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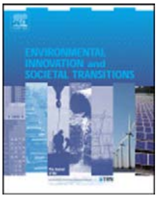

Survey

Innovation system analyses and sustainability transitions: Contributions and suggestions for research

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ABSTRACT

This paper argues (1) that technology-specific policies are necessary if we are to meet the climate challenge and (2) that a main contribution of innovation system (IS) analysis to the study of sustainability transitions is that it allows policy makers to identify the processes and components in a system where intervention is likely to matter most. We demonstrate that an IS framework can identify a diverse set of system weaknesses in the field of environmental innovation and identify five venues for further research that can help strengthen the framework and improve its application to environmental innovations.

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1. Introduction

Greenhouse gas emissions need to be reduced by 80% if a stabilisation is to occur in terms of concentrations of carbon dioxide (CO_2) equivalents at the level of 500 ppm (Stern, 2006). Much of this transformation needs to have taken place by 2050, and will entail an almost complete decarbonisation of the electricity sector. To achieve this within the suggested time frame is a formidable challenge, which requires that adequate climate policies are put into place.

The neoclassical guidance for policy is the “market failure” approach. With respect to the introduction of new energy technologies, two failures are usually emphasized: positive knowledge externalities and negative environmental externalities (e.g., Jaffe et al., 2002). With respect to the former, the argument is that firms tend to under-invest in research and development compared with a socially

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optimal level due to, e.g., knowledge spill-overs that benefit other actors than the investor.[1] The policy approach to handling this inability to appropriate the full benefits of R&D is to fund basic R&D and co-fund some industrial R&D. With respect to the latter, it is generally accepted that energy markets fail to internalise the environmental costs of energy supply. Favoured solutions are to either make polluters pay or to make good environmental performance someone's property and create markets where this property can be traded. Policy instruments that do not distinguish between different technologies are usually advocated, for example general CO_2 taxes, tradable emission permits and tradable green certificates. Under the influence of such instruments, the main selection mechanism is marginal cost; investments will first occur in the currently most cost-efficient technologies and only after these encounter rising cost levels will more costly technologies be fostered.

Market-failure based climate policies, thus, rest on two legs: R&D support and general, often "market-based", economic incentives. In this paper we will argue, with Azar and Sandén in this volume, that such general policies are not enough to stimulate sustainability transitions; technology-specific policies are also required. However, implementing such policies raises the question of how policy makers can identify the processes that are of critical importance to the dynamics of specific technologies and to which policy intervention should be addressed, i.e. where intervention is required.[2] This is where innovation system analyses make their prime contribution to the study of sustainability transitions.

"Innovation systems" was developed as a policy concept in the mid-1980s. In the context of debates over industrial policy in Europe and as a reaction to perceived inadequacies of neoclassical economics and the spread of neoliberalism, a range of system approaches emerged (Sharif, 2006). These include national innovation systems (NIS) (Freeman, 1987; Lundvall, 1992), sectoral innovation systems (SIS) (Breschi and Malerba, 1997; Malerba, 2004), technological innovation systems (TISs) (Carlsson and Stankiewicz, 1991) and regional innovation systems (RISs) (Cooke, 1996). Whilst differing in system boundaries, these approaches have many shared features, in particular, that the innovation and diffusion process is both a collective and an individual act. The various systems are, furthermore, interdependent. For instance, an innovation system that is specific to a technology is situated in a context of systems at higher levels of aggregation (NIS, RIS, SIS) (Markard and Truffer, 2008).

The key contribution of innovation system analyses to the study of sustainability transitions is, we argue, that it provides policy makers with a tool for identifying system weaknesses. It promises, therefore, to inform policy makers of the problems that an intervention needs to solve in order to promote the growth of a particular system or to influence its direction. So far, the bulk of innovation system scholars have not focussed on technologies within the environmental field.[3] It is primarily the technological innovation system (TIS) approach that has been used to study the emergence of new energy technologies. This has given rise to a fairly large literature which provides an opportunity to review what we have learnt with respect to its capacity to inform the policy making process by identifying system weaknesses. The purpose of this paper is therefore twofold: (1) to take stock of the achievements of innovation systems research in identifying system weaknesses in the area of environmental innovations and (2) to provide some ideas for further research that can improve its usefulness for policy in this field.

The structure of the paper is as follows. Section 2 develops the arguments for technology-specific policies. Section 3 discusses system weaknesses as a core concept in innovation system analyses. Section 4 presents a selective review of the literature on innovation systems and sustainability, demonstrating the diversity of system weaknesses identified. Section 5 states the main conclusions and identifies five venues for further research.

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[1] Additional reasons for underinvestment in innovation are the under-valuation effect (profits do not reflect true economic value of new products/technology) and the stand-alone effect (firms consider only their own gains from innovation and not the gains from having others innovate) (Grubb and Ulph, 2002). In addition, incomplete and asymmetric information can also lead to under-investment in innovation (Jaffe et al., 2002).

[2] This is related to but different from identifying the economic phenomena, such as lock-in and externalities, which lead to a policy problem (Swann, 2010).

[3] It is perhaps instructive to note that none of the nine themes in the call for papers for the DRUID conference in 2011 includes sustainability, environment or energy. These were also neglected topics at the most recent Schumpeter conference in Aalborg (2010).

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