

# Promoting Technological Environmental Innovations: The Role of Environmental Regulation

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## ABSTRACT

*This paper reviews and discusses the debate over the effectiveness of environmental regulation in promoting industrial Technological Environmental Innovation (TEI). Using the innovation-friendly regulatory principles adapted from Porter and van der Linde (1995a, 1995b), this paper demonstrates how properly designed and implemented environmental regulation (TEI promoting regulation) has played a critical role in promoting TEI in the transport industry in California and Hong Kong. In both cases, it has shown that stringent environmental regulations that send clear and strong signals for future environmental performance requirements are critical in promoting TEIs in the public transport industries. Unlike traditional command-and-control regulations, TEI promoting regulations are strongly supported by incentive and capability-enhancing measures.*

*Keywords:* Environmental Regulation, Fuel Cell Vehicles, Innovation-Oriented Regulation, LPG Taxis, Technological Environmental Innovation, Zero-Emission Bus Regulation

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## INTRODUCTION

Technological Environmental Innovation (TEI) has been seen as a critical means to achieve both economic gains and improved environmental performance in the greening of industry literature (Porter & van der Linde, 1995a, 1995b; Gouldson & Murphy, 1998; Murphy & Gouldson, 2000; Mol & Sonnenfeld, 2000; Mol, 2003). TEI offers not only the potential to reduce emissions and resource consumption but also the opportunity to improve eco-efficiency and economic competitiveness (Porter & van der Linde, 1995a, 1995b; Gouldson & Murphy,

1998; Mol, 1995; Mol & Spaaragaren, 2000). Industries can achieve long-term economic sustainability through continuous greening of their production and operational processes. Economists have argued that economic, institutional and attitudinal barriers may hinder the adoption of TEIs and that relevant environmental policy instruments are needed to overcome the barriers (Klemmer, Lehr, & Lobbe, 1999; Jaffe, Newell, & Stavins, 2005). This paper reviews and discusses the debate over the effectiveness of environmental regulation in promoting industrial TEI. With reference to the innovation-friendly regulatory principles modified from Porter and van der Linde (1995a, 1995b), this paper argues that properly designed and implemented

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environmental regulations have played a critical role in promoting TEI in the transport industry in California and Hong Kong.

## TECHNOLOGICAL ENVIRONMENTAL INNOVATION AND REGULATIONS

It has been argued that traditional environmental regulation as characterized by environmental standards or permits offers little incentive for TEI because of its inflexible, technology-forcing, bureaucratic and adversarial characteristics (Fiorino, 2006). There are repeated claims that environmental regulations, typically those employed in the US, are based on existing technology and do not provide additional incentives to innovate once the regulatory requirements have been met (Porter & van der Linde, 1995a, 1995b; Jaffe & Stavins, 1995; Norberg-Bohm, 1999; Fiorino, 2006). Environmental regulations are often not effective in promoting TEI diffusion because regulatory standards are usually more lax than standard practice and therefore provide little incentive for diffusion (Jaffe & Stavins, 1995; Fiorino, 2006). Environmental regulations that are based on performance standards are usually technology-setting, which could hamper radical innovation because firms do not like taking risks (Norberg-Bohm, 1999). In some cases, the incentive to innovate and diffuse environmental technologies is further constrained by bureaucracy long embedded in the regulatory system (Fiorino, 2006). Finally, the relationship between regulators and regulated industries are sometimes highly adversarial (Fiorino, 2006). High uncertainty and the lack of trust have left industries with little incentive to move forward.

Despite these claims about the inefficiency of environmental regulation in promoting TEIs, Porter and van der Linde argue that "the problem with (environmental) regulation is the way in which standards are written and the sheer inefficiency with which regulations are administered" (1995a, p. 46). They contend that environmental regulations that are properly

designed and implemented and aim at innovation can provide strong pressure and incentives, and result in higher resource productivity and efficiency and more competitive advantages. Consequently, industries can actually be incentivized to innovate continuously. Nevertheless, innovation-friendly environmental regulation differs from traditional compliance-oriented forms in a number of ways, namely, goal-setting, outcome-oriented, stringency, flexibility, certainty, consistency, incentive-based, voluntary-based, information-coupling, participatory, process-based and capability-enhancing (Ashford, 2000, 2002; Porter & van der Linde, 1995a, 1995b). Among all the regulatory characteristics, Norberg-Bohm (1999) argues that environmental regulations that provide stronger political or economic incentives (incentive-based), and clearer signals about future environmental performance requirements (certainty), are critical for driving TEIs where pay-offs are more long-term or uncertain (radical TEIs). Other regulatory characteristics such as information about the magnitude and cost of pollution control, flexibility in choosing which technology can be used to meet the regulatory targets, and the demonstration of key short-term economic benefits are also important in spearheading incremental TEIs. In addition, empirical studies on industrial environmental innovation in the United Kingdom (Gouldson & Murphy, 1998), European countries (Klemmer, Lehr, & Lobbe, 1999; Hitchens et al., 2000) and the United States (Porter & van der Linde, 1995a, 1995b; Ashford, 2000, 2002; Fiorino, 2006) have consistently highlighted that regulatory pressure is a key factor in motivating industries to adopt new environmental technologies and initiatives. Some may consider economic instruments a better alternative to direct environmental regulation. However, economic instruments alone, such as tax exemptions, may actually "result in fewer incentives to innovate than direct environmental regulation. The tax rate is often set at a low level in order not to impose excessively high costs on the industry" (Mickwitz, Hyvattinen, & Kivimaa, 2008, p. 168). If an economic instrument does not

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