

International CCS Research Centre. Managing Innovation in Heterogeneous Research Consortia.

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The overall objective of the current work is to seek productive approaches to one of main challenges of research consortia, which is the actual transformation of research results into environmentally and commercially valuable solutions, and the possible part of consortium members in these processes. This problem is related to the establishment of a number of Centers for Environment-friendly Energy Research (FME) by the Norwegian Authorities, intended to develop new knowledge, foster breakthrough technology and promote innovation in order to solve specific challenges in the field of energy and environment. The condition for public support is that research is carried out in close cooperation between research communities and industrial actors entering into long-term binding consortium agreements. One of the prioritized areas is research on Carbon Capture and Storage (CCS). An International CCS Research Centre (BIGCCS) aiming at extending and releasing the potentials for large scale deployment of CO₂ capture and storage was granted FME status in 2009 (Tangen et al. 2010). The center is managed by SINTEF Energy Research, it involves 22 partners from industry and academia, and administers a budget amounting to 45 million € over 8 years.

The authors of the present paper constitute the Centre Management Group for the BIGCCS Center. As such, they are given a unique opportunity to learn about important aspects of consortium collaborations for innovation as they evolve, and about the management of such processes. This work has been going on for about two years, and the paper explores experiences from the BIGCCS Centre efforts as observed from 'within' the ongoing processes. Our particular focus in this paper is on the management of multidisciplinary, multiorganizational processes for knowledge production and innovation.

According to the Research Council of Norway, the FME centres are expected to meet the challenge of innovation by stimulating active cooperation between innovative industry, public administrative bodies and prominent research institutions, to promote the development of application-oriented research communities, which, among other activities, should generate excellent research-based knowledge and technology, as basis for innovation. The challenge includes issues related to the expectations that research results should be openly shared among consortium partners, and at the same time, potentially pursued by one or a limited number of the partners as separate, non-shared innovation initiatives. It also involves the recognition that being

on the 'offerer-side', research partners' freedom of action is limited to substantiate value creation by making available knowledge anticipated to support the process of capturing, transporting and storing CO₂ in an efficient way.

Although the research on the management of collaborative innovation efforts is extensive, focus is generally on performance seen from the perspective of individual companies or research institutes. In later studies on knowledge production, it has been argued that science systems are changing into more interactive and 'socially distributed' systems. To the best of our knowledge, the dynamics of such transdisciplinary collaborations and the managerial challenges in terms of innovation have, however, been explored only to a limited extent. To approach the current problem, this paper explores the relevance of the ideas of 'Mode 1' and 'Mode 2' knowledge production, originally introduced by Gibbons et al. (1994), as an approach to investigate ongoing collaboration processes for knowledge development and the emergence of innovation.

While 'Mode 1' knowledge is seen to be the result mainly of work in scientific institutions, 'Mode 2' knowledge is shaped by broad specters of intellectual, social, and also commercial needs. The concept of 'Mode 2' knowledge production was introduced to denote "*knowledge produced in the context of application, by so-called transdisciplinary collaborations*" (Hessels & van Lente, 2008:740). In 'Mode 2' the distinction between basic and applied research is no longer relevant. The overall objective of research is to respond to perceived needs for new applications, involving the necessity of taking into account the different requirements, values and demands of collaborating partners.

Application of the attributes of 'Mode 1' and 'Mode 2' knowledge production, in particular the emphasis on transdisciplinarity, heterogeneity, reflexivity and context, is seen as a potential help to broaden the understanding of how new knowledge and innovation evolve and diffuse in innovation-oriented research consortia for those charged with the responsibility of coordinating and managing such complicated forms of co-operation. The concept of reflexivity incidentally points at a distinct characteristic of the 'Mode 2' knowledge production, which is the researchers' awareness of the potential societal consequences of their research, and the implication of this for their choice of research objectives, methods and approaches. Another issue is to what extent consortium partners consider the innovation potential of research results and how this affects their priorities.

The present research is based on a view that knowledge and innovation processes are emerging and evolving in the interplay between interdependent individuals representing different organizations, fields, interests and commercial considerations (Aasen, 2009). This approach suggests an apparent limitation of the concepts of 'Mode 1' and 'Mode 2' knowledge production, which is the lack of focus on individual actors and their motivation for contributing to new knowledge and innovation. Nevertheless, it is found that the concepts of 'Mode 1' and 'Mode 2' knowledge production, combined with a perspective on innovation as both technological and social processes, represent a promising basis for the exploration and explanation of knowledge development and innovation management in heterogeneous R&D consortia.

The intention of the innovation oriented activities integrated in the BIGCCS Centre is to increase consortium partners' attention towards collaboration and innovation, and to support them with

knowledge about how to handle such processes, including the authors' own part in it. The expectation is that this will promote the development of commercial valuable knowledge and technology, as well as encourage the dialogue between the research communities and the industrial partners. Although this study is within the particular context of CCS research, the publication of experience gained from these processes should be relevant both to science studies, to the innovation research communities, and to research and business managers charged with a responsibility for similar processes.

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