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Established sectors expediting clean technology industries? The Norwegian oil and gas sector's influence on offshore wind power

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ABSTRACT

The development and deployment of clean technologies must be accelerated to avoid a more than 2-degree warmer world. Redeployment of the vast resources concentrated in established sectors is one possible way to advance cleantech industries. However, prior research on sustainability transitions tends to emphasize competition and conflict between established sectors and cleantech industries. There is thus a need for exploring in more depth how established sectors may positively contribute to cleantech industries. Based on the notion of structural overlaps, we propose an extended version of the technological innovation systems framework to study how established sectors influence cleantech industries, and present new conceptual definitions and indicators. We apply the framework to a case study of the relationship between the oil and gas sector and the offshore wind power industry in Norway. Our empirical results show that the oil and gas sector has several positive influences on offshore wind power enabled by technological overlaps and diversifying firms. However, misaligned informal institutions weaken such influences, manifested as e.g. conflicting priorities and wavering commitment of diversified oil and gas firms to the new industry. We conclude by discussing the usefulness of the proposed framework and the relevance of our findings for policy and further research.

1. Introduction

The world's endeavour to mitigate climate change and staying within a less than 2-degree warmer world is challenged by an enormous gap between what financial and technological resources are needed and what have thus far been committed to this task. In other words, significant acceleration in development and deployment of clean energy technologies currently constitutes a major policy challenge (EC, 2016; IEA, 2016). Mobilizing the vast resources of established industrial sectors to support cleantech industries is one possible way of meeting the challenge. This paper discusses how established sectors may positively influence the development of clean-tech industries.

Within studies on sustainability transitions in socio-technical systems (Markard et al., 2012), the relationships between established sectors and emerging cleantech industries have been studied in situations where established sectors react antagonistically to potentially disruptive innovations (Hess, 2013; Smink et al., 2015; Wesseling and Van der Vooren, 2017). Recent contributions have, however, moved the research agenda beyond the dimension of conflict and competition, and now also focus on how established sectors could contribute to development and diffusion of clean technologies (Hockerts and Wüstenhagen, 2010; Berggren et al., 2015; Dewald and Achternbosch, 2016). Nevertheless, more knowledge about these processes is still needed.

We approach this issue by developing and applying an extended version of the technological innovation system (TIS) framework. The TIS framework is often used for analyzing emergence of cleantech industries by using a functions approach (Jacobsson and Bergek, 2011; Markard et al., 2012). The approach has received criticisms for under-conceptualizing the context in which new industries form (Coenen and Díaz López, 2010; Smith and Raven, 2012). In response, TIS scholars have recently called for further attention to how TISs interact with different types of context, including other TISs, established sectors, geographical context, and politics (Bergek et al., 2015; Coenen, 2015; Kern, 2015; Andersen and Markard, 2017).

Focusing on how established sectors influence TIS formation, we draw but also elaborate on these tentative observations to articulate an extension to the TIS framework. It is based on the notion of shared components – also referred to as structural overlaps – between the TIS and the established sector in the form of actors,

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institutions, networks and technology. Our main purpose is to explore the value and usefulness of this proposed framework through a case study from Norway. Our empirical research question therefore is: how does the established oil & gas sector influence the nascent offshore wind TIS in Norway? Accentuating structural overlaps in TIS analysis can, we argue, help us to systematically attend to the ways in which context elements (here an established sector) influence a TIS in its formative stage. This enables us to understand parts of TIS formation that have not yet been fully appreciated. Our analysis thus contributes, firstly, to our understanding of formation of new clean technology industries in context of established sectors, and, secondly, to conceptual and methodological advancement in TIS studies.

The structure of the paper is as follows. Chapter 2 reviews TIS literature with a particular focus on relationships between TIS and sectors. Chapter 3 introduces our case and outlines methods and data. In Chapter 4 we analyze the implications of structural overlap with oil and gas sector on offshore wind TIS by structuring the analysis according to the four structural dimensions of technology, actors, networks and institutions. Chapter 5 discusses the main empirical findings and concludes.

2. Literature review and a synthesis

2.1. Sector-TIS relationships

The technological innovation system (TIS) framework was developed for studying emergence of new industries and/or knowledge fields (Carlsson and Stankiewicz, 1991). A TIS is defined as a set of actors, networks, institutions and technology engaged in developing, diffusing and utilizing new products (goods and services) and processes related to a certain technological field or industry (Jacobsson and Bergek, 2011). A characterizing feature of TIS analysis is the functions approach, i.e. conceptualizing different processes that support innovation and influence the build-up of an innovation system (Bergek et al., 2008a, 2008b) (see Table 1 for overview). The central idea behind the focus on functions is that TIS performance cannot be reduced to the existence or absence of system components, as has been common in more traditional innovation system studies. The introduction of TIS functions constitutes an attempt to describe system dynamics in more detail. Functions can be understood as emergent properties of the interplay between actors and other components (Markard and Truffer, 2008). Hence, networks, institutions and technology constitute the structural environment in which the activities of actors generate system dynamics. It is assumed that all functions should individually be rather strong for the TIS to progress.

However, a drawback of the TIS framework is that it is focused very much on single technologies which risks overlooking important interactions with other relevant technologies and sectors (Coenen and Díaz López, 2010; Jacobsson and Bergek, 2011; Markard and Truffer, 2008). As Smith and Raven (2012, p. 1029) put it: "*TIS tends not to highlight the interplay between the wider selection environment of an emerging system and internal system dynamics as an endogenous explanation in the emergence of that system*". In response, TIS scholars have recently called for further attention to how TISs interact with different types of context, including other TISs, established sectors, geographical context, and politics (Bergek et al., 2015; Coenen, 2015; Kern, 2015; Andersen and Markard, 2017). In this paper we contribute to narrowing this gap in the literature with a particular focus on sector-TIS interactions.

Recent studies have shown that established sectors can indeed exercise significant influence on an emerging TIS, understood here as a nascent industry. Wirth and Markard (2011) show how the formation of a biogas TIS in Switzerland benefitted from the presence of established sectors, such as sawmill industry and forestry, but also that prior industry routines and values (informal institutions) led to tensions in the TIS. Hanson (2017) illustrates how the established electrometallurgical industry provided a foundation for building a photovoltaic TIS in Norway. Also, Haley (2015) reports how structural overlaps between the established hydropower regime and electric vehicle TIS in Quebec have supported the growth of the latter through e.g. legitimacy benefits and knowledge development. We draw but also elaborate on these studies to articulate an extension of the TIS framework.

2.2. Structural overlaps

In terms of the basic nature of linkages between established sectors and a TIS, two types of interaction can be distinguished: negative (competitive) and positive (complementary) (cf. Sandén and Hillman, 2011; Wirth and Markard, 2011). When negative relationship prevails, sector firms can attempt to block the growth of emerging industries. Positive relationships may take two main forms. First, emerging industries can feed on the demand for productivity-enhancing technologies from established sectors (Hirsch-Kreinsen et al., 2005). Second, actors from the established sector can see the emerging industry as a new promising business opportunity, and on entry, bring various resources which fuel further progress.

In terms of the direction of influence, Bergek et al. (2015) distinguish between two types of linkages between a focal TIS and a sector. First, external links refer to 1-way influence from a context element on a TIS, such as national institutions, politics, or sudden price shifts. Second, structural overlaps (or couplings) refer to a situation with shared components between a TIS and a sector, possibly resulting in a 2-way interaction where systems influence each other. The content of structural overlaps, and how they influence a focal TIS and a sector, is likely to change over time. For example, a TIS in its early and formative phase is characterized by entry of organizations, formation and early alignment of institutions, emergence of networks, and immature technology. These processes therefore necessarily draw on external sources, e.g. more established sectors and infrastructure (Bergek et al., 2008b). However, if the TIS enters a growth phase with technology diffusing in a self-sustained way, feedback loops between the sector and the TIS may appear and the TIS can transform the sector (Bergek et al., 2008a; Markard, 2016). The nature of the actual interaction is ultimately an empirical question, though. For example, in situations where a significant asymmetry remains between the systems in terms of size and maturity, influence may remain 1-way.

We define structural overlaps as components shared by the sector and the focal TIS. Sectors and TIS fundamentally have the same "texture", i.e. they can be conceptualized by the same analytical components: actors, networks, institutions, and technology (Markard and Truffer, 2008). Structural overlaps influence the focal TIS' functions by facilitating different forms of resource redeployment from sector to TIS. Indeed, this is the main reason for analysing structural overlaps.

"Overlap actors", which could be e.g. firms, research institutes and public organizations, are per definition active in several industries. This is in contrast to dedicated actors which operate only in one industry. Many of the overlap actors are diversified firms venturing from established sectors into an emerging TIS. Diversifiers play a dual role. On the one hand, they may contribute positively to the TIS by for instance bringing with them various resources as new technologically related industries offer growth opportunities by use of e.g. existing knowledge (Penrose, 1959; Montgomery and Hariharan, 1991). On the other hand, diversifiers