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Analysing the past and exploring the future of sustainable biomass. Participatory stakeholder dialogue and technological innovation systems research

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ABSTRACT

This paper explores the potential of combining technological innovation systems research with a participatory stakeholder dialogue, using empirical material from a dialogue on the options of sustainable biomass in the Netherlands and several historical studies into the emerging Dutch biomass innovation system. These studies identified and analysed functions (key processes) needed for the diffusion of this system. Using the functions as a heuristic to analyse and present this material, this paper shows that combining both approaches results in a richer understanding of the Dutch biomass innovation system. Where innovation systems research has not inquired in-depth into the normative dimensions of biomass innovation, the dialogue contributes to a better understanding of these. In contrast to systems research where the researcher defines system boundaries, the dialogue allowed system boundaries to be defined along the process in a bottom-up manner. This resulted in different ideas about challenges and opportunities. Where dialogue discussions were based on somewhat anecdotal information, biomass innovation systems research provided a historical and systemic contextualisation. Furthermore, the functions served as useful categories to explore future sustainable biomass options. We conclude that triangulation, using both historic and participatory methods, provides more insight, in terms of both range and depth, in the actual functioning of innovation systems and opportunities for improvement.

1. Introduction

In order to address the threat of climate change and other persistent environmental problems, our current energy system is in need of profound technological and societal transformations. Socio-technical innovation has gained attention from both research and policy making over the past decades. Different research strands in this area have been discussed elsewhere (see for example [1]). These methods share a common feature in rejecting a linear model techno-economic approach. Instead, they aim at an understanding of the complex dynamics involved in innovation processes [2–5], focusing in particular on barriers that innovations need to overcome during their development to maturity.

Technological innovation aimed at sustainability has been a focal area of the *Technological Innovation Systems* (TIS) approach [6,7]. This approach has recently shown great progress in mapping and explaining the dynamics of technological innovation processes [6,8–10]. The TIS approach aims to account for both the structure of an innovation system and key processes that contribute to or hamper the diffusion of technology. Emerging technological fields are conceptualised as emerging systems where actors, institutions, networks and technologies interact and where the quality of these interactions influences the development and diffusion of technologies. In terms of structure, a Technological Innovation System is understood as a social network that is constituted by actors and institutions around a specific technology [11]. The analysis of dynamics centres around seven key processes or system functions (see Table 1) that are considered necessary for TIS build-up [6–12]. These functions provide a framework for identifying barriers to

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Table 1
The seven functions of innovation systems.

F1: Entrepreneurial Activities
Activities that aim at proving the usefulness of the emerging technology in a practical and/or commercial environment, e.g. experiments, demonstrations and entrepreneurial and business ventures.
F2: Knowledge Development
Learning activities, mostly related to the emerging technology, but also related to markets, networks, users etc. There are various types of learning activities, the most being learning-by-searching (R&D in basic science) and learning-by-doing (learning in practical context) [21]
F3: Networks and Knowledge diffusion
The characteristic organisation structure of a TIS is that of the network [22]. The primary function of networks is to facilitate the exchange of knowledge between all the actors involved. Knowledge diffusion can occur in the formation of partnerships, or in meetings like workshops and conferences. Lundvall's notion of interactive learning as the *raison-d'être* of any innovation system entails that innovation happens only where actors of different backgrounds interact [23].
F4: Guidance of the Search
Activities within the TIS that shape the needs, requirements and expectations of actors with respect to their support of the emerging technology. It also refers to the promises and expectations expressed by various actors [24]. Important is the convergence of signals – expectations, promises, policy – in a particular direction of technology development, which may work out positively or negatively for the technology concerned. As various technological options exist within an emerging technological field, this convergence is bound to become important at some point — because resources are limited.
F5: Market Formation
Emerging technologies usually cannot compete with incumbent technologies. Therefore the creation of artificial (niche) markets is needed. This function involves activities that contribute to the creation of a demand for the emerging technology, e.g. by financially supporting the use of the emerging technology.
F6: Resource Mobilisation
The allocation of sufficient financial, material and human capital to make the emerging technology viable [22]. Examples include investments and subsidies; the deployment of generic infrastructures such as educational systems, large R&D facilities or refuelling infrastructures; and the mobilisation of natural resources like biomass.
F7: Lobbies, Support from advocacy coalitions
The rise of an emerging technology often meets with resistance from established coalitions with stakes in the incumbent energy system. In order for a TIS to develop, an advocacy coalition should be strong enough to effectively influence policy making. This function involves political lobbies and advice activities on behalf of interest groups and can be regarded as a special form of Guidance of the Search, because such pleas in favour of particular technologies are attempts to shape expectations.

the development of innovation systems which can be translated into policy recommendations [13].

In the field of biomass – the topic of this paper – several TIS studies have been performed in order to understand why developments so far have been rather unsuccessful in the Netherlands [9–11,14,15]. These TIS analyses of institutional, network, market and technological dynamics, conclude with ideas on how to support emergent systems to become mature. Policy support can encourage this process but the extent to which biomass niches, options and practices are desirable from an ecological, social and economical sustainability perspective and therefore 'deserve' policy support, has been subject to severe controversy. In the Netherlands, a heated debate took place at the time when empirical work for this paper was carried out (2007–2009). The sustainability of biomass and the legitimacy of policy support for biomass applications were central in this debate. For instance, the co-firing of imported palm oil for energy production was subsidised by the Dutch government, while at the same time the sustainability of this imported palm oil was contested because of the associated negative environmental and social impacts (such as land conflicts, human rights violations and ecological degradation as a result of oil palm cultivation on cleared forest land in Southeast Asia). In this controversy, values and facts became closely interrelated. Dutch scientists diverged in their opinions regarding the opportunities for sustainable biomass. It was in this context that a Dutch commission (known as the Cramer Commission) started developing criteria that would have to be met by biomass applications in order to be considered sustainable [16].

Where the TIS approach contributes to analysing historical trends in biomass innovation, it fares less well in grasping the controversial nature of biomass. For that dimension, a participatory stakeholder dialogue can be useful, as it reveals and confronts different underlying stakeholder perspectives. Successful innovation requires a certain level of commitment, support or at least acceptance by relevant societal stakeholders [17], which depends on the extent to which stakeholders manage to align their diverging expectations, needs and interests. Participatory stakeholder dialogue method can support such processes of alignment and in doing so, future options and solutions can be explored. The TIS approach can provide the historical context for such a future exploration. In addition, it can help to structure new ideas generated in a dialogue by means of the functions.

Hence, it appears that both approaches can be fruitfully combined. To learn whether this really is the case, this article addresses the question as to whether both approaches (the stakeholder dialogue method and Technological Innovation Systems Analysis) can reinforce each other in two related ways: (1) findings obtained using both approaches combined provide a more comprehensive picture of the innovation system under study than findings obtained using each approach separately and (2) combining the approaches helps to avoid specific methodological constraints of the individual approaches in question. Fig. 1 shows how the two approaches may be regarded complementary.

We present and analyse the following empirical material in order to address the question posed. First several ex-post