Breaking barriers for a bio-based economy: Interactive reflection on monitoring water quality

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ABSTRACT

In a transition to a bio-based economy new ways of monitoring waste-streams and water quality can then contribute to sustainable production processes. As niche innovation, new ways of monitoring face systemic barriers. The present article examines how barriers to change manifest in discursive practices with differing normative attachments and implications. A frame analysis revealed two competing frames: (1) the dominant 'norm water' frame in which thresholds of chemical compounds are used to set policy targets; and (2) the contesting 'living water' frame, which entails innovative continuous monitoring tools that take into account the ecological effects of chemical compounds. We introduce the concept of *interactive reflectivity*, as a discursive tool, to collaboratively visualize, scrutinize and overcome discursive barriers to innovations. The stakeholder dialogue shows how systemic barriers are uttered discursively in niches – or other forms of responsible research and innovation – and may hinder change even at the niche-level.

1. Introduction

The transition to a bio based economy does not take place overnight. The replacement of most fossil fuels by bio-based forms of energy, and the transition to sustainable industry by, for example aiming for a zero emission of waste streams, is challenging. Often actors from academia, industry and society collaborate in what Geels and Schot (2007, p. 400) refer to as 'socio-technological niches' to explore alternatives to common practice. Over time, innovations and collaborations from such niches may lead to changes in practice, or what is referred to as the 'regime'.[1] In our case, we are examining innovation in water monitoring as part of a desired transition to a bio-based economy. Transformations or 'system changes' (Werbeloff et al., 2016) follow a variety of patterns of interactions between niche innovations, the regimes and the socio-technical landscape. System changes in the literature are also referred to as 'regime transformation' (Van de Poel, 2003), 'system innovation' (Elzen et al., 2004; Geels, 2005), or a 'transition' (Rotmans et al., 2001).

Geels and Schot (2007, p. 400) outline a number of patterns for systems transition, but point also to resistance to change as shared feature of all possible patterns of change. Resistance or challenges may take many forms, from difficulties with the exchange of data, to inability to translate concepts and ideas to the discourse of collaborating actors. In transitions literature, resistance is understood as entrenched in the form of 'systemic barriers'; as routines and practices of organizations. Such entrenched practices form what is referred to as path-dependencies, sunk investments or habitual ways of thinking and acting, which makes it hard to initiate change towards, for example, a bio-based economy (Berkhout, 2002; Grin et al., 2010; Schuitmaker, 2012; Stirling, 2014). In the present study, we investigate the manifestation of routine practice in the discourse of actors. We understand routine discourse as a barrier to change. Discursive barriers manifest through differences in underlying norms and values, encapsulated in different understandings and framings of the goals and tools of actors working on new water monitoring tools (Fig. 1).

In our research project, we examined a 'niche', where actors where collaborating to develop tools for enhancement of sustainable waste- and water monitoring (see below). We studied if and how efforts of academics, industry, and governmental actors to contribute to socio-technological innovations were resisted. We studied this resistance discursively and understand systemic barriers to be produced and reproduced in dominant framings. Our guiding research questions were: (1) How to understand barriers to innovations in eco-based and eco-toxicological monitoring of water quality for more sustainable
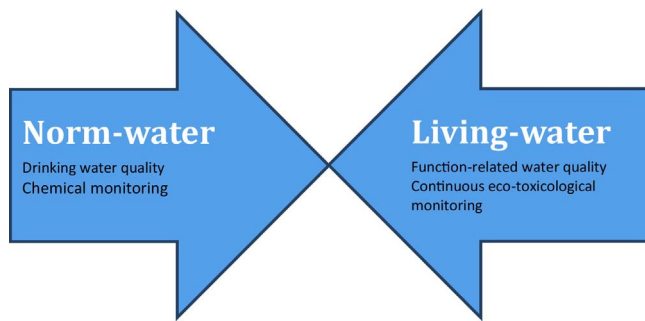
Fig. 1. Two competing frames on (monitoring) water quality.

water- and waste management? (2) How to experiment with interactive reflectivity in a stakeholder dialogue, in which participants deliberate on the discursive barriers in order to reframe them, and develop alternatives ways to cope with them?

In the 'niche' we studied, actors from chemical industry, government, non-government and academics – chemists, hydrologists and eco-toxicologists – collaboratively developed new bio-based waste water-monitoring tools. For example, they aimed to improve *passive sampling techniques*, which is the "time-integrated measurement of bioavailable contaminants in water and sediment" (Namiesnik and Szefer, 2010). These new water-monitoring technologies might also lead to innovations in regulatory frameworks that may start to include measures based on the combinations of chemical compounds and their ecological effects, for example, on the shores of a river. The group we studied was affiliated to a Dutch public–private partnership under the name 'Bio-based Ecologically Balanced Sustainable Industrial Chemistry', abbreviated to BE-Basic. The BE-Basic consortium was financed by a variety of public and private actors and they collaborated to develop all sorts of new technologies in the field of bio-based fuels.

In order to examine what discursive barriers to change emerged in the efforts to innovate waste-water and water-monitoring, we conducted a frame analysis of interviews and documents. In addition, we experimented with a stakeholder-dialogue, in order to have relevant stakeholders reflect[2] on barriers we found, and on the underlying normative assumptions. The analysis revealed that a dominant 'norm water' frame prevented change even among stakeholders who shared a willingness to innovate. In reflective conversations, they identified opportunities for change; however, they felt inadequate to address those in practical ways.

In section two, we further develop our conceptual framework of *interactive reflectivity* on systemic barriers. In section three, we introduce the methods, and in section four the results. Section five presents the conclusions and discussion.

2. Systemic barriers and interactive reflectivity

In transition-theory, small networks of actors that support and co-create niche innovations are often considered as protective spaces where innovations may develop in relative peace, before possibly leading to changes on the regime and landscape-change level (Geels and Schot, 2007, p. 401). Whereas transition theory mainly conceptualizes and studies the interactions between the socio-technical landscape and the regimes that contextualize the niche innovation, we turn to the field of responsible research and innovation (RRI) to better understand how the niche-innovations can become sustainable and responsible. In RRI, it is argued that responsible socio-technological change is created in interactive processes involving diverse groups of actors with different (disciplinary) backgrounds (Owen et al., 2012; Von Schomberg, 2013; Koops et al., 2015). RRI is achieved through "*a transparent, interactive*

process by which societal actors and innovators become mutually responsive to each other with a view to the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products*" (Von Schomberg, 2013, p. 69). This type of coproduction of knowledge facilitates interactions between science, technology and society to align norms, values, and different interpretations with technological knowing and developments (Van Bommel, 2008; Turnhout et al., 2013).

However, coproduction of knowledge is not cut lose from its systemic context. From transition theory, we learn that embedded routines, organizational cultures, assumptions and interpretations can be systemic barriers for the development of niche-innovations (Berkhout, 2002; Grin et al., 2010; Schuitmaker, 2012). These barriers can prevent learning and experimentation *within* the niche. In the context of this paper, these barriers are understood to manifest discursively. Even though actors agree to collaborate, innovate and aim for responsible research and innovation – in this case for more bio-based and sustainable water and waste-water monitoring – they will discursively resist (elements of) the innovations. Earlier work on the same case demonstrated that there are at least four barriers: (1) those between academics with the goal to produce fundamental knowledge and the industry's need for practical knowledge; (2) academics who need to share data for innovations but where those within industry want to protect data due to competitive reasons; (3) struggles between eco-toxicologists who emphasize the integrated eco-systems and chemists that study and identify specific compounds in water and waste-streams (see also Halffman, 2003 on boundary work); and (4) conservative rules and regulations that are not based on the latest technological possibilities (see Schuitmaker et al., 2013; Metze and Schuitmaker, 2015). The question then becomes how to understand and cope with these barriers within the relatively small networks of actors and stakeholders that support and co-create niche innovations.

First, we understand these barriers to be expressed discursively. The barriers arise from the forms of interpretation and meaning giving – framings (see methods) – and are part of the collaborations because actors will express them in their conversations. For example, a chemist may express the need to focus on the chemical compounds at some point in the collaborations; chemical industry may refuse to share data; and collaborating actors may find out that they have different goals when working together (see Schuitmaker et al., 2013). This discursive approach means that we understand the barriers to manifest themselves in what Frank Fischer (1995) calls *first order discourse*, in which 'situational validation' takes place. In first order discourse, actors frame reasons for their actions in their conversations, in documents and interviews. Through the study of this first order discourse, we are able to scrutinize less visible *second order discourses* that address more fundamental norms and values (Fischer, 1995), and that provide more systemic, more obdurate barriers.

Second, we argue that some form of *interactive reflectivity*[3] is needed to scrutinize these barriers in order to collaboratively search for ways to cope with them. But what does interactive reflectivity mean? Reflectivity can be defined as "*conscious thinking about the past, present and future, including the potentially radical interrogation of the nature of social progress*" (Meadowcroft, 2007, pp. 310–311). Applying this definition at the level of niche innovations means two things. First, it means that, in conversations about technologies, awareness is needed about underlying norms and values of the technological innovation. In other words, all participants need to be able to "*step backwards and reflexively question some taken for granteds*" (Wynne, 2002, p. 497). This means engaging stakeholders in a conversation (a) about the past, present and future – in other words contextualizing the niche-innovations; and (b)

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[2] Reflection is defined as critically scrutinize and be empathetic (Metze, 2010).

[3] The concepts reflexivity and reflectivity often are used interchangeable. However, reflexivity suggests this type of critical thinking to be a reflex. In our research we are interested in the more arranged for forms of reflectivity and therefore, we will use the concept reflectivity in our further development of the notion.