogas in general. A few projects deal with a safe and clean development of already known technologies such as nuclear fuel. A number of projects aim at developing new ways of limiting the CO^2 emission from various energy forms and some deal with the required adaption of the distribution net to new energy forms. Others work with the challenges of handling and storing new energy forms or they focus on adjusting machineries and motors. The majority of projects cover more than one technology; in fact, nearly all respondent state that interdisciplinary research is a prerequisite of success in their projects.

1.3.3 CHARACTERISING THE DIFFERENT TYPES OF COLLABORATIONS

The collaborative projects described in the questionnaires differ in regards to size, organizational complexity, aim, etc. In order to give an overall impression of the projects, their similarities and differences, this section will display the core characteristics of the collaborative projects described in this report.

20 of the 66 projects are initiated less than 3 years ago (q 207 [4]) (note: in 2 of the projects date of initiation

4 *The q207 refer to the Questionnaire, question no. 207-*

Table 6: Number of Projects Categorized According to Size

NUMBER OF PARTNERS IN THE GROUP	Joint unit*	1-4	5-9	10-19	20+	NA	**Total**
NUMBER OF PROJECTS	6	16	18	13	12(10)	1	**66**

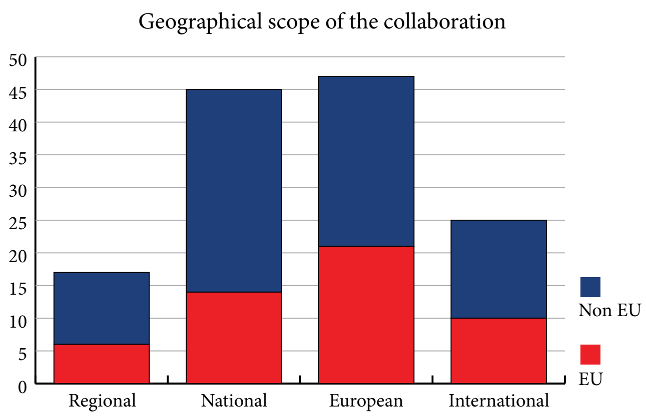
was not informed) and many respondents indicate that the aim of the projects has not yet been fulfilled. In both new and older projects a majority of respondents state that they draw on previous relations between the partners. 9 of the projects have been running for more that 8 years in the present form.

The number of partners involved in the different collaborative projects varies from 2 partners to nearly 70 partners. In 6 cases a partner is functioning as a network facilitator but it is hard to tell how many partners are included as this is either not mentioned or the number is varying. This type of organising differs from the majority of collaborations as the network facilitator is not as such part of the collaboration; rather this partner is supporting the other partners who are doing the actual research, education or innovation activities.

Larger collaborations involving more than 20 partners are interesting to study separately as we expect them to be more complex and hard to manage than the smaller projects. In 12 of the questionnaires, the project described has 20 or more partners. Two international associations (EAWE and ENEN on Wind and Nuclear energy) are described twice in two separate interviews and therefore the number of large projects is actually only 10, thus the bracket. Three of the large collaborations are associations (EAWE, ENEN, ENES) such as interest association or political association favoring the interests of the sector, in relation to either politicians and education of competent staff. One is a regional hydrogen experiment with buses in Oporto. This is an interesting regional collaboration, which shows some of the complexity of energy collaborations as so many partners are involved locally. One project is a large network in the Netherlands and Belgium, which has the form of a framework for other embedded projects, as it includes 9 sub projects organized in a matrix linking the projects together based on subject of interest. One of thesis focusing on hydrogen and the relation to other technologies and an additional project is on new materials (unfortunately poorly described).

8 out of the 10 large scale projects are financed by the EU framework programs. This is interesting as it may indicate that partners do not tend to design very big projects unless it is prescribed by the framework program. Also, it is interesting that 6 out of the 10 different projects are functioning without a joint governing board. This indicates that partners in large scale projects operate as independent units meeting only for knowledge exchange and/or a limited number of shared activities.

Many projects span national borders; 26 projects bridge the borders of different European countries and 15 are international projects going beyond the borders of Europe. The European projects may be coincident with the international projects. 31 are national and only 12 projects consider themselves strictly regional in scope (q210). The diagram below shows the projects grouped according to geographical scope and the red colored part of each pillar illustrate the number of projects based on EU funds (EU framework program 6 or 7). Accordingly, a little more than one third of the projects that are national in scope are undertaken as part of an EU framework program, whereas the EU funds a little less than half of the European projects. This is quite surprising, as we expected more of the European collaborations to be initiated based on EU-funding.

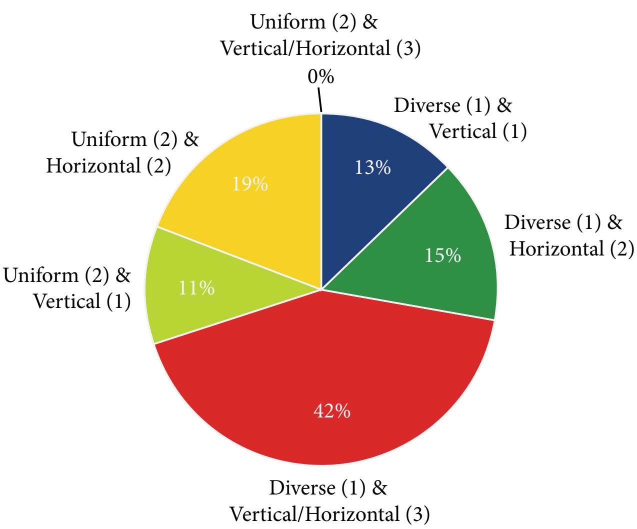


In order to analyse the level of complexity characterising the collaboration projects, we have to combine the dimensions of cross-disciplinarity or diversity in technology and look at whether or not the projects are based on vertical collaboration along the value chain. It is interesting to study the technological diversity but also to assess whether collaboration is carried out at the same 'level' of either research or innovation.

Some projects involve only two or a few partners from a single, core technological field. These projects are characterised as 'uniform'. In other projects participants come from many different disciplinary fields spanning different technological areas. These projects are termed 'diverse'. Additionally, projects are characterised by the degree to which partners are dispersed along the value chain. Some projects comprise, by way of example, partners from basic research, development and production. Such projects are 'vertically integrated' as they span many parts of the value chain.

Other projects are undertaken with the aim of conducting basic research on a core part of a given technology and are therefore not involved in development or production. Such projects are 'horizontally integrated'. The pie chart below displays the various combinations of connections between partner organisations in terms of diversity (diverse or uniform) and in terms of integration (horizontal/vertical).

Partner Diversity & Integration Value Chain



42% of the projects are characterized as being both diverse in relation to the disciplinary or technological background of partner organisations and as being vertically and horizontally integrated along the value chain. Being both horizontally and vertically integrated means that projects are focused on basic research in a manner that includes a variety of disciplines (horisontal) while having a vertical scope as well due to partners with a focus on application, further development and commercialisation of basic research outcome. In general, 70% of the projects are diverse in relation to partner background. 19 % are uniform and horizontal which may represent the lowest degree of complexity and the most narrowly focused or specialized projects.

1.3.4 LEGAL UNITS AND JOINT SPACES

21 of the 64 interviewees state that they have formed a shared legal entity in the collaborative project (q 203), and 29 say that the project has its own physical entity (q204). Thus, some projects are located at a shared physical domain even though no legal entity is established. Only one third of the projects studied have a legal entity, meaning that a specific unit takes care of legal issues before and after project initiation. The central unit takes care of certain limited activities such as determination of property ownership, contract design, and prosecution of potential lawsuits. A little more that a third of the projects (22 projects) share a physical space in the in the form of a shared laboratory or offices.

49% neither have a legal unit nor a shared physical space, and 30 % both have a legal unit and a shared space. 5% have a legal unit, but no shared space, whereas 16% of the projects have no legal unit but do have some shared facilities. This provides us with a clear picture of a relation between the existence of a shared space and the need for a common legal unit:

almost 80 % of the projects have either none or both. The central unit or the shared space may be reflecting the type of collaboration. The larger collaboration networks where some are closer to associations or regional development offices will have a shared space or joint unit. The central unit may act as 'the spider in the web', or as a kind of joint venture. It is hard to make a precise interpretation on this subject as a joint unit may reflect either a very diverse and weak collaboration, or it may represent a very strong-committed collaboration developing into a joint venture as the joint co-operative unit.

1.3.5 TYPES OF SHARED ACTIVITIES

As already described, partners of collaborative projects undertake a number of different activities and the activities are very diverse in regards to how they are formally organized. 12 projects is organized as joint ventures or based on a third party structure and 47 projects include the convention of shared workshops. 38 of the projects are EU projects, meaning that they are either part of the framework 6 or the framework 7 program, and 46 are characterised as cooperative programmes. In 21 projects a common laboratory is established. 18 projects are NOEs or clusters (q202).

When asked whether collaboration includes the formation of a new, formal entity, 7 respondents answered that they formed a joint venture, 2 that they formed a service company and 10 respondents answered that they have formed a spin-off on the basis of the collaborative project (q313). Then we know that some of the joint ventures are not legal units, or maybe they play the role as organisations initiating projects, not being a result of the collaboration.
In 24 projects partners own the intellectual property jointly (q205). This means that almost 2/3 of the projects are undertaken with split rights to the results or the partners have just been planning on dealing with IPR issues along the way. This may seem as a potentially problematic situation, but as we shall see below, only 7 respondents state that they have experienced problems due to IPR matters. This does not imply that disagreements cannot potentially pop up, but it indicates that many have taken precautions against these kinds of troubles.

1.3.6 CHARACTERISTICS OF THE EU FRAMEWORK PROGRAM PROJECTS

When focusing exclusively on the 38 projects that are undertaken under the EU framework programs a few trends stand out. 31 of the 38 respondents state that the main motivation to join the project was to explore new knowledge, and 5 point to exploitation of already existing knowledge or resources as the main driver for engaging in a collaborative project (2 have not answered this question). 10 of the EU projects share a legal unit and 13 have a joint physical space. 24 EU projects are diverse as they have more than two partners that belong to different organizations and they have a broad focus on different technological areas. 11 EU projects are characterized as uniform as they either have only two partners or a narrow research scope with a focus on one, primary technology, i.e. they stay in collaboration with the same type of partners focusing on the same technology.

1.3.7 MOTIVATION TO COLLABORATE

When asked why they wanted to engage in a collaborative project at the outset, 45 interviewees state that they were motivated by the need for new competences. In a little more than 30 projects the reasons for collaborating are to be found in the need for combining research and education, the wish to share research infrastructure or the need for complementary resources. In 36 projects an opportunity to collaborate on funding or application activities is said to be the motivation behind the collaborative project, whereas only 13 partners state that access to financial resources are the reason for their involvement in collaboration. 16 point to economies of scale as an original motivation to collaborate. This demonstrates how main motivational factors do not pertain only to economic considerations in a narrow sense. Indeed, in many cases the motivation to collaborate is about accessing new knowledge or sharing tasks related to application processes. In the EU projects this may be understated as the motivation of getting funding is understood as obvious. This being said, it is also clear that EU project partners would not go through the hard work of applying for EU funding and of making the actual collaboration work, if there were no other benefits besides economic funding.

An additional motivational factor relates to the fact that many partners regard interdisciplinary research as necessary in order to solve key research problems of their field. Out of 41 respondents answering this question 40 state that interdisciplinary research is crucial.

Besides being characterized by the motivation (measured as either exploration of new knowledge or technologies or exploitation of already existing knowledge or resources), projects are also categorized by what type of activity they involve. In keeping with the overall focus of the SUCCESS project and the idea of the Knowledge Triangle, the collaborative projects are categorized as being oriented towards innovation (I), education (E) or research activities (R), or a mix of the three. The distribution and combination of essential activities is illustrated in the following chart:

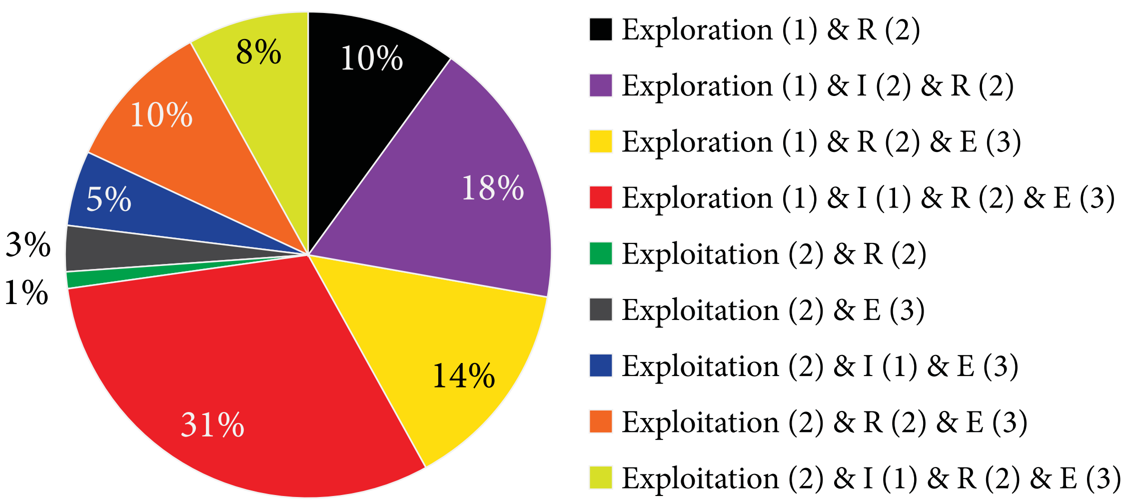
Almost every third project is undertaken with the aim of exploring new knowledge while simultaneously engaging in innovation, education as well as research activities. This could in part be explained by the presence of EU-projects, as EU funding criteria emphasize all 3 aspects of the knowledge triangle as a necessary condition for receiving EU funding. The exploration with research and innovation is 18% and exploration with research and education is 14%. Indeed, it seems that the projects initiated with an exploratory aim (73% in total) are more likely to engage in a diverse range of activities.

1.3.8 BENEFITS AND RESULTS OF COLLABORATIONS

61 respondents consider collaboration to be a win-win situation for all partners and 58 of the respondents state that the project conveys new technologies (q304).

At the same time, 49 respondents state that their collaboration project marks an improvement of existing R&D and technologies (q305). This shows that many projects may hold elements of both improving existing technologies and developing new technologies. Fundamental innovations are found in 38 projects and 40 projects are said to be economically beneficial.

Motivation & Purpose



39 interviewees responded that the outcome of projects were the expected ones (q308) and 23 state that unforeseen results has occurred during the project (q309). However, many projects have not yet produced any results as the projects are launched recently.

In addition to answering questions about the expected results, respondents were also asked if their project was beneficial in other respects. To this 39 answered that the project has resulted in publications. 51 have participated in new networks due to the engagement in the project and in 19 cases new patents are taken, and 51 respondents point to new training or educational activities as an additional benefit. This implies that a number of additional benefits do emerge while projects are carried out. This reflects the fact that R&D activities are never completely predictable.

1.3.9 MANAGEMENT

In almost all projects (in 59 cases) a formal leader is appointed to be responsible for managing the diverse workgroup. 5 projects are operating without any formal leader. Even though it is common to appoint a formal leader, some characteristics of the projects without leader may be interesting to look into. In brief, the five cases where projects were undertaken without formal leadership were characterized by having no own legal entity, no shared physical space and no ownership of intellectual property. Still they were all successful projects working with new technologies. 39 projects (approximately 2/3 of the collaborations) decided the collaborative model in concerted action. 12 respondents state that the collaborative model was decided by tradition and 15 point out the sponsor to be the mind behind the collaborative model. In 33 projects, the initiator is the one who designed the collaborative model. Only in one project the collaborative model is formed by chance (q206).

1.3.10 CHALLENGES

From previous studies of collaborations, strategic alliance and the like, we know that many collaborative projects fail to live up to the expectations of the project constituents. Therefore we have tried to cover this issue in the questionnaire in order to get more information on the reasons for controversies to crop up. As the projects in this study are all characterized by being successful we expect that no major problems have occurred.

The most common type of problems that respondents refer to are passivity of a partner and/or lack of delivery of promised services. Additionally, 14 respondents say that they have experienced problems tied to organizational issues such as problems in management structure or in relation to the steering group. Some respondents have mentioned that the word ‘problems’ might be too harsh, but that they had in fact experienced a number of challenges or obstacles throughout the project. This indicates that ‘project challenges’ is a potentially problematic issue to examine as people may have vey different perceptions of what constitutes a real problem and when an issue transforms from being a minor discrepancy of perceptions into being a distinct problem that impedes the project.

Only 7 respondents tell about problems due to IPR disagreements while 50 respondents state that no such problems have occurred. Even though IPR issues are among the less mentioned reasons for problems to occur contracts and formal agreements are still mentioned by 18 respondents as a problematic area.

1.3.11 INDUSTRY/UNIVERSITY DIFFERENCES

We asked a number of questions to either the university partner or the industry partner separately. 44 respondents answered the questions targeted to the university people and 14 answered the industry questions. Thus, in 7 cases the respondents did not answer these questions.

As already shown, the need for new competencies is a shared, primary reason for collaborating for industry as well as university partners. In addition to this, gaining access to complementary resources is stated as a core motivation to collaborate by 73% of the industry respondents whereas only 48% of university partners refer to this as a motivational factor. This represents the strongest example of diverging motivation factors. Only 19% of the university respondents point to the option to utilize economies of scale whereas 32% of the industry people see this factor as an important reasons for collaboration. Motivational factors that are more important to university partners than industry partners, comprise the opportunity to access complementary technologies, sharing research infrastructure, accessing distribution systems and sharing of applying for funding.

When looking at the answers given by the university respondents alone it is legible that a majority of universities are very keen on dealing with IPR issues. Thus, 37 out of 41 answered that their university (or the university involved in the collaboration) has a policy for taking care of IPR matters (q705).

As a final question, the industry partners were asked to point to what kind new knowledge or competencies they have gained as a result of collaborating. Only industry partners answered this question, and from these responses we see that the accessing new master or PhD student was the most often mentioned gain from collaborating, but the multiple purpose of innovation, access to public research, and new employees are nearly as important.

1.3.12 SURVEY FINDINGS - CONCLUSION

The data material collected through the survey is in many ways unique, and to our knowledge, there are no equivalent study in the area of research collaboration. We are, therefore, able to produce an interesting description of a variety of projects pointing to several important aspects of research collaboration in the field.

Clear models describing the variety of collaborative projects do not easily emerge from the material. However, a number of key findings are important to outline:

- First, it has become clear that decisions taken on how to govern collaborations are closely related to questions of size, age and the specific type of organizations that participate in the collaboration. However, the core challenge in these projects seems to be general to all projects. It has to do with the passivity of partners, who fail to deliver the promised knowledge or resources. Often, the management of the collaboration have no real option to sanction passive partners by managerial intervention, and this is a typical problem in networks of this kind.

- Second, we have asked about success criteria for collaboration. Unfortunately most of the respondents do not answer this question. It seems that the majority of respondents perceive their projects to be generally successful, but they do not further specify this. However, a few respondents state that specific events are seen as critical as they have either kick-started the project process or made the benefits of collaboration visible.

> *"The key moment was when we get together the first time and we decided to do this. We were just the key partners, the initial core group partners, and we realized that we can do this and we can win this proposal."*

Others point to the evaluation of whether the milestones are reached as vital. Additionally, the process of evaluation is also said to entail a dilemma as it is hard to asses the results of new project, yet at the same time, they need good evaluations to proceed.

> *"Critical moments are the evaluation. The programme is only three years old and the evaluation must be made before planning the next phase, before continuation. On the other hand, the evaluation must wait until sufficient amount of results and experience of the programme is ready. This*

creates a tension"

"Milestones and deliverables have been set in the project proposal and have been the key moments for the finalisation of project results."

"The annual external review"

"The Annual review by general assembly leading to changes in research directions"

"A milestone was the event in which we signed the agreement for the Academy."

Partners also refer to the physical meetings as essential to the success of the project.

"Frequent meetings of the key core partners including the funding agency [are essential]. Flexibility is required, we must be able to react whenever immediate decisions/action. Open communication of issues. Trust is important and it is gained through personal long-term relations."

This quotation points to the importance of creating trustful relations.

"The real test cases where the collaboration based on [exchange of] documents are not calling for strong collaboration. Yet, if [the collaboration] involves real demonstrations and real implementation, then the collaboration needs to be strong. The big milestone was starting operating the hydrogen buses in the city of Oporto."

- Third, there seems to be some correlation between the size of the collaboration, its inclusion of different types of partners and the setting of a managerial unit, often with its own location. Larger collaboration networks have their own location, and a clear management structure. 10 of the EU projects (F6 and F7) share a legal unit whereas only 15% of all projects have a joint ownership to IPRs, leaving a large number of collaborations open for potential conflicts. However, it seems to be possible to negotiate these matters as only seven collaborations reports on conflicts in this area. The issue of size of collaboration is an important dimension, due to the importance of creating trust in relatively homogeneous groups, or between people who have collaborated before. This type of informal, trust-based organization is difficult to maintain in large collaboration networks. A few of the smaller collaborations are based on earlier experience with large, collaborative EU projects, and they are stressing the need for collaborating with people that they can rely on and know well. The process of selecting the right partners is therefore seen as essential.

- Fourth, the level of engagement in the partnerships is very different across collaboration projects, as some are not close collaborations affecting core activities, but only a part of forming associations and contracts beyond the firm or local university. The assessment of the need for firm management structures are to be evaluated in this light. Additionally it seems that when an industry partner is involved as initiator of large projects they want to stay in charge of the project

As already stated at the outset of the survey analysis, no confirmation or rejection of a well defined hypotheses was expected. However, the key findings of the survey represent a number of important aspects characterising the majority of the collaboration projects in the survey.

More importantly, the survey clearly illustrates that there is no one best model of collaboration to be implemented in the complex area of sustainable energy and climate change research. Nevertheless, the survey has produced a number of important insights into the area and in the following chapter we will investigate this further by presenting three in-depth case studies from the portfolio of surveyed collaborations. The case studies were conducted as a supplement to the survey using interviews with collaboration managers and employees in order to develop a more rich picture of the diverse contexts characterising collaborations in the area of energy and climate change research.

1.4 COLLABORATING FOR SUSTAINABLE INNOVATIONS: THREE CASES

In the following we focus on three case studies where the interdependent nature of innovations in the energy sector has influenced three research and development (R&D) projects. In all the cases the focal firm has chosen a R&D projects in close collaboration with external partners and we will focus on the challenges in regard to managerial and organizational matters that this may generate.

1.4.1 CASE 1: THE SMALL AND ELITIST NETWORK FOR PRODUCT INNOVATION - TOPSOE FUEL CELL

Topsoe Fuel Cell is a subsidiary of a large Danish firm Haldor Topsoe. The Fuel Cell Company is dedicated to development, manufacturing and marketing of solid oxide fuel cell (SOFC) technology. The firm is established as a subsidiary in 2004, and is now employing 100 people. They are engaged in a number of collaborative R&D projects for developing and testing fuel cells.

The fuel cell technology is dependent on a number of cross disciplinary skills and technologies, and Topsoe Fuel Cell's core competencies are on ceramic processing, catalysts, and catalytic process design. They are adding value on cell, stack and the catalytic parts of the overall fuel cell system. They collaborate with companies and universities involved in power conversion products, who fit the cells and the modular fuel cell stacks into a complete system. The prototypes are constructed for different market segments in collaboration with partners in order to ensure that the development is market driven. In 2008 there is an emphasis on three (pre)-markets: distributed generation, micro-combined heat and power, and auxiliary powers units for transport units. The idea is to work on both local micro-level and large scale level and hopefully get some elements working in 2012.
The development of this unit is a continuation of earlier technology development in this advanced research based firm. There is a focus on application of the technology, but also an emphasis on trying to get public funding into the early stages of research and development. Haldor Topsoe Fuel Cells have received funding and grants from the Danish high technology fund in a consortium with Risoe National laboratory and Danish Technical University both on materials physics and calculations on these. Previously they have worked with a number of different small specialised firm, some on hydrogen for fuel cells. Earlier collaborations have included different EU funded projects, some of which included a large number of partners (over 20). At present they lead a small EU project with five other partners (three research companies or institutions and two universities), whom they successfully have worked with before. This latter collaboration is different as it involves a public institution testing out the product and working on a vertical specialisation of the technology. In sum, the managers and employees at Haldor Topsoe Full Cell have a diverse experience in collaboration with a variety of partners.

According to the research director who is managing the collaborative project, the company need to collaborate vertically; that is, with companies that can add knowledge and know-how, for example for the application side of the product. In order to be successful and effective in this collaborative endeavour it is necessary to form a small group of people within the partner firms, who know each other well. This may also be beneficial as fewer resources are spent on coordination and communication in the group as the participants know each other and know what to expect. In order to build up a good collaborative group it is necessary that the partners clearly complement each other with regard to knowledge and competencies. In this project the sharing of intellectual property rights are solved as they are handled in the original contract, as this is an issue that otherwise may create problems. As all background knowledge is not part of the rights of the innovations it is important to describe the parts that are included in the joint project very carefully. The contract has to be workable, also when innovations develop, and thus have a clear decision structure to cope with changes.

The motivation to engage in this project is to get access to complementary technology and resources, and to get knowledge on implementation of the technology. The universities that participate in this project have Ph.D.-students working on these technical issues. The research collaboration is an important part of R&D in this industry, as there are aspects that are very much research based, and far from innovation and implementation. The demanded collaboration for public funding is a challenge, but has been used also to confirm and exploit other technical knowledge in universities and research laboratories. Yet, as the research manager stresses that based on experience, they only want to engage in collaborations when they are in control of the process. External funding is necessary for the early stages of advanced research for innovation, but the external funding is not enough to start new projects and even new experimental project have to be well embedded in the firm's strategy and research profile.

Analysis
Some of the most important results from this case of a very tight and closed network is:

1) Need for verticality:
It is interesting that even with such a technology that will be so flexible to focus both on transport, on small units, such as house-energy and for large power plants, the link and relationship to the users and the distribution net is stressed as very important for the development, and could be the clue for creating a market. They want tight networks of complementarity (Burt 2005).

2) Necessary new knowledge:
Collaborations are not just for the funding of research, but also for both developing research, innovation and for creating a system for implementation and use of the technology. The interdependency between technologies becomes even more important when looking at fuel cells, as they may be combined with other technologies for production of energy, and may preserve some of the energy in the decentralised sustainable units. Also, being a well defined network with a clear need for specific knowledge areas this network can in a limited way act as a recruitment system.

3) Management perspectives:
The coordination is easy as it is a small group who know each other well, and trust each other's competencies, delivery of results and - more informally - the people involved in the process. This type of small and very integrated group with long experience of close collaboration does not need a high level of managerial control. Basic outlines of strategy and project management will be sufficient after the contract is settled.

1.4.2 CASE 2: LONG-TERM PLANNING FOR GLOBAL RECRUITMENT AND KNOWLEDGE LOCATION - SIEMENS

The general strategy of Siemens has been to set up collaboration with universities to form 'Centres of Knowledge and Innovation', as they believe that technological challenges are too complex and expensive for one university or institution to handle alone. The overall goal is to start these kinds of collaborations all over the world, with an emphasized geographical focus on new markets, to engage in joint research with researchers, promote teaching and take part in Ph.D.-projects as a way to recruit qualified staff.

In all of the offices at the centres senior ambassadors are aiming to connect to universities and create joint projects. This has been done since the 1970es, where the ambassadors have been assessing a large number of universities for possible collaborations. Once the broker in Siemens has identified possible good partners, the relevant local division takes over and include the collaboration into their own budget. This is a way of securing that collaborations are shaped by actual needs of the involved researchers and that the collaboration project has a joint space or organisational platform.

At Siemens they find that the early stages of collaboration are often the most difficult ones, especially when they collaborate with academic institutions. US universities are often easier to work with, as they have industry liaison offices taking care of contractual and other formal issues. Another difficult issue is to find the "right" project leader. A corporate contract with top management is not in itself sufficient. The contract has to be anchored at the right people in the organisation. In the collaboration with DTU and the National laboratory of Risoe they have a long collaborative experience, where expertise is developed both at Siemens and at the involved university and public research institutions. The need for both specialised and cross disciplinary innovation in the field makes it necessary to include the relationship to education, in order to produce the next generation of researchers who can push new technologies forward.

In an interview with the project manager about the special challenges of the energy sector, the many paradoxes of future energy systems come up. Siemens operate on the basis of a 10 year perspective on many different technologies, both on fossil power, oil, gas, instrument control, wind, turbine design and thermal energy. As a manager state: "the energy sector is special in the way that the technological development and innovation rate is very slow compared to other sectors, such as IT or biotech." Biotech has a much more elaborated networking and collaboration structure. He continues; "the distribution nets are based on old technology: there is a very urgent need to work on grid net innovations to cope with new forms of sustainable energy". This demands new forms of collaborations with the state and partly privatised institutions running the grid net, but it is the same in US, where it is private. "It is a paradox that we have 10-20 years of investments in the planning, but we do not have so much time, as climate problems demand faster solutions", as the research manger concludes.

Analysis

Core learning from the case of Siemens is related to the following subjects:

1) Collaboration as a recruitment strategy
Having invested in and build a worldwide network of partnerships with universities, Siemens has access to a broad pool of talent. Nourishing strong relations to university environments is therefore a key part of Siemens overall recruitment strategy.

2) Local Anchoring for staff, network and market
At Siemens a corporate strategy for university –industry collaborations is developed. This means that strategic decisions are taken both at corporate level, and at department level where researchers are involved. Even when a collaboration project is a long term and highly profiled engagement based directly on headquarter strategy, the actual implementation always unfolds at divisional level, where relationships of trust are build and where division of labour between partners is specified. This highly decentralized model also reflects the need for regional/local solutions in a globalised company.

We may – as a comment to the Siemens case – point to a possible link between the pressure for and complexity of new energy solutions and Siemens' focus on collaboration as a mean to accelerate innovation processes. Siemens' strategic focus on collaborative projects reflects the pressure for innovation in the field of energy and climate in the sense that bringing together diverse yet mutually reinforcing capacities may accelerate the process of delivering new solutions to the marked. In other words, the demand for new energy solutions do not only impact the development of technology. It also put pressure on the more closed innovation models characterising many R&D

activities. As such, the energy and climate challenges intensify both technology and the organisational and managerial aspects of creating innovative solutions. In the case of Siemens the collaboration strategy is also interesting due to its potential effects on how big corporations handle the pressure for innovation in general. A decentralised model with close collaboration with cutting-edge knowledge environments outside of the organisation provides a strong example of how big (and often very bureaucratic) companies may reinforce its capacity for innovation and knowledge creation.

1.4.3 CASE 3: LONG-TERM COLLABORATION FOR LOCAL KNOWLEDGE BASE - VESTAS

In 2007, the Danish company Vestas Wind Energy Systems A/S (Vestas) decided to establish a local office at the Danish National Laboratory, RISØ. The purpose for Vestas is to be close to new knowledge and ground breaking ideas in the field of aerodynamics specifically, and wind energy in general. Having an already well established tradition for collaborating, the office is seen as a perfect frame for facilitating future collaborative projects between Vestas and RISØ. Furthermore, setting up an office at RISØ is part of Vestas' corporate strategy to systematize and consolidate activities involving external partners. In addition to this, having an increasing need for talent, Vestas will benefit from a direct access to graduates and PhD-students at the Technical University of Denmark (DTU) which is the mother institution of RISØ. By establishing an office at RISØ Vestas is hoping to make their way through a field marked by high competition and constant need for new knowledge. Vestas have experience from a local unit at Aalborg University on electricity specialisation, where they also have one of their own researchers placed. Vestas is also looking for similar agreements with a number of US universities.

The first collaborative project initiative at the shared premises was a project focusing on how to demonstrate and advance wind turbine technologies in a cost-reducing direction. More specifically the project was about how to develop and demonstrate an intelligent, cost-reducing wind turbine blade. The project partners were DTU (represented by the MEK/DTU and RISØ/DTU Departments) and Vestas' Global Research Organisation.

The problem to be solved is to develop a wing turbine blade that which is able to adapt to changing wind conditions. The research agenda is to create "adaptive wind turbines" with the capacity for "intelligent responses to turbulence." In a vivid description of the project references are made to the ability of raptorial birds to adapt the shape of their wings in accordance with the turbulent airflows around them: "On a windy, hot summer day, with beautiful cauliflower clouds in the sky, the air is turbulent. If we could see it, it looks like a hot pot of boiling water on the move. In these unsteady surroundings, we will see a raptor hovering, completely still, with the eyes focused on its prey in the field. The raptor manages to do this by adapting the shape of its' wing, while the air surrounding the raptor is constantly in flux due to the turbulent wind conditions. If we could adapt the same intelligence to a wind turbine; that is, manage to keep the blades still while harvesting the turbulent wind, we would be able to reduce the loads on the turbine structure." In order to extract knowledge from adaptive birds, researchers need to detect the wind in details, and they must learn how to take an intelligent course and rapidly adapt the blades. They expect that adapting the blade can be done by means of a flap on the trailing edge of the blade, which can be compared to the large feathers on a raptor wing, or, more technical, to the aileron-flap on an airplane wing. The flap affects the ability to steer through air, making the wing react to turbulence. Adding sensors that detects the wind, a computer can find out how to react; – "So, all we have to do is to find the intelligent reaction to turbulent wind on a hot summer day" as it is stated in a project description. Thus, the most important achievement in the project is a practical demonstration of the intelligent wind turbine blade.

The project group expects that reducing the weight of the turbine blades, will allow lighter constructions. A lighter construction uses less material and is cheaper to manufacture, cheaper to transport, etc. The adaptability of wind turbines to react upon non-linear wind conditions will open new possibilities and expand the potential of wind energy worldwide. Therefore, the project is defined as a high potential project with possibly high impact on future generations of windmills and the economical and ecological efficiency of wind energy. Still, it would hardly be impossible for Vestas to pull this project through alone; they need the knowledge and the experimental experience of DTU/RISØ[5]. Especially the different and complementary knowledge of the two groups has motivated the managers to start the collaborative endeavour. An additional factor attracting the interest of Vestas is the capacity of RISØ researchers to carry out the feasibility studies needed in order to decide on the viability of this specific technological development. Accessing new knowledge and the best researchers in the field is thus one of the driving forces behind the establishment of a Vestas office at RISØ.

Even though a number of good reasons can be listed as to why this collaboration is beneficial to the partners, it requires a good deal of coordination and managerial skills to make the collaboration work. The formal parts of the collaboration such as the contract and IPR issues are taken care of by the governing board and the Danish National Advanced-Technology Foundation, A-TF (Højteknologifonden) who not only support the project financially but also offer assistance in project management. The overall governance structures are decided by A-TF who is also represented in the governing board. They expect a one-page monthly report on project status and coming activities. In accordance to the project manager from Vestas, the service provided by A-TF is highly professional and helps the local project manager to focus on the issues regarding the day-to-day management tasks. As the project manager stresses, "the successful project is not about applying the right formal structures, it is about creating trust between project members". The fact that VESTAS was about to establish an office at DTU/RISØ at the time where the project was initiated was just a positive factor that eased the practical set up of the project.

The project manager estimates the project to be 10 times as big as an ordinary collaborative project measured by man-hours and other resources spent. Even though the project is large in scale it only involves a few partners who know each other from previous projects. Deciding on a small number of partners was, according to the project manager, a joint decision. Vestas is experienced in doing very large projects as well, but for this project they preferred a smaller group of partners making it easier to coordinate the ongoing project activities. In larger projects "it is easier for peripheral partners to hide and omit to deliver the promised knowledge".

Analysis
2 themes are specifically pertinent in this case. These are:

1) Barriers for collaborations
In other university-industry collaborations issues such as intellectual property rights and agreements on commercialization of the results can infuse a number of unsolvable conflicts among partners. Vestas see these issues as the biggest barrier for future collaborations with universities as it is difficult for companies to accept that a partner aims to disseminate the jointly produced knowledge and even wants to commercialize on it. For companies the core aim is to get exclusive rights to the knowledge that is produced and it is difficult to accept that the university partner wants to play by the same rules as companies. This will, according to the project manager who draws on own experiences, cause many firms to refrain from collaboration in the long run. It may also harm the

5 The RISØ National Laboratories was previously a public research institute, and is recently subsumed under the Danish Technical University.

daily communication as the companies will hold knowledge back if they are afraid that the universities will disseminate new results. In the long run companies may start to do all research by themselves if they fear that their exclusivity is threatened. This is a field, where both Topsoe Fuel Cells and Siemens do not find problems. In the Vestas case the collaboration is old, and based on a long experience of building up the wind mill industry together and the conditions for this trust based access to public research has changed with a new patent law for universities. Contracts have to include issues such as Intellectual Property rights.

2) Need for Professional Management
Another issue that is highlighted in the Vestas case is the need for professional management in collaborative projects. An external partner like the A-TF that offers professional project management and keeps track of deadlines and provides support to the project managers are of high value to the project.

1.4.4 GENERAL ANALYSIS

In all three cases we saw companies with a strategic focus on collaboration. The experiences from collaboration projects seem to be that large collaborative projects involving a broad scope of complementary competencies are difficult to maintain. In every case, therefore, we see an increased focus on smaller projects with fewer constituents. Also, all three companies stress the need for collaboration in order to intensify technological development by accessing researchers and basic research environments at universities. In addition to this, collaboration is pursued in order to build strong, complementary relations between R&D departments and to accelerate the process of reaching applied technological solutions.
On the basis of the cases, and the experience from the survey in SUCCESS, dealing with management of collaborations involve a number of important dimensions. First, defining the level of management becomes important when there is a need for up-scaling of a given project. This may for example be a consequence of a wish to join all activities in a given discipline. Second, defining the level of integration of different sub networks becomes an important task in this setting. A high degree of integration will be beneficial for knowledge transfer between the units, but it may also harm the productive diversity of knowledge if all network members hold the same knowledge. Thus, the cases illustrate one of the basic managerial dilemmas of collaboration namely balancing the unity/diversity relation among project constituents. Third, the need for engagement in large, related networks is a core issue to handle. Decisions on more practical issues such as whether or not to design a shared legal unit and whether or not to have shared facilities are also core decisions to be made by collaboration managers. Finally, the cases illustrate the importance of understanding that network management is not solely an administrative task. Network managers need to understand how the disciplinary content of a project affects how to best solve ongoing managerial issues. Thus, the manager of a project need to have a clear understanding of the scientific content in order to facilitate and coordinate network activities optimally.

When analyzing the cases it becomes clear that the need for speed in the development of usable energy solutions is a core motive for engaging in collaborative projects. The increasing need for new solutions demands a high level of research progression and productivity. This demand can not be coped with if different knowledge resources and capabilities are not combined. Collaboration, therefore, is not simply chosen as a way to access more funds. More importantly, collaboration makes possible a high degree of inter-organizational learning and creative tension between different organisational capabilities.

A number of the arguments in the cases centers around the wish for creating solid partnerships based on trustful relations to known partners. It is argued that when basic research is the aim the project groups need to be of a limited size. The reason for this is that trustful relations are both robust and flexible making the project able to adapt to changing conditions and circumstances.

All the collaborative projects referred to aim to bring about new knowledge that can help the participating firms in staying innovative in their respective business areas. The projects are all about cutting-edge development securing the future of participating firms.
The project on collaboration has not been particularly focusing on markets. But it is interesting that all the firms are very much aware of the need to include potential customers or local groups with local networks. The access to front-end fundamental research is one type of collaboration, but they all stress the need to have vertical collaboration to get research into innovation. The integration of the application area is a means to get access to and create new markets.

1.4.5 SUMMARY OF PART ONE

Before we move on to part two a few summarizing points should be outlined: The literature study and the empirical survey together indicate a number of important insights into the complexity of research and innovation collaborations within the fields of sustainable energy and climate change.

- First, it has become clear that collaboration projects that are large, open and heterogeneous may be more innovative than small, closed and homogeneous projects. However, we also learned that the managerial challenges are equally important in order to not only create potential for innovation but also to actually deliver innovation. Large, open and heterogeneous projects are very complex to manage while small, closed and heterogeneous projects are significantly easier to handle for managers. One of the key reasons for this is that trust is easy to build in smaller projects and creating a common ground and engaging purpose is much easier in smaller projects. The risk of course is that smaller projects are not sufficiently diverse in their knowledge base making partner organisations less exposed to new knowledge.
- Second, we saw that when analysing managerial challenges facing collaboration projects it becomes important to differentiate management in and management of collaboration projects. Together these two levels of management constitute the whole of an efficient governance structure. We also learned that the importance of these levels change over time as the project goes through different phases.
- Third, we learned that managing collaboration projects essentially is about understanding and handling a number of dilemmas such as balancing between creating a sense of unity and common ground while maintaining the productive tensions that derive from the knowledge diversity of collaboration projects. The managerial dilemmas change over time and seems to be one of the most important aspects of building innovative and efficient collaboration projects.

Now we will turn to the macro-level analysis of the report and try to put the findings of part one into context.

PART TWO: THE BIGGER PICTURE – CONTEXTUALISING COLLABORATIVE PROJECTS

After having analyzed more than 60 research and development collaborations in the sectors of sustainable energy and climate change in Europe the next chapter will present a discussion of the context for these collaborations. One of the conclusions from the study was the diversity in size, in sectors, in participating organizations, in time perspectives made it impossible to think of one specific model for collaboration. The common thread in all collaborations was the fact that they all received some kind of funding from EU. The role of the EU governance and EU funding was at the time of the study very much in focus, not the least because of the announcement of the new European Institute for Innovation and Technology and the planned announcement of a number of Knowledge Innovation Centers to be established in Europe.

Up till now (i.e. within the WP1 of the SUCCESS project) we have discussed barriers and support for collaboration based on information from the survey and as a consequence hereof primarily in relation to a meso level of analysis. It means that we have focused on how existing research organizations, universities and companies have and can handle collaboration projects under existing systems of EU policy. On such a level it is possible to come up with a number of important insights on how specific types of network relations either are a hindrance or a support for development of a successful collaborative network. None of these networks exist in a vacuum – they are all part of the larger European system of innovation, consisting of regional, national and EU based policy initiatives supporting innovation.

The following chapter will present a framework for the discussion as it took place at the time of the study on the future of sustainable energy and climate change research and development collaboration in the knowledge triangle in Europe. The framework consists of an elaborated study of the system of innovation in Japan and USA (see appendix 6.1, 6.2, and 6.4 for further discussion) and presentation and assessment of the EU innovation system primarily based on literature studies on different national systems of innovation.

The following should of these reasons be read as background information for the status of the how the perspectives of future collaborations in these fields looked like in the spring of 2008. The discussion of the various governance policies (i.e. the EIT and KIC's as mentioned in the report) are on a completely theoretical level and have no direct bearing to the results analyzed in chapter 1. They have, however, the status of establishing a broader policy frame of reference for the understanding of the interconnectedness between the general EU policy on innovation and the way this policy define the framework in which specific strategies for collaborations are formed. The relevance of these discussions is furthermore very high as they are based on the official EU stated policies which all researchers in Europe have related to in the various framework programs over the last decade.

2.1 NATIONAL SYSTEMS FOR INNOVATION[6]

2.1.1 INTRODUCTION

The increasingly fast pace of economic globalisation has utterly changed the world's economic order bringing together opportunities and challenges. This new economic order demands countries to strength their inventiveness and capability to adapt to changing environments, quickly react to emerging social needs and preferences, and therefore, innovate more (EC, 2006a). Europe has acknowledged this pressing need and has developed a "broad innovation strategy" aimed at increasing its capability to translate technological and non-technological innovation into commercial goods and services. The Commission expects large benefits based on Europe's endemic innovativeness, cultural diversity, and its growing common market in which innovative products and services can be successfully placed (EC, 2006a).

6 Edited version of appendix 6.4. Edited by Finn Hansson.

The current "European innovation policy framework" finds its origins in the Lisbon Strategy for Growth and Jobs (See EC, 2005a). The Lisboan strategy sets a number of reforms and policies to make the European economic regulatory environment more innovation friendly, increasing the average research and development spending (R&D) from 1.9% up to a 3% of GDP and the private funding proportion from 55% to 66% by 2010. This Financial Framework targets innovation through cohesion policy, the 7th Research and Development Framework Programme – the FP7 – and the Competitiveness and Innovation Framework Programme. A second milestone in the new EU innovation policy is the Commission's Communication "More Research and Innovation" – October 2005 – setting up 19 actions regarding innovation and research across the Member States coordinated through the National Reform Programmes (See EC, 2005b). The action plan proposed different measures to strengthen the capacities of the higher education, research and innovation sectors, and the links between them (EC, 2006b).

Although the implementation of this action plan has influenced positively research and innovation policies in some Member States, notably in the Nordic Region, the overall competitive and innovative performance of the EU remain weak, particularly in comparison to rival economies such as the US and Japan (EC, 2006a). "Europe still falls short in turning R&D results into commercial opportunities, developing a concentration of human, financial and physical resources in research and higher education, promoting an innovation and entrepreneurial culture in research and education, as well as in setting up new organisational models suited to today's needs" (EC, 2006b). A recent attempt to overcome this impasse is the creation of the European Institute of Innovation and Technology (EIT). This initiative aims to become a flagship for excellence in European innovation in order to face the challenges of globalisation and to become a world-class innovation-orientated model, inspiring and driving change in existing education and research institutions (See EC, 2006b). The EIT is the first European initiative aiming at a full integration of the three sides of the "Knowledge Triangle" – higher education, research, and business-innovation. Hence, by increasing Europe's capacity to transform education and research outputs into tangible commercial innovation opportunities, the EIT will further bridge the innovation gap between the EU and its major international competitors (EC, 2006b). The EIT structure and performance will, as far as described by EU presently (spring 2008), be based on collaborations known as "Knowledge and Innovation Communities" (KICs) or "highly integrated public-private networks of universities, research organisations and businesses" (See EC, 2006b). The EIT's activities and its strategic management will be coordinated through a Governing Board representing actors from all sides of the "knowledge triangle" and financed by an initial budget around EUR 300 million during the period 2008-2013. The KICs will be selected by the EIT Governing Board on a strategic base in line with EU priorities, and their operations will be extended across Europe. Likely, the first areas covered by the Institute include climate change, renewable energies, and next generation of information and communications technologies. The Governing Board will propose seven-year "Strategic Innovation Agendas" (SIA) outlining the Institute's long-term priorities and financial needs. The first SIA is expected at the Council and the European Parliament before the year 2011.

The present chapter concerns a contribution to Work Package 1 regarding two of its main objectives:

- Clarification of the analytical framework of innovation systems and detailing plans and criteria for the analysis
- Detailed analyses of the most important existing regional, national, EU and intercontinental growth and innovation models, both on the education, research and business sides.

Our contribution focuses on the present EU innovation governance, its comparative international performance and implications with the goal to identify the (spring 2008) state-of-the-art EU description towards an eventual future KIC on Climate and Energy within the EIT competence.

2.1.2 EU POLICY ON ENERGY AND CLIMATE CHANGE

The energy policy in the European Union addresses three issues of major concern among Member States: the challenge of energy security, environmental impacts of energy use, and the continuation of energy deregulation and system integration across the EU (Runci and Dooley, 2004; Jørgensen, 2005). In the context of energy security, EU energy policy focuses on issues such as rising energy import dependence and the political constraints that emerge from increasing levels of energy dependence. The EU energy policy in environmental terms primarily focuses on global climate change, aiming the coordination of efforts to reduce greenhouse emissions across Member States. Finally, the EU energy policy seeks to encourage the harmonization of national regulatory regimes and networked energy systems, as well as the promotion of common energy markets.

In the particular context of Climate Change, the EU has committed itself to reduce drastically greenhouse emissions ratifying the Kyoto Protocol, in 2002. Accordingly, the EU is legally compelled to reduce the cumulative emissions of six key greenhouse gases within the period 2008-2012. Within this treaty, each Member States have different emissions reduction obligations according to the differences in economic development and emissions levels. In order to coordinate related actions, the EU launched in 2000 the European Climate Change Programme (ECCP). The programme addresses all economic sectors – notably the energy supply and consumption in transportation, industry, and buildings – and aims to reduce CO2 emissions – that account for 95% of the total EU's greenhouse emissions – across all Member States (Runci and Dooley, 2004). The ECCP supports the efficient management of electricity transmission and distribution networks, use of renewable energy, a wide use of combined heat and power, and energy efficiency. Under this programme, the EU established the first international greenhouse gas emissions trading regime, hoping to position itself strategically into the global emission trade market emerged from the Kyoto Protocol.

2.1.3 EU ENERGY RESEARCH AND DEVELOPMENT

Energy R&D in the EU entails two separated budgets under two different research programs. The "non-nuclear energy R&D" is financed and performed under the general Framework Programme for Research and Technological Development while the nuclear energy R&D is funded and performed under the Euratom Framework Programme.

Non-nuclear energy R&D has been consistently considered in the Framework Programme since its establishment in the early 1980s. However, the overall budget for this area has decreased over time from 49% of the total programme budget in 1980s to 4% in the period 2007-2013. The current Framework Program (FP7), with a budget of 2.35 billion Euros for the energy theme, considers the following thematic areas: hydrogen and fuel cells, renewable electricity generation, renewable fuel production, renewables for heating and cooling, CO2 capture and storage technologies for zero-emission power generation, clean coal technologies, smart energy networks, energy efficiency and savings, and knowledge for energy policy-making.

The objective of energy research under FP7 is "to aid the creation and establishment of the technologies necessary to adapt the current energy system into a more sustainable, competitive and secure one. It should also depend less on imported fuels and use a diverse mix of energy sources, in particular renewables, energy carriers and non polluting sources" (See http://cordis.europa.eu/fp7/energy/).

In response to concerns about industrial participation and a smooth innovation process cycle from R&D to commercialisation during the previous Framework Program, the EU has set up the so-called European Technology Platforms (ETP's), that function as a technology development forum for stakeholders from industry and research. The aims of ETP's entail 1) formulate a common vision for the development and employment of particular technologies (roadmaps); 2) define a joint strategic research agenda (R&D priorities), and 3) Implement a joint agenda by mobilizing significant human and financial resources through so-called Joint Technology Initiatives (JTI's). In the energy area, there are three specific ETPs: Hydrogen and Fuel Cell Platform (HFP), Zero Emission Fossil Fuel Power Plants (ZEP), and European Photovoltaics Technology Platform (Photovoltaics)

The Strategic Agendas of these platforms are playing an increasingly important role in EU governance of energy innovation and their implementation plans will increasingly determine the level and direction of public/private partnership funds in the EU. The platforms are now in the stage where they have finished strategic research agendas and are in the process of implementing those agendas through Joint Technology Initiatives. Eventually, the European Commission presented an Energy Package of policy proposals in January 2007, including the establishment of a European Strategic Energy Plan (EC, 2007). The plan considers:

- The establishment of European Industrial Initiatives to strengthen energy research and innovation by bringing together appropriate resources and actors in a particular industrial sector. Priorities mentioned are wind, solar, bio-energy, CCS, smart grids and nuclear fission
- The creation of a European Energy Research Alliance enabling greater co-operation between universities, research institutes and specialised centers. Areas for focus mentioned are basic energy science, breakthrough and enabling technologies, and advanced energy efficiency

2.1.4 THE EU INNOVATION SYSTEM IN THE PERSPECTIVE OF ENERGY AND CLIMATE CHANGE

As mentioned in the first sections of this chapter, the average innovation performance of the EU remains (according to several authors) behind those exhibited by Japan and the US. This assessment however, does not address differences in particular technology developments or sector's performance. In the context of energy and climate change policy – for example – the EU presents an outstanding innovation performance that has influenced related policies at global level. However, the performance of the energy sector in Europe presents large national differences while successful development of innovative energy technologies concentrates in few member states.

The EU governance of energy innovation obviously influences the performance of national innovation systems in member states, by having an impact on the different functions of these systems as described in section 2.1. For the purpose of this analysis we have modified these criteria slightly. First we have consolidated the criteria of innovation guidance and legitimacy (both being high-level government functions). Secondly, we have split resource mobilization in human and financial resource mobilization (since they involve different actors in the triple helix model). Using these functions as success criteria, we can provide an outline of the overall performance of EU energy innovation system (See Table 7). Such an assessment concerns the average performance of the EU energy innovation system in a global context. The results confirm the prevailing perception that Europe is unable to convert its above average environmental policy push performance in the area of climate change mitigation (functions of innovation guidance and market formation) into commercial success (functions of entrepreneurial involvement and financial and human resources mobilization). This conclusion underlines that climate and energy should indeed receive priority in the realization of the European Institute of Technology (EIT). It also indicates in which functional areas performance must be improved. Nevertheless, these results are far too general to generate concrete propositions for the design of a future EU-coherent action within Climate and Energy. However, we can identify two important questions from this assessment. The first question has to do with national differences in energy innovation system performance and how to deal with this national heterogeneity in the design of EU-coherent actions in the area. The second question has to do with technological heterogeneity in the energy sector and its implications for the performance requirements of the energy innovation system.

Regarding the first question, it is important to consider that to present a picture of average European performance in energy innovation can be misleading, because of the enormous differences in innovation performance in European nations. In addition, there is no data available specifically for the energy sector in each member state. Such specific data would undoubtedly affect the relative position of some countries, but it is unlikely that it would affect the overall conclusion of heterogeneous performance. It is reasonable to assume that the experimental nature and limited budget of a coherent Climate and Energy EU-action makes the choice of raising the average European innovation performance across the board of all member states impossible. A first relevant strategic question therefore concerns the choice between trying to increase the lead of the EU frontrunners or trying to catch up on the backlog of the laggards. Strengthening the position of the frontrunners would be a preferable option in order to secure a pole position for Europe at the global scale. A second relevant strategic question would be, if a Climate and Energy EU-action could be designed in such a way, that the position of the frontrunners would be safeguarded while at the same time providing ways for laggards to catch up.

Regarding the second question, there are not only substantial differences in national innovation performance, but also substantial differences in the developmental stages of different technologies in the energy sector. Some renewable technologies such as wind turbines are relatively mature in the sense that they are close to competitive cost levels and no longer dependent upon major technological breakthroughs. Other renewable technologies such as solar power operate in niche markets allowing far higher costs than competitive levels in main markets. Only major technological breakthroughs – often referred to as second-generation technologies – would allow entrance in mass markets. It would seem that the different functions described in the assessment of the EU energy innovation system, are of a different weight and nature at different stages of the technological cycle depicted. The implication is that the design of a Climate and Energy EU-action therefore depends on the thematic focus of the action at the subsector level in terms of specific energy resources, conversion technologies and end-use applications. Hence, it is reasonable to assume that the experimental nature and limited budget of a Climate and Energy EU-action necessitates clear thematic choices.

This raises the first strategic question with regard to technological heterogeneity: is the added value of a coherent Climate and Energy EU-action larger for some types of subsectors and technologies than for others? In other words, are the present functional limitations of the EU energy innovation system more damaging for some types of subsectors and technologies than for others? Secondly, the heterogeneity of technologies is reflected in the heterogeneity of actors and interests involved. Cooperative alliances with vested industries in the energy sector may require very different institutional arrangements than those with emerging SME's. It is likely that the nature of collaborative arrangements should be geared to the prevailing features of actors involved in specific technologies. In the energy sector these actors include many companies that are already truly European players such as generation equipment manufacturers, utilities, car manufacturers and end-use equipment manufacturers and relatively few SME's. To come up

Table 7: Performance assessment of EU Energy Innovation System

Function	Performance	Assessment
Knowledge development	Low	Knowledge development is often measured by R&D expenditures as percentage of GDP. For Europe, this expenditure is about 1.8% compared to 2.7% for the US and 3.2% for Japan. This figure is perceived as far too low in comparison to the urgency of energy security and climate change solutions. We have therefore ranked this function under poor performance
Knowledge distribution	Average	In qualitative terms we can say that the EU performance is average, particularly because the European energy sector is characterised by relatively large companies operating in liberalising markets at a European or global scale. The liberalisation process has generally resulted in scrapping of large, internal research programmes and increasing reliance on outside knowledge for technological innovation. Although this has been to the detriment of knowledge development, it has raised awareness of and attention for technological innovations elsewhere. In fact, many companies may have become dependent on open innovation processes for lack of internal alternatives.
Innovation guidance	Very high	The European Commission has been at the frontier of establishing goals and instruments for guiding sustainable energy transitions on the global level. EU directives on renewable and end-use efficiency often operate as important drivers of national initiatives in member states. The ambitions of the EU in the area of energy and climate change make it a global frontrunner.
Market formation	High	The European Emission Trading System for CO2 is an important example of European market formation as are efforts to set dynamic standards for technological performance such as average CO2 emission standards for vehicles. Nevertheless, many instruments such as feed-in tariffs, renewable obligations or public tenders are implemented at the national level. In fact, the lack of harmonisation of national policies is viewed by some as a major deterrent for an efficient renewable energy market in Europe
Entrepreneurial involvement	Average	To close the gap between knowledge development and knowledge commercialisation (valley of death) entrepreneurial involvement seems a necessary condition. A large pool of inventive and risk-taking SME's and related venture capitalists and industrial entrepreneurs is often cited as the main reason for the on average better performance of other global innovation systems, in particular the US. Whether this general observation is valid for the energy sector is not a priori clear, because energy technology ventures tend to be large-scale and capital-intensive. Moreover, when there is substantial innovation guidance and market formation at the public level, incumbent companies will be more inclined to invest in new opportunities if only to counter increasing threats from new entrants.
Financial resource mobilization	Average	Like in the case of entrepreneurial involvement the function of financial resource mobilization is often considered weak in Europe compared to the US. Since the state-of-the-art with respect to financial resource mobilization is in general not related to sector specific circumstances, we may assume that this is also the case for the energy sector. However, these constraints can be considered less pervasive for financial resources than for entrepreneurial involvement.
Human resource mobilization	Low	Human resource mobilization at the European level shows a poor performance, in particularly when compared to the US. The differences in performance relate to both the quantity and the quality of high-level skills available. The European market for high-level skills remains fragmented and nationally oriented. The ability and willingness to attract top talent from outside Europe remain limited. This limitation in the human resources area is particularly problematic in the energy sector at a time of major transitions to sustainability. Many companies involved in fossil fuels supply and electricity generation or the equipment and services sectors of the energy industry view the problems of attracting high-level skills in the sector as a significant bottleneck for sustainable energy transitions.

with optimal innovative conditions, may therefore require a simultaneous choice of technological themes to be pursued by both EU and the kind of companies that play a central role in promoting the role of the relevant technologies.

2.1.5 CONCLUDING REMARKS AND RECOMMENDATIONS

Based on our observations and the assessments presented in this chapter, we conclude the following:
On a comparative basis, the performance of the emerging innovation system in the EU appears lower than that of Japan and the US. This lack of performance has been analyzed from the point of view of the university-government-industry relationship and the structure and function of innovation systems. This suggests that there are considerable differences in the EU innovation system with regard to the structure and function of university and governance. These differences can be assessed as deficiencies in certain functions particularly in knowledge diffusion and human resource mobility. At the level of governance these differences mainly regards the functions of knowledge creation and research guidance.

In the case of US and Japan, it is clear that innovation systems are becoming less differentiated. This is due to a common path of learning from success and failure and an open bilateral collaboration policy. However, this has implied deep transformations in the structure and function of both innovation systems, notably the recent restructuration of university and public administration in Japan. The suggested merger of these innovation systems has important policy implications. It seems that globalization has played an important role in this process, although national competitiveness seems yet related to different national capabilities rooted in the social and cultural structure. If so, the role of historical developments and the capability to learn from them in a social sense, become important drivers in the innovation systems. Hence, this implies that innovation policies should consider the enhancement of national capabilities while avoiding to focus on the competitors' advantages. Because the EU innovation system is yet immature and cannot be seen as a simple aggregation of national systems, the perception of "national capabilities" should be addressed in a regional sense, where countries with different trajectories and performances, coexist shaping a region – Europe – with unique and evolving features. This of course, remarks the role of the "resultant effect" of the EU enlargement process on (re)defining the union's innovation performance. Innovation policies, therefore, should tackle this issue properly. An excess of focus on Member States with high innovative performance can bring the undesirable effect of deepening the innovation divide within the Union. Conversely, moving all resources and attentions towards the states with lower performance can inhibit the strengthening of innovation in leading states. Thus, as occur in countries that present regions or communities with unequal socio-economic development, resources in Europe – human and financial – should spread widely, fostering an innovation system capable to self support its own demand for capability and infrastructure building. This suggests that the outputs of an innovation system should bring benefits to all involved actors at all levels of organization. If higher competitiveness and welfare is to be the outcome of the EU innovation system, all member states must become competitive and their societies wealthier.

In the particular context of the WP1 objectives, we observe that *models of collaboration* are less relevant than the benefit implicit in the simple *action of collaborating*. This benefit is the creation, diffusion, and absorption of *knowledge* as economic and social inputs/outputs within the innovation system. An important lesson from the Japanese and US common experience is that any collaboration model – even a successful one – becomes rapidly obsolete in the core of a system that does not properly adapt to its surrounding environment. Hence, *adaptability* is an important condition for collaborations but it is also a requirement for the system in which the collaboration takes place.

Regarding the implications of our work with regard to establishment of an eventual coherent EU-action towards energy and climate, we would like to suggest the following recommendations:

1) Avoid a Eurocentric approach: A new Climate and Energy EU-initiative should avoid a Eurocentric approach to strategic positioning a core network of partners. A new Climate and Energy EU-initiative must position itself within both an increasing globalising and open network of energy R&D, and innovation while at the same time taking care to absorb the benefits and potential of already existing networks in climate and energy in the EU innovation system. It should promote its position as a specialised node linking global innovation networks and European innovation networks effectively in specific thematic areas. Embedding activities strategically in both global and European networks will improve the flexibility and effectiveness in many ways.

2) Focus on strengthening human resource mobilization and knowledge development functions: Expectations on the role of the EIT have always stretched across the breadth of all innovation functions. Our comparative analysis of the functions of the EU energy innovation system (See Table 4), however points out that strengthening human resource mobilization and knowledge development is most needed. Moreover, in view of the limited available resources and the recent emphasis in the SET plan on fundamental research not necessarily dictated by technology specific priorities, such emphasis seems justified.

3) Integrate human resource mobilization and knowledge development smoothly: Successful universities and research organisations value the mutual impact of excellence in human resource mobilization and knowledge development. A Climate and Energy EU-action must be able to attract the best minds in Europe and globally. This can be achieved only by combining goals of human resource mobilization and knowledge development smartly. Attracting top students and scientists to poles of excellence would lead to brain drain from Europe's underperforming member states and developing countries. An smart integration should therefore move from brain drain to brain exchange, particularly with Eastern Europe and Asia, thus fitting in with open innovation approaches that do not try to dominate knowledge acquisition.

4) Articulate innovation ambitions from a long-term, integral perspective: The EIT will, according to the expressed EU policies, address all sides of the knowledge triangle; it cannot afford to retreat to a defensive position in the research domain. Any EIT action should thus position itself in knowledge domains where the perspectives for second-generation breakthroughs and enabling technologies for gaining a competitive edge are crucial and leave the innovation potential of technologies "on-the-shelve" to other instruments and parties.

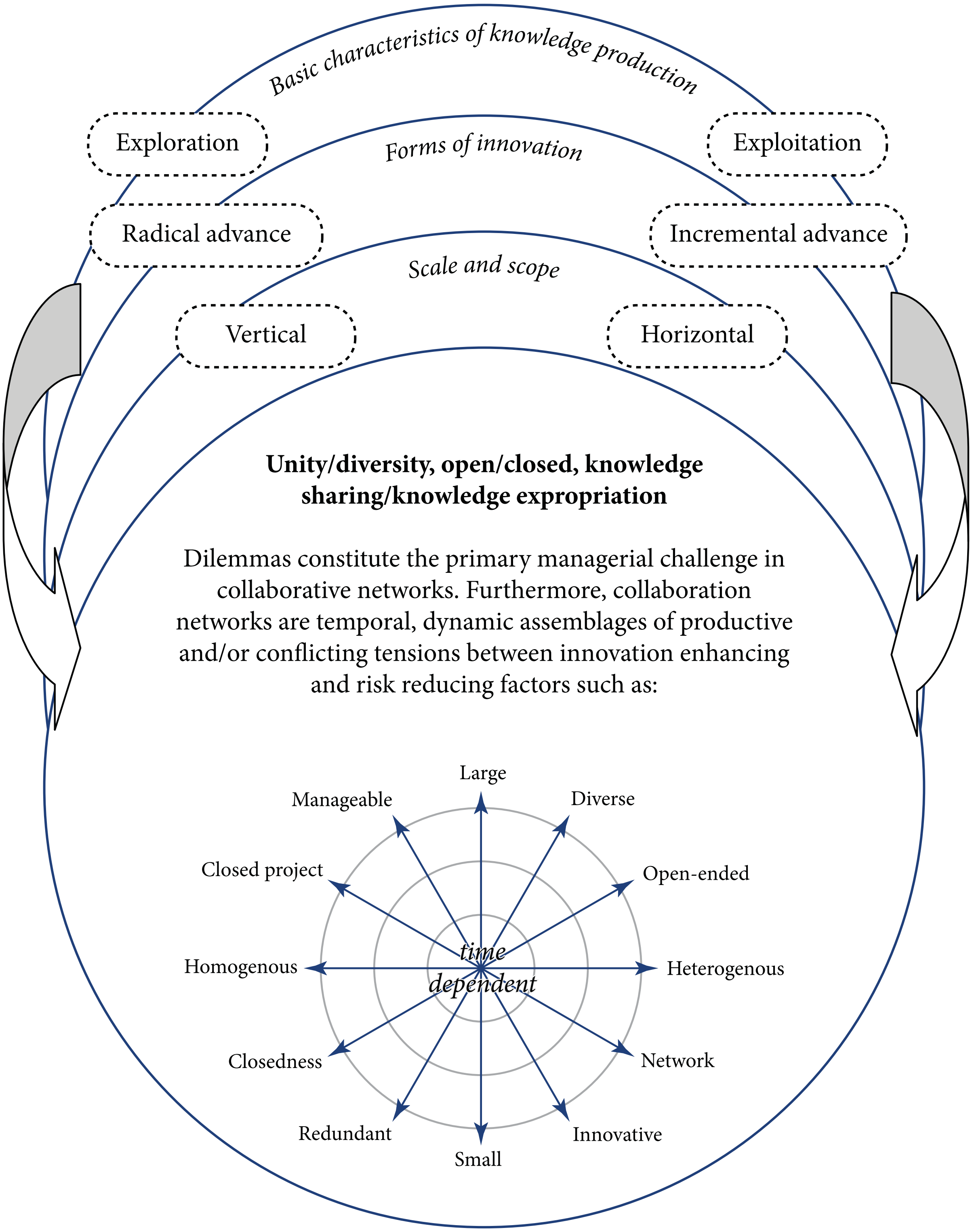
5) Identify long-term commitment features preferred by industry: Evaluations of existing EU energy innovation instruments often stress the difficulties of attracting long-term commitments from industry. Often this is explained in terms of the administrative and management burden of formal networks, the complexities of guarding IPR positions in networks, the expected return on financial outlays and the inherent risks of public-private partnerships. Hence, more attention should be paid to the shortcomings of energy innovation systems from a strategic company perspective in order to secure additional private commitment and financial support in the Climate and Energy sector. Given the sharply increased tendency for outsourcing research activities in the energy sector, industrial involvement should be addressed both as an emerging opportunity and as a latent threat for a Climate and Energy EU-initiative.

6) Aim for critical mass in terms of excellence and focus rather than scale and scope: There are already many formal and informal networks operating within the European energy innovation system. Rather than to strength this networks in terms of scale and scope, It would be worthwhile to aim for critical mass in terms of excellence (scientific performance and limited number of partners) and focus (defined aims and limited coverage of issues). In this context, focus should avoid specific conversion technologies and concentrate on systemic specific technological challenges in energy use sectors (e.g. public transportation) or in broadly applied energy technology components. (e.g. energy storage).

7) Establish thematic priorities at an early stage of a Climate and Energy initiative formation analysis: Given the heterogeneity of actors and technologies involved in the energy sector, it seems that an optimal design of new modes of innovation governance, is greatly dependent on the characteristics of key actors and key technologies in the knowledge community that will receive thematic priority. Conversely, if a Climate and Energy EU-action is to be designed in an experimental way such that new business models and new modes of governance can be tried out, such experiments will likely try to involve research partners and companies that are presently underrepresented in the energy knowledge community. For instance, if one wishes to attract commitment from SME's and the service sector rather than multinationals and equipment manufacturers, this will obviously affect the design of the EU-action. Therefore, it seems that an early choice for several, preferably contrasting, thematic priorities in the SUCCESS project, may be necessary for effective experimental design in the formation analysis of the later Work Packages of SUCCESS.

8) Devise flexible and dynamic, formal rules for access to EU resources: The creation of the European Research Area (ERA) is intended to address the present fragmentation and duplication characterising the academic and research community in Europe. Hence, a coherent EU-action Climate and Energy must not attempt to establish a monopoly in its area of competence but to promote a smoothly functioning European market for knowledge and researchers. The best way to guarantee this may be to devise transparent and workable rules for access to the action in terms of entry and exit of individual students and research staff, but also of associated private parties. While the core of long-term committed universities and research organisations is likely to be small and permanent, they should be able to demonstrate their European role in the representation of students, staff and business partners by formal rules rather than good intentions.

The basic dimensions and inherent dilemmas of management in/management of collaborative networks



PART THREE: CONCLUDING REMARKS

3.1 CRITICAL FACTORS FOR SUCCESS AND LESSONS LEARNED FOR FUTURE SUCCESS WORK PACKAGES

In this concluding chapter we will summarize the major results from the literature study and the empirical survey. In the respective chapters we have already discussed and summarized in more detail the results and in this last chapter we aim to present what we consider to be the major results of our work on collaborations on the knowledge triangle in the field of sustainable energy. In a very short form it can be summarized as follows:

'NO ONE MODEL FITS ALL COLLABORATIONS',

meaning that our combined study have very convincingly demonstrated that network collaborations in this field (as in any other alike) are very diversified; very much depending on context, on local conditions, on financial resources like funding agencies, on aim of collaboration and not the least on time, young collaborations will be very different from old ones.

On the other hand, we feel that the work done in this work package has much more to offer than producing a single statement like the one above, even if it is extremely important to state the fact, that even if it would have been much easier to have one or two ideal models, the reality is very different, as can be seen in the survey. In order to present an overview of the complexity and details from the study in another form than the summaries in the specific chapters, we have constructed a model aiming at visualizing the complexity of collaborations and the specific constrains also formulated as dilemmas they are operating under. The model is constructed by input from our literature survey, where theories on network, collaborations and open organizing list a number of key variables to consider not necessary for any network but in a more general sense. We have selected the ones we found most important and relevant in relation to our analysis of the empirical data collected from more than 60 collaborations.

A few words about how to read the figure: No collaboration network is either/or but always both/and. The time dimension affects networks and collaboration assemblages by inducing continuous change in terms of what factors characterize a given project on a given point of time. In other words, collaborations can look very different on the dimensions illustrated below, e.g. moving from a closed network in the beginning of a collaboration process to an open network in a more mature state or vice versa.

Depending on how a collaborative network is constructed, the purpose of the collaboration and the level of complexity this produce, the inherent dilemmas emerge differently, varying in importance over time. Dealing continuously with the dilemmas of collaboration is probably the most important "factor" for success. Therefore, understanding the basic dimensions that impact the way dilemmas emerge become a central managerial obligation.

As already pointed to, the managerial challenges of collaborative projects and networks are better handled if a division of responsibility is defined between management in and management of a given collaborative network. As summarized in the literature review (p15) such a division will in many cases result in the following management areas:

Management of networks:	Management in networks:
Integration at different levels Changes in the surroundings Competence alignment Creating engagement Decision structure Incentive structure Legal unit Shared facilities Up-scaling	Core or marginal activities Integration of different kinds of activities Time frame Vertical and/or horizontal integration

From our empirical study we can observe clear differences in the means to manage, that is the overall governance system in collaboration, making constrains on some of the variable listed here. For instance, the combination of public sector research organizations, universities and private companies by itself present a very different setting for managerial interventions both of and in the network. The possibilities for more direct managerial interventions in private companies in collaborations is a challenge for the public sector organizations, who either has a more diffuse set of key activities such as teaching obligations which cannot be disregarded. These challenges make it much more important to have a clear set of managerial agreements in place from the beginning – both in relation to management of networks but also to management in networks and for maintaining a visible and active management function throughout the collaboration.

Each level of management however is always confronted with the challenge of balancing the tension between execution-centered and innovation-oriented processes. As we saw in the literature review and in the empirical survey, collaboration projects tend to challenge traditional management in a number of ways. Thus, collaboration projects needs to some degree to be fragile or "sensitive" towards emergent, non-linear processes that may call for re-configuration and re-negotiation of a project. Also, the basic fact that collaborations takes shape across organisational boundaries obviously challenge the involved partners, both in how they communicate? how they negotiate? and how expectations and means to success are clarified and redefined as the project evolves?

Therefore, in any type of innovation-oriented collaboration between different partners we will see a number of challenges that may represent real threats to the success of a project. Especially in cases where large networks are mobilized and diverse partners are involved. Large, diverse collaborations with the aim of exploiting new knowledge are probably the most difficult type of project to manage. And as we have seen throughout this report, projects that are not easily managed are more likely to fail to achieve their goals.

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About SUCCESS

The SUCCESS pilot project is carried out according to an action grant agreement with the Commission of the European Communities, Directorate General for Education and and Culture, Task Force European Institute of Technology.

Within the knowledge triangle of education, research and innovation the, pilot project SUCCESS (Searching Unprecedented Cooperation on Climate and Energy to Ensure Sustainability) is intended to establish efficient and effective structures of collaboration in large distributed consortia in Europe featuring new governance schemes thereby maximising the efficient use of available resources and an increase in turning R&D results into commercial opportunities. The field of sustainable energy and climate change is the underlying subject.

The partners involved are a comprehensive group of institutions in the knowledge triangle in the field of sustainable energy and climate change as well as establishments dealing with knowledge transfer, business administration, governance structures and innovation management.

The overall objective of establishing effective and efficient structures of collaboration in large distributed consortia in Europe has a number of partial objectives, namely 1) to improve the link between research and innovation thereby strengthening Europe's capability to transfer results of collaborative research programmes into commercially competitive products; 2) to strengthen the education in the field of research, innovation, and entrepreneurship within the field of sustainable energy and climate change and 3) to develop models of management of innovation to handle the level of complexity of geographically dispersed and complex network relations.

The duration of the pilot project is limited to 24 months. As stressed in the section above, the main goal of the pilot project will be to identify new - or improve existing - models of cooperation and governance of integrated partnership in the knowledge triangle of education, research and innovation in the field of integrated sustainable energy supply and climate change bringing together the main stakeholders in Europe in the most creative, effective and efficient way.

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