Energy Policy 81 (2015) 122–130

Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

Determinants of innovation in energy intensive industry and implications for energy policy

ChiUng Song [a], Wankeun Oh [b,*]

[a] Science and Technology Polity Institute, Seoul 156-714, South Korea
[b] Department of Economics, Hankuk University of Foreign Studies, Seoul 130-791, South Korea

HIGHLIGHTS

- We analyze determinants on two innovations in energy intensive industry (EII).
- The R&D personnel ratio is effective in product innovation in EII.
- Both R&D intensity and R&D personnel are effective in process innovation in EII.
- In less EII, R&D variables have positive effects on product and process innovations.
- The Korean government should strongly support R&D to improve energy efficiency.

ARTICLE INFO

Article history:
Received 26 December 2014
Received in revised form
10 February 2015
Accepted 23 February 2015
Available online 3 March 2015

JEL classifications:
Q400
Q480

Keywords:
Energy efficiency
R&D
Energy intensive industry
Innovation

ABSTRACTS

The Korean government adopted "green growth" in 2008 as an environmentally friendly growth strategy. The energy efficiency of Korea, however, is still relatively low due to the large portion of energy intensive industry (EII) in its manufacturing sector. To improve energy efficiency in Korea, from an EII perspective a new approach has to be taken because restructuring entire industries would take too much time and be too costly. This study aims to emphasize the importance of innovation and analyze the effects of R&D on product and process innovations in EII in Korea. The Probit model is adopted to estimate the effects of eight determinants in the Korea Innovation Survey 2008 data. The results of this study demonstrate that one of the most important determinants, the R&D personnel ratio, has a strong positive effect on both product and process innovation, while another determinant, R&D intensity, only has a strong and positive effect on process innovation in EII. Because of the resulting innovation, energy policies should be enacted to enhance energy efficiency. Thus, the Korean government should keep providing incentives for firms in EII to invest more financial and human resources in their R&D activities.

1. Introduction

In this era of energy crises and global climate change, energy policies have become more important than ever before. Developed countries, including the United States and the European Union, have introduced several energy strategies to secure energy resources and reduce greenhouse gas emissions (European Commission, 2006; United States Congress, 2005; The White House National Economic Council, 2006). For example, the EU's report (2006) identified the bottlenecks of cost-effective efficiencies and initiated plans and options for how those bottlenecks could be overcome. These countries tend to focus on improving energy efficiency as a top-priority agenda item in their energy policies, since they clearly recognize that an improvement in energy efficiency is one of the quickest, most effective and most cost-savings ways to resolve both high oil prices and greenhouse gas emissions at the same time.

In August 2008, the Korean government (2008) adopted "green growth" as an environmentally friendly growth strategy to sustain its economic growth and overcome energy crisis challenges. Going along with the Korean green growth strategy, the United Nations Environment Programme United Nations Environment Programme (2008), OECD (2009a, 2009b, 2011), and World Bank (2012) have accepted "green growth" as a main agenda for sustainable development.[1] Furthermore, the Korean government also announced the First National Energy Master Plan (2008–2030) in

[1] In January 2012, the Global Green Growth Institute, OECD, UNEP, World Bank signed a Memorandum of Understanding to formally launch the Green Growth Knowledge Platform. Its mission is to enhance and expand efforts to identify and address major knowledge gaps in green growth theory and practice, and to help countries design and implement policies to move towards a green economy.

* Corresponding author.
E-mail addresses: cusong@stepi.re.kr (C. Song), wanoh@hufs.ac.kr (W. Oh).

http://dx.doi.org/10.1016/j.enpol.2015.02.022
0301-4215/

2008 and the Second National Energy Plan in 2014. The Plans declared that energy efficiency was a top policy priority and they directed Korea's national energy policy towards the improvement of efficiency through technological development and industrial restructuring.[2]

Energy efficiency is a way of managing and restraining the growth in energy consumption (International Energy Agency, n.d).[3] Something is more energy efficient when there is the same energy input and more services are delivered, or when the same services are delivered with less energy input. This can be measured by energy intensity, which is energy consumption divided by output. Research shows that the energy efficiency of Korea is relatively lower than that of developed countries (Lee and Oh, 2006; Oh, 2011). In addition, Korea has a large portion of energy intensive industry (EII), which refers to industries that consume relatively more energy resources than other industries[4] in the manufacturing sector.[5]

During its economic growth, Korea has been export-driven and manufacturing-based.[6] Since EII can provide cheap raw materials for manufacturing industries in Korea, it has played the role of a growth engine in the course of rapid economic growth over five decades. However, to reduce energy use in Korea now, the restructuring of entire industries would take a long period of time and be costly. Enhancing the efficiency of EII through innovation seems to be, in the short term, more critical and urgent.

In light of innovation, the United Nations (UN) (2011) has also emphasized technology and innovation as the most important factors in driving industrial energy efficiency, since the introduction of new or improved technologies and innovation can boost the energy efficiency of a production process and manufacturing facilities. To overcome any administrative, systematic and institutional barriers in firms, the UN (2011) has continued to suggest that the government provide public policy measures that incorporate financial, institutional and legal assistance for the development of technology, technology transfer, knowledge diffusion, and innovation activities. The enhancement of efficiency in EII can be achieved through technological innovation. Thus, the effect of innovation in EII has become the focus of energy policy research.

This study aims to emphasize the importance of innovation and analyze the impact of Research and Development (R&D) on both product innovation and process innovation in EII and compare it to less EII. To do so, we use data from the 2008 Korea Innovation Survey to estimate the impact of key economic variables (e.g. firm size and market structure) that are proposed in the Schumpeterian hypothesis, along with other economic variables on innovation in EII. Based on the empirical results, we uncover the implications that energy policies have on facilitating innovation in EII.

This study is organized as follows. Section 2 reviews the literature and explains the data and methodology used to estimate the determinants of innovation. Section 3 presents the empirical results of this study and Section 4 discusses issues relevant to this study. Section 5 presents the conclusions along with policy implications.

[2] The Plan is explained in Section 4.
[3] http://www.iea.org/topics/energyefficiency.
[4] The details on EII are provided in Section 2.2.
[5] Choi and Oh (2014).
[6] Korea Development Institute (2010) and Oh and Kim (forthcoming).

2. Methods

2.1. Literature review

At the present time, with fluctuating oil prices and global climate change, securing an environmentally and financially reliable energy supply has become the focal point of national economic policies. In this context, most advanced countries have designated energy efficiency as a top priority in their policy agendas and have tried to figure out how to improve energy efficiency. As a result, a significant amount of academic and policy literature has dealt with the general issue of energy efficiency and has focused on energy innovation in particular.

In 2005, the National Association of Manufacturers (2005), in cooperation with the Alliance to Save Energy (Alliance), published a report that highlights the main energy issues in the American manufacturing sector. This report emphasized the importance of manufacturers' efforts to facilitate financial performance and employ energy-smart procedures from the start. Upon evaluation, a lack of concern about outdated budgetary (financial) practices and a shortage of skilled staff appeared to be major barriers to energy efficiency in most companies. Thus, it was concluded that U.S. manufacturers should enhance human resource development and reform business practices.

In addition, this report pointed out the importance of socio-economic factors that can influence energy usage such as government policies, public programs, environmental regulations as well as technological and managerial innovation. Then, the report advised U.S. manufacturers to invest in innovative technologies such as information technology, material science and nanotechnology. This is because technological innovation will bring about not only new technological opportunities to improve energy efficiency, but also financial benefits and a better social reputation.

The Center for Low Carbon Futures (2011) made another report in order to provide innovative technology solutions for energy intensive sectors and submitted it to the Trade Union Congress and the Energy Intensive Users Group. According to this report, there are a number of promising technologies that can substantially decrease carbon emissions in manufacturing sectors. However, there are also many critical barriers to the realization of these potential technologies. In the report's list of the top eight barriers, the shortage of financial resources for R&D expenditures was one of them.

In this context, the report has suggested a provision of policy measures that can stimulate investment in technological innovation as well as fill the gap between R&D and the commercialization of rising technologies. The policy measures include long term regulation, reform and financial support. Then, most of the energy intensive sectors will accept the transformative technologies required to reduce carbon emissions. In addition, this report recommended that government, industry and trade unions should have ongoing dialog for supporting the policy framework.

In 2008, the Business and Industry Advisory Committee (BIAC) of the OECD (2008) pointed out the importance of research in the energy sector. BIAC insisted that research is essential in developing and understanding new technological options as well as in comprehending how to integrate technology options to support innovation. Thus, public R&D programs should cover a certain scope of energy-related technology development and be incorporated into a scheme of national energy supply and demand. In addition, BIAC suggested that the OECD consider energy as a top-notch agenda item in their Innovation Strategy launched in May 2007 at the OECD Ministerial Council Meeting. In cooperation with its allied organizations, including the IEA and Nuclear Energy Agency, the OECD had to play an important role in devising, proposing, implementing and revising policy packages to support innovation.