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A survey study of energy saving activities of industrial companies in the Republic of Korea

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ABSTRACT

This study measures industrial energy saving activities (ESAs) in the Republic of Korea and identifies their determinant factors by a questionnaire survey to the energy-intensive companies. More than 90% of the samples have practiced the institutional and managerial ESAs, requiring relatively lower costs and efforts. Although the companies have felt strong pressures from the governmental regulations and recognized the importance of industrial associations, the externally coercive, normative and mimetic factors still indicate no significant influence on their ESAs at present. As internal factors, the willingness for energy saving, support from top management and internal training specific for energy saving determine a company's practice level of ESAs. Economic incentives, like financial subsidies, are useful for encouraging the company's involvement in ESAs. Korean government shall also provide more technical support to the companies, particularly the small and medium-sized ones, for enhancing their capacities in promptly reacting to the newly initiated mandatory regulations on industrial energy efficiency.

1. Introduction

The Republic of Korea (Referred as Korea hereinafter) has developed its economy by heavily relying on energy consumptions (Kim et al., 2011). The rapid economic growth along with sharp increases in energy consumptions has led the country to be the tenth largest energy consumer in the world since 2005. The national total CO_2 emissions have been substantially increasing since 1990. According to a report of the Organization for Economic Co-operation and Development (OECD), the most CO_2 emissions-related industries contribute to around 30% of the Gross Domestic Product (GDP) of Korea. In spite of a temporary slowdown of CO_2 emissions during 1997–1998, the upward trend remains far more significant than the other OECD countries (OECD, 2008).

The national energy efficiency strategy of Korea has been outlined in its 'Energy Use Rationalization Act', enacted in 1979 soon after the global oil crisis in late 1970s. As so far, four master plans for rational utilization of energy were consecutively launched since 1993. Accordingly, a series of policies have been introduced and implemented, including the support of diffusion of energy efficient facilities and equipments, energy audit, voluntary agreement between the government and industry and the ESCO (Energy Service Company) projects. In the 4th master plan for 2008–2012, the Voluntary Agreement (VA) for energy efficiency improvement is emphasized for the companies using more than 20,000 TOEs (Ton of oil equivalents) of energy per year. This policy will be gradually expanded to the companies with annual energy consumption of 5000–20,000 TOEs. The 'National Energy Plan (2008–2030)', as the country's long-term strategy for energy security, specifies three energy policy goals: to improve the overall energy intensity in a unit of TOE/1,000USD to 0.185 by 2030 from 0.341 of 2007; to reduce the share of fossil fuels in total energy mix from 83% to 61%; and, to increase the share of renewable energies up to 11% from 2.4% during the same period.

Korea announced the new national vision of "Low carbon GreenGrowth" in 2008 and pledged in 2009 to reduce 30% of its greenhouse gases (GHGs) emissions from the business as usual (BAU) scenario by 2020 compared with 2005 levels. The national overall reduction target was further decomposed into specific targets of twenty five types of businesses in seven sectors, including industry, energy conversion, transportation, building, agriculture, waste and other public sector in July 2011. As a key measure for realizing the decomposed targets, the 'Target Management Scheme' (TMS) was recently initiated to limit the energy consumptions and GHGs emissions of major entities and business sites of each sector. The targets of TMS include entities emitting more than 125,000 t-CO_2 or using more than 500 TJ of energy annually, and business sites with more than 25,000 t-CO_2

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emissions or 100 TJ of energy use per year. As of the end of 2011, a total of 471 entities were designated as the TMS targets, whose GHGs emissions accounted for 61.3% of national total of 2007 (620 Million t-CO_2). Their energy consumptions shared 42.4% of national total of 2008 (10,087 thousand TJ). Among which, 372 entities are from the industrial and power sectors, with GHGs emissions and energy consumption accounting for 96.3% and 97% of all the TMS targets, respectively. The number of small and medium-sized enterprises (SMEs) under the TMS is 120, with a share of 32.1% of the entities from industrial and power sectors. The TMS targets from these two sectors will become 560 and the share of SMEs will increase to 40% by 2014 (MKE, 2010). These entities are managed by the monitoring, reporting and verification (MRV) system of Ministry of Knowledge Economy (MKE).

Korea government has been discussing market-based instruments (MBIs) for enhancing the industrial energy saving and GHGs mitigation, particularly carbon tax and emission trading scheme (ETS). In 2008, Korea Institute of Public Finance (KIPF) firstly suggested a carbon tax proposal with tax rates of 34–96 KRW/l for fossil fuels (Kim et al., 2008). The total expected tax revenues would be 8.5–9.1 trillion KRW (Korean Won) (7.38–7.91 billion USD) per year if based on 2007 emissions of Korea, about 1% of the country's GDP. KIPF further suggests the implementation of this policy from 2012 to replace the extant transportation tax to be ended in 2012 (Kim and Kim, 2010). The latest proposal of a GHG ETS, which will start from 1 January 2015, has been approved by the parliament after reflecting the comments of industries. The GHG ETS in Korea would cover the entities with certain amounts of energy use or GHG emissions and the policy targets will be adjusted considering international trend. Ninety five percent allowances may be allocated for free in the initial period. The emissions exceeding the allowances are subject to a penalty below three times of average market price. How to avoid the policy overlap between the TMS, ETS and carbon tax is a remaining question for further discussions.

Under such an emerging policy progress, Korean companies would have more motivations to integrate their energy saving into daily business operations. However, the company's green strategies were found still at an early stage since they were seldom required to do so in the past (Kim, 2009). The gap between the rapid policy progress and the company's laggard responses to energy and climate issues in Korea bears research concerns (Lee et al., 2010). With aims to close the existing research gap, this study seeks to identify major factors determining a company's energy saving practices in Korea by a survey mainly targeting SMEs from energy-intensive industries. Two topics are therefore discussed in this paper: a) the current status of energy saving activities (ESAs) of Korean companies; and, b) determinant factors, external and internal, predicting the level of a company's involvement in ESAs.

2. Literature review

Energy efficiency improvement is crucial, especially for the energy-intensive industries, due to its usefulness in cost reduction and GHGs mitigation. However, wide studies have indicated that the cost-effective energy saving measures could not be undertaken as expected (Rohdin et al., 2007). Barriers hindering the adoption of energy-efficiency practices have been largely discussed. Hirst and Brown (1990) once classified the barriers into structural and behavioral ones. Structural barriers include distortions in fuel prices, uncertainty about future fuel prices, limited access to capital, government fiscal policies, regulatories, codes and standards, and supply infrastructure limitations. Behavioral barriers include attitudes toward energy efficiency, perceived risk of energy-efficiency investments, information gaps, and misplaced incentives. Weber (1997) categorized the obstacles to efficient energy use into institutional, market, organizational and behavioral barriers.

Empirical studies have figured out specific barriers and drivers for energy saving practices in developed economies. Cagno and Trianni (2010) conducted a survey to 104 SMEs in northern Italy, and identified the access to capital and the lack of information on energy efficiency solutions as the most relevant barriers. Prindle (2010) distributed a questionnaire survey to nearly 100 companies of the U.S. and found that these firms' energy efficiency strategies are driven by the commitment to reduce CO_2 emissions and the desire to reduce operating cost. The common barriers for these U.S. companies include lack of funding; lack of personnel with the appropriate skills and insufficient technical information. A questionnaire survey to Swedish foundry industry confirmed that limited access of capital is the largest barrier to energy efficiency. Barriers within the private foundries are more related to information problems. The most important driver was long term energy strategies of these companies (Thollander et al., 2007). Kounetas et al. (2011) revealed that the information barrier is the major obstacle restricting companies from adopting energy efficiency technologies (EETs) in Europe. This study shared the experience for Greek manufacturing companies to adopt EETs by overcoming the information barrier. Thollander et al. (2007) confirmed the low priority of energy efficiency issues as a major barrier for SMEs of Sweden in energy efficiency measures in over the past 15 years. De Groot et al. (2001) analyzed the determinants of energy saving of Dutch firms by using a data set of 135 samples. They concluded that the cost saving potential is the most important driver behind investment decisions for energy saving. More attractive opportunities and uncertainty of possible declines in the price of new technologies are impediments for not investing in energy saving. In Asia, Liu (2012) carried out in-depth interviews to companies from the most fossil fuel-intensive industries in Fujian province, China. Although the companies are relatively well informed the knowledge and value of carbon management and have a strong willingness to act, there is no indication for them to take practical actions. He summarized the barriers as being structural, regulatory, contextual and cultural. Nagesha and Balachandra (2006) identified relevant barriers to energy efficiency in the small scale industry (SSI) clusters in India. The financial and economic barrier (FEB) and behavioral and personal barrier (BPB) have emerged as the two major impediments.

Empirical analyses at the company's level are rather scarce in Korea. As two exemptions, Lee et al. (2010) reviewed the green innovation status of 447 manufacturing companies of ten energy-intensive industries and confirmed the importance of regulations in pushing the company's green innovations. A company's green innovations are determined by the company's capacity and the perceived regulation pressures. Supportive policies and strategies are recommended to satisfy the needs of companies. Hong (2010) conducted a survey to 500 SMEs in Korea, with 33.8% of them being energy-intensive. More than half of respondents have recognized the regulative initiatives for GHG reductions. Lack of awareness and sufficient preparation is identified as major barriers for them to make efforts in GHG reductions.

3. Methodology

3.1. Analytical framework of this study

The analytical framework of this study is similar with our previous analysis of energy saving practices of Chinese companies, as depicted in Fig. 1 (Liu et al., 2012).

This model admits the importance of externally coercive, normative and mimetic pressures, recognized by the institutional