

## Public governance for green innovation

Governance will play a key role in transitioning to green technology and innovation. The OECD area provides ample evidence that countries' innovation performance depends in part on the quality of the governance of STI, i.e. the set of largely publicly defined institutional arrangements, incentive structures, etc., that determine how the various public and private actors engaged in socioeconomic development interact in allocating and managing resources devoted to STI.

### Figure 1. Energy productivity, GDP per toe TPES, constant USD PPPs

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### The rationale for innovation policies in a green growth strategy

If innovation is regarded as an important driver of green growth, the question is whether this can be simply left to the market or whether policies are needed to support (green) innovation and also what such policies should look like. The rationale for policies for innovation lies in several market failures (Newell, 2009; 2010: UK Committee on Climate Change, 2010; OECD, 2010a). First, there are the negative externalities of climate change and other environmental challenges. If firms and households do not have to pay for the climate damage imposed by GHG emissions, for example, then GHG emissions will be too high. If customers do not have to pay for the water they use, they are unlikely to use it efficiently.

This has implications for innovation – both the creation and diffusion of technologies, products and processes – because, if there is no demand for environmental solutions, then the demand for green innovation will also be below the social optimum. In turn, there will be insufficient incentives for companies to invest in innovation, because there will be little market demand for any products or processes that might come of it.

This particular market failure implies that policies will be needed to correct this negative environmental externality, e.g. through carbon taxes, tradable permits or other market instruments. Carbon pricing or other market instruments that put a price on environmental externalities will therefore be crucial to green innovation (OECD, 2010b). Such policies will also contribute to the credibility and viability of a policy regime, which is often key to encouraging investors to take the necessary risks to bring about “green” innovation.

### Barriers to development and uptake of green technology and innovation

Policies for green innovation should take account of barriers. Many barriers to technological innovation and diffusion are known and have been studied. The usual entry point for government intervention occurs when market forces provide inadequate incentives for entrepreneurs and firms to invest in either the development or the diffusion of green technologies. The main rationale for public support for R&D is spillovers – large, broadly dispersed societal benefits – that may occur as a result of research. As firms are unable to capture fully the results of R&D, they tend to underinvest in the socially optimal level.

In the case of green innovation, the policy rationale is what is usually referred to as the “double externality” problem (Jaffe et al., 2004). One argument concerns the underperformance of private research owing to knowledge externalities and the disincentives provided by free riding (Arrow, 1962; Nelson, 1959). Other market failures, such as credibility problems or learning-by-doing effects, can also inhibit the development and diffusion of green technology. A second argument arises from the negative externalities of climate change and other environmental challenges and has implications for both the creation and diffusion of technologies. Because GHG emissions are not

priced by the market, incentives to reduce them through technology development are limited. Similarly, there is less diffusion and adoption, once green technologies are available, if market signals regarding the environmental benefits of such technologies are weak (Jaffe et al., 2005; Newell, 2010).

Other barriers to innovation may arise from systemic failures (OECD, 1998) that hinder the flow of knowledge and technology and reduce the overall efficiency of the system-wide R&D and innovation effort (OECD, 1999). These include capability failures, institutional failures, network failures and framework failures (Arnold, 2004). The issue is less the divergence between private benefits and social benefits than the insufficient development of the innovation system itself. Such systemic failures can arise from mismatches between different parts of an innovation system, such as incompatible incentives for market and non-market institutions, i.e. firms and the public research sector (Faber et al., 2008). This is particularly the case for research and technology infrastructure, such as data collection and dissemination or the training of scientists and engineers, which the market is unlikely to provide fully on its own. From the perspective of transformative change – here defined as a drastic change in governance practice – further types of policy failure that are relevant for green technologies in the context of transition policy can be identified, such as directionality, demand articulation, policy co-ordination and reflexivity failures (Weber and Rohracher, 2012).

### **Specific barriers to the development and uptake of green technologies**

Apart from typical market failures related to innovation, some market failures and barriers to innovation and adoption may be unique to, or more prevalent in, markets for green innovation (UK Committee on Climate Change, 2010; Stavins, 2003; Popp et al., 2009; Geroski, 2000; Gillingham et al., 2009; Aghion et al., 2011). These include dominant patterns in energy and transport markets, uncertainty of success, long timescales for infrastructure replacement and development, a lack of options for product differentiation, liquidity constraints, path dependency, uncertainty and behavioural failures.

Barriers may also relate to firm size. These include a lack of financing and qualified personnel and, in some countries, the relatively small size of the domestic market (OECD, 2011a). Even for large firms, whether multinationals or national corporations, with scale, scope and experience, adapting to rapidly changing market environments and the high costs of R&D are challenges for commercialising new green technologies. Results from the Eurobarometer survey (EC, 2011) show that uncertain market demand, uncertain returns on investment and lack of funds are the three biggest obstacles to the uptake of green innovation.

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