Bulletin of Science, Technology & Society
Volume 29 Number 2
April 2009 124-138

10.1177/0270467608330024
http://bsts.sagepub.com
hosted at
http://online.sagepub.com

The Restoration of a Local Energy Regime Amid Trends of Power Liberalization in East Asia

The Seoul Sustainable Energy Utility

Jung-Min Yu
Center for Energy and Environmental Policy, University of Delaware

Since the mid-1980s, power sector liberalization has been embraced at different levels in the East Asian countries of China, Japan, South Korea and Taiwan. The dominant rationale underlying power liberalization has been a quest for efficiency improvements, to be achieved by substituting private market activity for public regulations and by opening a country's electricity system to the global economy and management techniques. However, as the power system is increasingly liberalized, the possibility of establishing a local energy system, which has the great potential to restore sustainable environment-society relations, has been diminished. As an alternative to the power liberalization strategy, this paper proposes a restoration of local energy regimes based on the model of an energy commons and a decentralization paradigm. The innovative energy-policy model of the Sustainable Energy Utility, as applied in the case of Seoul, Korea, is explored as a possible option for a local energy strategy for East Asian countries.

Keywords: *power liberalization; electricity sector reform; electricity policy; sustainable energy utility*

The total installed generation capacity of the four East Asian countries of China, Japan, Korea, and Taiwan was 790 GW, which accounted for 20% of world total generation capacity as of 2005 (Energy Information Administration [EIA], 2007a). Accordingly, their CO_2 emissions from fossil fuel energy consumption, a major factor of global warming (International Panel on Climate Change[IPCC], 2007), are substantial, representing 26% of global CO_2 emissions from the energy sector in 2005 (EIA, 2007b). Moreover, it is projected that the power sector of the countries will continue to increase for the next two decades (e.g., the average annual growth rate of China would be 5.3% and 2.9% for Korea; (EIA, 2008a). Given this current and future scenario for the region, the kind of energy path taken by each country stands to significantly affect not only local and global environmental sustainability but sociopolitical relations as well.

In their own respective political and economic contexts, the four countries have implemented market-oriented power sector reform since the mid-1980s. Although the scale and pace of reform in each country differs to some extent, the underlying rationale for its pursuit has essentially been the same: "more energy in an efficient way." The conventional wisdom—emphasizing the state's role in being responsible for the provision of public goods such as electricity—was reconsidered and ultimately gave way to neoliberal ideas that markets would do better in seeing to the provision and ultimately the commodification of energy. The main purpose of this article is to challenge the adequacy of this efficiency discourse predominant in the power sector reform by broadening the scope of the energy discourse to sociopolitical and environmental dimensions. These broader agendas are discussed with empirical analysis of global power sector liberalization.

As an alternative to the power liberalization strategy, this article proposes a restoration of local energy regimes based on the model of an energy commons and a decentralization paradigm. The innovative energy-policy model of the Sustainable Energy Utility,

Author's Note: Address correspondence to Jung-Min Yu, Center for Energy and Environmental Policy, University of Delaware 277 Graham Hall, University of Delaware, Newark, DE 19716; e-mail: thinyu@udel.edu.

as applied in the case of Seoul, Korea, is explored as a possible option for a local energy strategy for East Asian countries. Its emergence may serve to guide alternative energy development schemes in locales that seek a range of social, economic, and environmental benefits as a function of 21st century investment in this sector.

Power Sector Reform in East Asia

This section briefly reviews the process of power liberalization within the four selected East Asian countries. The major driving forces and key elements of the reform are identified for each country.

China

The electricity industry in China, from 1949 to the mid-1980s, was owned and operated by the central government administration, and the whole industry was vertically integrated (Ma & He, 2008). Because of its strategic importance for the country's industrialization process, massive resources were channeled into the electricity sector from the central government's budget (Zhang & Heller, 2007). In return, a rapid expansion of the electricity sector provided a foundation for rapid economic growth in China. The phenomenon of this mutual reinforcement of China's economic development and energy growth has been identified as "synergistic development" (Byrne, et al., 2004).

Power sector reform in China occurred as a gradual process, rather than as "shock therapy" (Ma & He, 2008). This is in part because China practiced a planned economy since the founding of the People's Republic of China in 1949 and was not as severely constrained by the macroeconomic troubles experienced by other developing countries, which in turn had undergone neo-liberal restructuring of their domestic economies in the 1980s and 1990s. The development of electricity reform in China can be divided into three stages with regard to organizational structures and price schemes as follows.

Electricity sector reform in China started in the mid-1980s, as with other developing countries, and aimed to resolve the bottleneck of capital constraints in order to expand generating capacity as driven by economic growth (Ma & He, 2008; Zhang & Heller, 2007). The investment authority for the power sector was partially decentralized to local governments, state-owned enterprises, and the private sector (Zhang & Heller, 2007) and was accompanied with a new tariff structure, often called the "two-track" pricing scheme. While existing vertically integrated state-owned utilities were paid the internal transfer price that covered only fixed and operating costs of power plants, newly-built facilities were provided with a guided price that guaranteed costs plus "rate of return" (Ma & He, 2008). The second stage of reform introduced more market discipline into the electricity market by separating business operations and administrative authority, which had long been held by the central government in the planned economy. For this purpose, the State Power Corporation (SPC), which took over the responsibility of business operations, was founded in March 1997. The governmental administration and planning function was transferred to a newly-established State Economic and Trade Commission (SETC; Zhang & Heller, 2007). Furthermore, experiments in wholesale competition, on a limited basis, were implemented in six provinces in 1999. The experiment was prompted by an attempt to address a capacity surplus that had resulted from the success in adding generation capacity in the previous reform period alongside an unexpected slack in energy demand caused by the Asian financial crisis of 1997-1998 (Yeh & Lewis, 2004; Zhang & Heller, 2008). However, the experiment in wholesale competition proved to be insignificant and was suspended after 2 years largely because the monopolistic status of SPC remained unchanged and demand rebounded again in 2001 (Yeh & Lewis, 2004). Reform in the third phase marked a milestone in the development of the Chinese electricity industry for its comprehensive embrace of various major elements associated with power liberalization. The reform was a direct response to the failure of an efficient dispatch of power because of the monopolistic behavior of regional SPC firms (Zhang & Heller, 2007). The reform included a dismantling of the monopoly authority of the SPC, the introduction of a new pricing mechanism, and introduction of competitive forces through the creation of a wholesale and retail market (Ma & He, 2008).

Japan

The pace and scale of power restructuring in Japan has been relatively gradual and limited compared to other industrial settings such as the United States and the United Kingdom which introduced more drastic changes into their electric power systems. Prior to a first period of reform in the mid-1990s, Japan's electric power system was mainly composed of ten private, vertically-integrated utilities that were subject

to governmental regulation, and no companies were allowed to enter the electricity generation market (Asano, 2006). Each of the investor-owned utilities (IOUs) was responsible for generation, transmission, and distribution in their service area.

One of the motivations for reform was an attempt to address high electricity prices in Japan as compared to other developed countries. In particular, export industries increasingly put pressure on government to reduce the electricity rate (Toda, 2005). Making electricity prices more competitive through market mechanisms was believed to be an effective means to bring about recovery in Japan's stagnated economy in the 1990s following the bursting of the "bubble economy" (Goto & Yajima, 2006).

In 1996, Japan started power liberalization by introducing a competitive bidding system in the wholesale power market. This allowed independent power producers (IPPs) to enter the electricity market by selling electricity to incumbent utilities. In addition, a "yardstick assessment" was applied to the incumbent investor-owned utilities on the occasion of a rate increase in order to provide incentives for improved managerial efficiency (Goto & Yajima, 2006). In 2000, the electricity market was further liberalized, with retail competition introduced for customers with contract demand over 2 MW or customers supplied power through transmission lines over 20,000 V. New market entrants known as "power producers and suppliers" (PPSs) were allowed to supply electricity to these eligible customers using wheeling services provided by incumbent utilities (Goto & Yajima, 2006). The retail market was further liberalized for power demand over 500 kW and then over 50 kW in 2004 and 2005, respectively (Nakano & Managi, 2008). It is a unique feature of Japan's reformed market structure that the divestiture of generation from transmission or distribution segments was not adopted. Instead, they were separated only in terms of accounting for each sector, whereas ownership of the three segments remained intact (Goto & Yajima, 2006). To operate and manage the electricity market, two new institutions—the Electricity Power System Council of Japan (ESCJ) and the Japan Electric Power Exchange (JEPX)—were established in 2003.

Korea

The bedrock of Korea's rapid industrialization was the energy sector, particularly its electricity sector. The state-owned Korea Electric Power Corporation (KEPCO), established in 1961, was granted broad monopolistic power at that time. Not only responsible for generation, transmission, and distribution, KEPCO also was responsible for the planning, construction, and financing of approaches to meeting national electricity needs (Byrne et al, 2004). The government's plan for power sector liberalization was originally laid out when the first civil president announced a plan to privatize KEPCO in the rationale for globalization in the mid-1990s (Lee & Ahn, 2006). Although the plan, which sought the introduction of wholesale competition by 2010 and privatization of KEPCO after 2010, was relatively gradual and ultimately not put into effect, the monopolistic status of KEPCO was diminished by allowing IPPs to enter the business of electricity generation (Lee & Ahn, 2006).

The more drastic plan for power liberalization came after the country was struck by the Asian financial crisis in 1998. In accordance with the International Monetary Fund (IMF) structural adjustment program, Korea was forced to implement an austere budget policy to pay off foreign debt. A curtailment of the government's budget, an increase in the interest rate, elimination of regulatory barriers in order to attract foreign investment, massive lay-offs in the name of rationalization of management and cost reductions, and the selling of state-owned enterprise as a means to overcome the country's insolvency problems—all these have followed. The KEPCO was immediately forced into the spotlight, and it became a mirror of the dictates of globalization that Korea was forced to embrace in the wake of its financial predicament.

Under the reform program adopted in 2000, the institutional structure that had supported KEPCO's statutory monopolistic position was to be replaced with private corporations and the creation of new governance and market bodies (Byrne et al., 2004). The restructuring plan followed key components of the so-called "textbook model," which included vertical and horizontal disintegration of KEPCO, the privatization of generating companies, and the creation of a power pool market. Byrne et al (2004) described the situation as follows:

> Given that the country's electricity sector had little experience in managing a power pool with multiple market players, the rapid introduction of both wholesale and retail electricity markets was one of the bolder features of South Korea's electricity sector reform.

In April 2001, KEPCO's generating assets, accounting for 46% of KEPCO's labor force and 55% of its assets and liabilities (Lee & Ahn, 2006), were divided

into six generating subsidiaries (GenCos). Fossil fuel power plants were evenly allocated to five GenCos and were planned to be privatized. Nuclear and hydro were grouped into another subsidiary and were slated to remain as a public firm. At the same time, the Korea Power Exchange (KPX) was created to take responsibility for the operation of the system and the newly introduced one-way power pool market in the first stage. The second phase of reform was to focus on wholesale competition, including the unbundling of distribution segments from KEPCO creating regional distribution companies (Discos) and a two-way bidding pool with multiple buyers and sellers.

However, the newly elected government (2002-2007) suspended this second phase because of strong opposition from civil and labor society (see Byrne et al., 2004) and the recognized risks associated with market-oriented reform in other countries, notably the California electricity market meltdown in 2000-2001. In August 2003, the Korean government created a special committee under the auspices of the Korea Tripartite Commission (KTC) to evaluate the reform plan, and the committee in turn agreed to establish a joint research team to examine the existing restructuring plan and recommend a rational reform plan for the power sector. After 9 months of research, the special committee as a majority opinion recommended on June 17, 2004, that the government should stop the planned restructuring process. This recommendation was immediately accepted by the government and the further unbundling and privatization of the distribution sector was halted.

Taiwan

Prior to reform, as in China and Korea, a state-owned power utility, the Taiwan Power Corporation (hereafter, Taipower), dominated virtually the entire electricity industry in Taiwan. In the mid-1990s, as influenced by the international trend for market liberalization, Taiwan decided to liberalize its own electricity industry to expand generating capacity and thereby improve its economic performance. The first step of power liberalization centered on introducing independent power producers (IPPs) into the electricity market in 1994. The limit on foreign investment in Taiwan's electricity sector was raised to 50% (Shih, 2007) and was subsequently removed when Taiwan joined the World Trade Organization (WTO) in 2001-2002 (EIA, 2008b). To date, IPPs own roughly one quarter of total generating capacity in Taiwan (EIA, 2008b). Under the current market structure, all of the electricity generated by IPPs is required to be sold to Taipower as part of a 25-year power purchase agreement (PPA). Similar to the introduction of a qualifying utility under the U.S. Public Utility Regulatory Policies Act (PURPA), which commenced in 1978, the rate paid to IPPs in Taiwan was decided based on the "avoided cost" of Taipower's similar facilities (Shih, 2007).

The Taiwanese government outlined plans for further liberalization of the power sector as part of the Electricity Act of 1999. Although the bill has not yet been passed in the country's legislative assembly, it stipulates a textbook model of power liberalization for the future, including establishment of an independent system operator (ISO), the breakup of the generation segment of Taipower, and the introduction of a competitive wholesale and retail market. Taipower is also supposed to retain its nuclear and hydro generation assets as regulated power generators even after the onset of the full liberalized electricity market (Wang, 2006). To date, the monopolistic position of Taipower has remained largely unchanged.

Unfulfilled Agendas in Power Liberalization

Because the process of power liberalization proved to be limited within the selected East Asian countries discussed above, it is probably premature to evaluate their reform performance. However, the global experience of market-oriented power sector reform in many other industrialized—as well as less industrialized—countries provides us with theoretical explanations and empirical evidence of the inadequacy of power liberalization as a strategy for addressing economic, social, and environmental challenges currently faced by modern societies.

This section discusses the environmental, sociopolitical, and economic implications of power liberalization, based on a global as well as a specifically East Asian context.

Environmental Contradictions

Bulk power favored by the market. According to market advocates, a competitive market context would serve to enhance prudent investment decisions in power generation, so as to make small-sized and distributed electricity generation more attractive than large power plants. However, in practice, it has been observed that bulk power from large coal and nuclear plants have gained ascendancy over small-scale generators in the competitive market.

For example, in the United States, even though only one nuclear reactor has been added since the mid-1990s, the total generation of nuclear has risen by nearly one third between the early 1990s and 2003 (Palmer & Burtraw, 2005). The gas turbine technology that was expected to contribute to an expansion of *small*-scale decentralized energy options has primarily been applied to use within *large*-scale turbines, which are better suited for a combined-cycle as base load competing with coal and nuclear plants (Ishii, 2004, cited in Palmer & Burtraw, 2005). This upsurge of base load technology is largely due to two major changes in the liberalized market. Under the auction system utilized in the energy market, base load technology occupies a more favorable condition to earn profits because the market price is set at the highest winning bid price (market clearing price) of the power plants with expensive marginal production costs, rather than the average cost of the winning bidders (Blumsack, Apt, & Lave, 2006). Secondly, so called "seamless" transmission lines for the integrated wholesale market provide great opportunities for base load generators to sell their bulk power across regional boundaries.

Nuclear favored by government. The neoliberal assumption that withdrawing government intervention and creating market mechanisms will reveal the *true* marginal cost of production, so that clean technology will be favored, turned out to be self-contradictory in the actual practice of power liberalization. A self-addressing market without governmental intervention did not take place as market proponents had expected. Furthermore, the remaining government authority continues to work against development of local energy systems while favoring centralized and authoritarian technologies, notably nuclear power.

For example, when the United Kingdom broke up the Central Electricity Generating Board (CEGB) into several generating and distribution companies in the 1980s, nuclear power plants were insulated from market discipline and placed under the control of the government. The failure in attempting to privatize nuclear power plants can be attributed to their overall lack of marketability. Likewise, Korea and Taiwan's power liberalization plan also proposed to keep nuclear power plants under government control, wheras other generation assets were supposed to be privatized. In Japan, nuclear power along with liquefied natural gas (LNG) became the major fuel for electricity generation after the two oil crises in the 1970s. Although Japan partially liberalized its electricity market, nuclear power is expected to prosper with government assistance (Goto & Yajima, 2006).

Renewable opportunities lost. In the United States, the total retail sales of renewable energy from the voluntary purchase markets was 8.5 billion kWh in 2005, which was about 0.2% of total U.S. electricity sales (Bird & Swezey, 2006). Among voluntary green power purchases, utility green pricing programs, competitive marketing, and Renewable Energy Certificate (REC) marketing accounts for 29%, 25%, and 46% of the purchases, respectively. Because utility-sponsored green pricing programs and RECs are more likely to be regulatory mechanisms rather than retail market forces emerging as a result of restructuring, renewable energy development—as driven by consumer choice in a competitive market—does not seem to be occurring as successfully as expected.

In developing countries, power liberalization was accompanied by the participation of Independent Power Producers (IPP) who had received significant investment from the foreign private sector. As most IPP projects that boomed in the 1990s were concentrated on lucrative large-size generating facilities, such as hydro and fossil fuel stations, rather than small-scale and distributed energy supply options, IPPs have been associated with potentially negative environmental impacts. In China, although many IPP projects were relatively small scale due to certain approval requirements, a large portion were fossil fuel-based with low thermal efficiency and high pollution discharges (Ma & He, 2008).

Sociopolitical Contradictions

A disregard for accessibility by the poor. One of the sociopolitical challenges of power liberalization has been accessibility to electricity by the poor, especially those in rural areas in developing countries, who in turn have been largely marginalized by the conventional electricity system. The conventional method of rural electrification entailed building centralized power plants and expanding transmission and distribution lines, a formidable challenge for those developing countries with severe deficiencies in capital. As pointed out by Reddy (2001), the profit-oriented electricity system was therefore unlikely to improve this situation as faced by developing countries: From the perspective of private investors, in places or sectors where demand is low and disperse, such as in rural areas, the recovery time for the initial costs of any infrastructural investment is prohibitively long. Given this fact, it is unlikely that the private sector will necessarily find sufficient incentives to commit to such unprofitable investment (Reddy, 2001).

These concerns have been proven to be true in many developing countries (see Foster & Araujo, 2004; Karekezi & Kimani, 2004; Sihag, Misra, & Sharma, 2004). While most benefits if any are shared between power suppliers, nonpoor consumers, and the government, the poor disproportionately suffer from the liberalization strategy (Besant-Jones, 2006). Specifically, action to enhance access to modern utility electricity services for the poor in rural areas was oftentimes characterized merely by a typical liberalization strategy of focusing on the addition of generation capacity rather than transmission and distribution (Besant-Jones, 2006; Wamukonya, 2003).

Recentralization. One of the promises of power liberalization was that decision-making processes would be decentralized through more economic competition and a resulting broadened freedom of individuals in the marketplace. However, Byrne and Mun (2003) questioned this view, which linked power liberalization to decentralization. To date, regulatory agencies or other kinds of controlling bodies (e.g., power exchanges and independent system operators)—as needed for the operation of a liberalized electricity market—have perversely tended to reinforce the centralized authority and to diminish the range of local decision making and governance options (Byrne & Mun, 2003). Moreover, a liberalized electricity market accelerates the global centralization of the energy industry through foreign investment and mergers and acquisitions, rather than encouraging multiple-actor competition. It has also even been observed that a reintegration of the unbundled sectors is now actually taking place in the United States. (Joskow, 2006; Lambert, 2006).

Poor democratic governance. Democratic governance in power sector reform would require constant public inputs in an open decision-making and implementation process by which diverse groups with sufficient information and equally distributed political leverage could take part. However, in the electricity sector reform process, as has occurred in many countries to date, an observed lack of public participation and transparency has occurred thus failing to incorporate public interests and any diverse sustainable energy options simultaneously. In the four Asian countries reviewed above, many decisions made as part of the reform process were undertaken overwhelmingly by technocrats and business experts, and accessibility of information and participation was considerably limited to the outside public. Furthermore, in a number of developing countries, confidentiality surrounding these events and inadequate public scrutiny was often accompanied by corruption, particularly for large projects associated with huge investment capital (Nakhooda, Dixit, & Dubash, 2007). For example, in Malaysia, the IPP contracts were granted—without a bidding process—to family and friends of Prime Minister Dr. Mahathir (Smith, 2003, cited in Nikomborirak & Manachotphong, 2007). Similarly, IPP contracts in Indonesia were usually granted to those who had connections with the President's family (Beder, 2003; Seymour & Sari, 2002). In this regard, Stiglitz's (2003) characterization of liberalization as "briberization" makes much sense in describing power liberalization in these developing countries.

Economic Contradictions

Price volatility. In the spring of 2000 in California, the wholesale electricity price soared ten times higher than in previous years, and the state experienced unprecedented rolling blackouts. Some consumers who were not protected by the retail rate freeze were exposed to 3 or 4 times higher electricity prices than before. The state's main investor-owned utilities (IOUs) that could not pass on wholesale price increases to consumers had to absorb the exorbitant price spikes and ultimately filed for bankruptcy (Clark & Bradshaw, 2004; Lambert, 2006). The debacle of the California power industry has been attributed to a number of factors, including lack of hydropower in the Pacific Northwest, a sharp increase in natural gas prices and the emission permit price, insufficient reserve margins and transmission capacity, over-dependence on the spot market, a retail price cap, and an absence of demand-side response programs such as real-time metering (Byrne, Wang, & Yu, 2005). It has also been suggested that the situation was exacerbated by inappropriate responses by state and federal regulatory agencies (Wolak, 2005).

However, the decisive cause that transformed the supply–demand imbalance from a temporary incident into a state-wide energy "meltdown" was fraudulent activity, including market power and price manipulation by generators and the energy marketing companies (see Lambert, 2006, pp. 169-182). The result of this use of market power was creation of an artificial scarcity of electricity by the power generators in order to drive up prices and earn larger profits. In fact, a competitive electricity market creates greater possibility for the exercise of market power. It has been argued that producers need not even keep a substantial market share in order to exercise market power, due to

the extraordinary attributes of electricity as a commodity, specifically its unstorability and the inelasticity of demand (Blumsack, Apt, & Lave, 2006; Wolak, 2005). Furthermore, some observers allege that the repeated rounds of bidding under the hourly market structure provided generators with the scope to "game" the system, adjusting their bidding strategies to their advantage without explicit collusion in the accepted legal sense (Blumsack, Apt, & Lave, 2006).

*IPP Trauma.*The primary rationale of an IPP project is that foreign private investment will provide the capital and expertise that developing countries need to expand generating capacity quickly. On the other hand, increasing demand in developing countries and favorable investment conditions as offered by host countries signaled lucrative profit opportunity for the international banks and multinational energy companies that were facing thin domestic markets within industrialized countries (Woodhouse, 2005).

Due to the confidentiality that can surround large private investments, as well as the lack of experience and expertise by host countries in dealing with such contracts, power purchase agreement (PPA) contracts have been observed to contain clauses that ultimately lead to damage for the host country's financial stability. In many PPAs, private investors' risks associated with IPP projects were inequitably shifted to the governments of host countries. For example, in Philippines and Indonesia, the currency risk to investors was avoided by requiring payment in foreign currency, particularly U.S. dollars (Beder, 2003; Wamukonya, 2003). Most PPAs in developing countries assumed the form of take-or-pay PPA contracts, which required host countries to pay for the electricity even when that supply was not needed. As a result, a state-owned utility often had to shut down its plants and buy electricity at higher prices from the IPPs when the demand was low (Nikomborirak & Manachotphong, 2007). Thus foreign private investors were insulated from the financial risks associated with technical obsolescence and a decline in demand within host countries. In addition, the revenue of the IPPs was often assured by government guarantee in the case of default by the utility. For example, in the case of the Dabhol project in India, the Maharashtra government agreed to pay the IPP investor, Enron, if the Maharashtra State Electric Board (MSEB) defaulted (Beder, 2003).

Restoration of a Local Energy Regime

The governmental monopoly and liberalized power market, despite seemingly substantial differences in terms of structure and ownership, share the modern energy paradigm, which is characterized by a support for commodification and centralization. Within the energy system based on this paradigm, considerations about what kind of energy services are needed by end-users and how to serve these *energy needs* in a more sensible way have largely been disregarded. Rather, the creation of a cheap and abundant energy supply to meet the aggregate *energy demand* remains the primary concern.

Alienated from the services it provides, energy is increasingly functioning as a commodity in the market, a phenomenon that is further exacerbated in power liberalization. The dominant order of an energy system entailing technology, utilities, and regulatory entities becomes bigger and more centralized, making it difficult for people to come together in consciously debating and choosing options related to the energy they consume. Thus, so long as this fundamental rationale continues to prevail in many parts of the world, it appears that possibilities for sustainable relations between society and the environment, as facilitated by democratic governance, may be hindered.

In this regard, what is immediately required is a paradigmatic change, in which our perception of energy—as well as the social and economic relations linked to energy development—will be significantly different from their previous incarnation. Instead of *commodity* relations and tendencies toward centralization, the paradigm of an energy *commons* and movement toward decentralization serve as necessary principles for the restoration of a local energy system. The implications of this energy paradigm shift are discussed in greater detail below.

Technological Change

In the preindustrialization era, social relations with the environment, in the context of energy development, were mostly based on renewable energy, especially use of wood, water, and wind. Because of the virtual impossibility of transporting most of these resources except for wood, renewable energy was treated as a "commons" to be governed under the close control of the local community. There was little discontinuity of space and time between energy production and consumption. As renewable energy sources were diffused, population and economic activities also were relatively spread. Hence, there was no clear distinction between urban and agricultural regions (Mumford, 1934).

Today, the industrial era overwhelmingly depends on nonrenewable resources, especially fossil fuels and uranium. For the first time in human history, energy production and consumption have been disconnected as

when coal succeeded water and wind power as the primary fuel for human activity. Spatial constraints imposed by energy sources disappeared and nonrenewable energy allowed for an unprecedented concentration of energy use, which resulted as well in the concentration of manufacturing and consumption alongside rapid urbanization. Energy is integrated into the global economy like other market commodities, with local energy autonomy virtually lost. Most important, unparalleled use of fossil fuels for the past 200 years has posed unprecedented environmental risks on a global scale, a phenomenon known as global warming (IPCC, 2007).

To reconstitute a local energy regime, the most important component must be restoration of renewable energy-based relations between society and the environment, a relationship that had been preserved for millennia in the preindustrialization era. With regard to its regenerative character and its relative lack of wastes, renewable energy is environmentally sustainable and virtually inexhaustible. Furthermore, the effects of a transformation from reliance on nonrenewable to renewable energy sources in the realm of social, political, and economic relations stands to be as great as those that occurred during the energy transition to fossil fuels two centuries ago in Western society. These two points are further examined here.

Economic Relations

The economic relationship associated with energy development is another contrasting characteristic between the local and globalized energy regimes. The fundamental difference in economic relations between energy and society comes from the relative view of how energy is conceived and the way energy is treated. The difference can be effectively highlighted as part of the classic discussion by Hardin (1968) of the problems he identified with what he termed "commons" regimes but which in fact may be understood as "open access" regimes (The Ecologist, 1993). The problem of depletion or degradation, as depicted by Hardin, brought up this seemingly distinctive prescription: the enclosure of commons, either by state or private forces (Byrne, Glover, & Alrøe, 2005; Ostrom, 1990). This approach is based on the belief that either centralized control (i.e., state regulation or nationalization) or soundly established private property rights are the only methods by which to avoid over-exploitation of commons resources. In this "tragedy" discourse, mutual cooperation, and self-governance among community members is ignored or regarded as unreliable at best.

Hardin's prescriptions for the problems he associated with his so-called "commons" regimes have been practiced with regard to energy since modern fuels began to prevail over renewable energy sources. The means of production for energy have been exclusively monopolized either by private or state actors under the rationale of economies of scale on one hand and an ideology for energy-as-progress on the other. In the liberalized power system, the role of the market is bestowed with increasing responsibility for the transaction of commoditized energy for the purpose of achieving efficiency.

Although it is assumed that renewable energy is unlikely to be monopolized because of its inherently decentralized form (Scheer, 2007, p. 74), the commodification of energy in fact continues to hold a certain dominance even in the emerging renewable energy regime. For example, large-sized wind farms, biomass and photovoltaic (PV) systems connected to a long-distance grid from remote locations have been planned in various instances just like any other conventional utility power plant. In this type of scenario, the use of renewable energy does not alone guarantee a shift away from an energy commodity paradigm, and it may be difficult to expect significant changes in the way that energy is treated and utilized. Rather, energy may still work as a mere medium for the creation of surplus value and economic growth, and people will continue to depend on energy producers and remain mere consumers, forced to pay for the use of sunshine and wind, neither of which belong to anyone.

As part of a local energy commons paradigm, by contrast, the means of production for energy are not monopolized. The access right, rather than property rights, to an energy commons is ensured either personally or collectively, and the resulting energy that is produced no longer need be treated as a commodity. Energy is now produced for sufficiency, rather than for surplus value, because the community uses the visibly available local renewable energy resources via collective action and responsibility. The long-established separation of producers and consumers in the energy commodity paradigm will no longer hold, because consumers now produce their own needed energy. Unlike the energy commodity paradigm, the economic incentive structure is reoriented away from how much energy is sold toward addressing how effectively energy needs are met, with attention to diverse possibilities and options for choices made in this regard.

Sociopolitical Relations

While the conventional energy commodity paradigm tends to foster centralized and market-directed decision-making processes, the energy commons paradigm encourages more decentralized and democratic energy governance. In the commodity-based electricity system, the sociopolitical implications of energy systems have been largely overlooked or regarded as less important than economic and technological imperatives (Dubash & Williams, 2006). In fact, a democratic process has largely been absent in the rapid adoption of power liberalization in many countries. The reform of the power sector was mostly initiated by government elites and disproportionately influenced by business and industry stakeholders. Thus, the agenda of electricity reform was narrowly confined to economic efficiency, excluding more diverse concerns about the impacts of liberalization or treating them as a secondary agenda.

Neoliberal advocates often argue that broadened consumer choice for electricity suppliers in a competitive market will lead to more democratic governance. However, the meaning of "democracy" in this context should be subject to careful scrutiny, as such characterizations often are depoliticized in practice, and are only conceived in the context of the operation of market mechanisms (Dubash & Williams, 2006). It is important to recognize, as pointed out by Byrne and Mun (2004), that consumers' choices in the market are just one of the many choices that societies make with respect to electricity. In fact, many important decisions related to energy, such as a commitment to energy efficiency and conservation, the decision to consume certain energy sources, and supports for energy-poor households, are made outside the electricity market. These decisions will not be appropriately considered and implemented simply by broadening the right to choose energy suppliers. Many public benefits associated with energy would thus be more likely achievable by a collective decision-making process in a "public sphere," rather than individual purchases carried out in an arguably autonomous competitive market. The identification of a broadened consumer choice as a form of "democratic" decision making may accordingly be explained as a form of confusion where democracy in a sociopolitical context has been narrowly equated with liberal individualism as guaranteed by the market and forms of trade.

Sustainable Energy in Seoul, Korea[1]

The role of cities in promoting global as well as local sustainability is increasing as half of the total world population resided in urban areas in 2007 (UN, 2008). Moreover, according to the United Nations, the urban population is expected to double by midcentury, increasing from 3.3 billion in 2007 to 6.4 billion in 2050 (UN, 2008). As the countries discussed in this article are already highly urbanized (e.g., Japan, Korea, and Taiwan) or are rapidly urbanizing (e.g., China), cities in these countries will be important agents for the promotion of sustainable energy development.

In particular, the case of Seoul, Korea draws special attention to the need for developing an innovative approach to rebuilding sustainable local energy regimes. In the past five decades, Korea achieved a rapid industrialization, which is characterized as a monopolized and fossilized energy structure, concentration of economic development, and urbanization of human space (see Kim, 1991). The city of Seoul is the embodiment of the country's industrialization. Seoul's population has increased by about four times, from 2.4 million in 1960 to 10.4 million in 2007 (Seoul City, 2008). The city used 12% of the nation's total electricity (mostly generated from remotely located fossil fuel and nuclear plants) and 27% of total city gas in 2006 (Ministry of Commerce, Industry and Energy[MOCIE] & Korea Energy Economics Institute[KEEI], 2007). The city is also the economic center of the country, accounting for 22.5% of the country's total GDP in 2006 (Korea National Statistical Office[KNSO], 2008).

Recognizing the important role of urban sustainability, Seoul recently announced its environmentally friendly energy declaration, which would cut local energy consumption by 15% against a 2000 baseline and reduce greenhouse gases 25% below their 1990 level (Nam, 2007). This local initiative may greatly benefit from the introduction of an innovative approach for energy service, the sustainable energy utility (SEU). Its concept and operating mechanism are discussed in the following section, and the impact of a potential Seoul City SEU is demonstrated subsequently.

A Sustainable Energy Utility as a Working Model of a Local Energy Regime

The operation of a SEU is proposed here as a working model of a local energy regime, one that is clearly distinguishable from conventional supply-oriented

energy models in three ways. First, the primary purpose of the SEU is to provide opportunities to use less energy, rather than encouraging more consumption. To this end, the SEU is more concerned with end-use energy *services* rather than aggregate energy *demand*.

Second, the methods to achieve this goal are principally efficiency upgrades in the overall system and end user-sited local renewable energy sources. In conventional electricity markets, these "soft" energy options are largely disregarded mainly because of the exclusive emphasis on "cheap and abundant" energy supplies and a domination of the market by conventional growth-centered utilities. Even though some policy initiatives and businesses aim to foster "soft" opportunities, their efforts tend to be fragmentally organized, whereas conventional energy suppliers are highly organized in their production and delivery of energy (Center for Energy and Environmental Policy[CEEP], 2008). To exacerbate matters, the complexity of procedures and a lack of information about various options frequently prevent end-users from accessing efficient and cleaner applications. The SEU helps to counteract these problems by being a single point of contact to customers seeking sustainable energy options in the same way that a conventional utility is a point of contact for energy supply (CEEP, 2008).

Third, the SEU is built on the participation of diverse social groups including local government, community organizations, energy service companies, and academic institutions. It is a nonprofit organization and operates its energy programs under public oversight. The energy services the SEU provides are not necessarily confined to electricity, but its service area may be limited to city rather than national-scale territories, so that the voices of end-users are more effectively reflected in the setting and implementation of policy goals.

Energy Efficiency Improvements in Buildings

To embrace a path which will ensure less energy consumption and continued economic development, city-centered policy initiatives and programs can play an important role. Special attention should be paid to the urban building sector, visualizing the energy saving potential, because this sector accounts for some 60% of the total final energy consumption of the city of Seoul (MOCIE & KEEI, 2007).

One method for assessing the available energy efficiency potential in Seoul is to compare electricity or gas intensity for its residential and commercial buildings with other jurisdictions. As shown in Figure 1, both the electricity and gas intensity of Seoul in 2005 were the highest among other cities in the residential building sector. The city's high intensity can be explained by a number of factors including income level, housing stock characteristics, differences in weather, and relative implementation of energy efficiency measures. However, because of a lack of available data, the construction of a comprehensive model by which to adjust for these factors is not offered in this article. Still, it can be worthwhile to note that Seoul's electricity and gas consumption per square meter in the residential building sector is 17% and 54% higher, respectively, than Washington, DC for example, which has similar weather[2], urban housing patterns, and energy prices[3]. Importantly, although per capita income in Washington, DC is three times higher than in Seoul, its housing stock is significantly less energy-intensive.[4]

According to economic theory, energy price has a reverse relationship with energy consumption, whereas the level of income is positively related to energy consumption. With this in mind, it is fair to conclude that electricity use in Seoul's residential buildings is less efficient than that in Washington DC, considering that Seoul's income level is much lower although prices and other factors are more or less the same. With regard to residential sector gas intensity, although gas prices and income level offset each other to a certain extent, Seoul shows a 54% higher gas intensity than Washington DC, which also indicates that gas is less efficiently consumed in Seoul's residential buildings.

Figure 2 shows electricity and gas intensities in the commercial building sector for five major cities in Korea, without adjustment for local GDP or weather factors. According to this data, Seoul's electricity or gas intensity for the commercial building sector also ranks highest among the other Korean cities. In particular, Seoul's gas intensity is more than double that of the other cities. This difference may be explained by the higher GDP per capita in Seoul. An econometric model with more comprehensive data would verify the impact of income, weather, and other factors in a more quantitative way. However, Seoul's 31% to 45% higher per capita GDP, compared to the four other cities, hardly justifies Seoul's 100% higher gas consumption.

Integrating PV into Seoul's Building Stock

Along with energy efficiency improvements, renewable resources can greatly contribute to the reduction of conventional energy needs in the buildings

Figure 1
Comparison of Residential Building Sector Energy Intensities

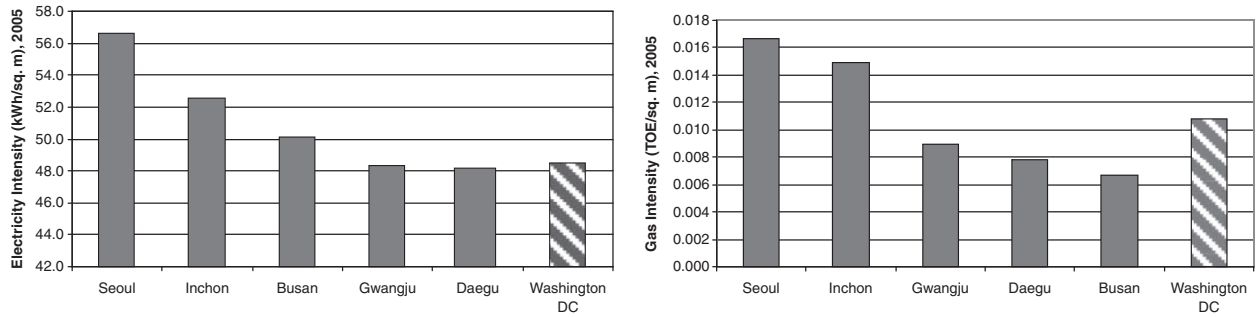
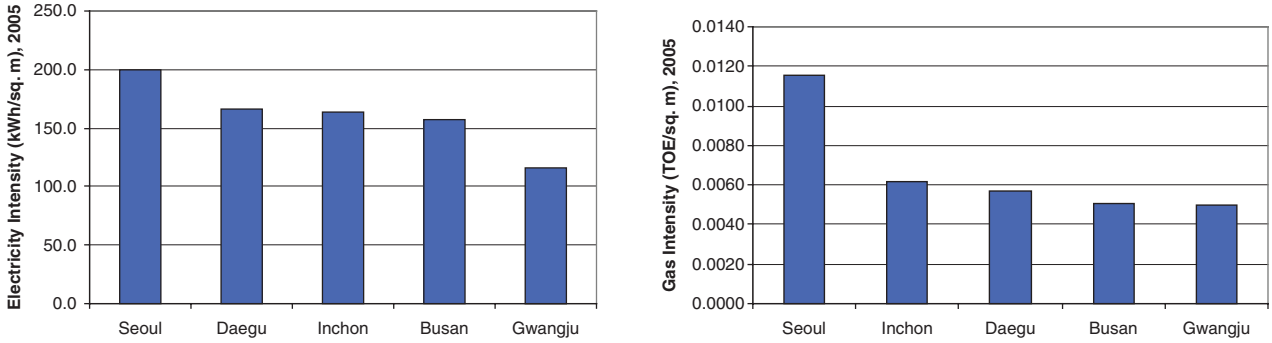


Figure 2
Comparison of Commercial Building Sector Energy Intensities



sector. In particular, PV among other renewable energy technologies can fit well within the dense urban patterns of Seoul because PV applications can be easily installed on rooftops or façades of buildings. The potential Seoul City SEU may consider taking advantage of the local availability of rooftops for such PV installation.

The available rooftop area can be estimated from floor area data of different types of buildings in Seoul. Once the available rooftop area is estimated, one may calculate the total capacity and generation of rooftop PV systems. As a first step toward estimating available rooftop areas for PV, several assumptions are made. First, as buildings less than three stories high may have less insolation compared to higher-rise buildings (due to shading), it is assumed that only 80% of the rooftop area of the lower buildings is available. In addition, it is assumed that only 40% of rooftop area can be used for PV systems due to solar orientation problems and design obstructions. Based on these assumptions, the PV-suitable rooftop real estate of existing residential, commercial, and public buildings is estimated to be 45.8 million m^2, which is approximately equivalent to 7% of the total area of Seoul City. The total PV capacity of this suitable rooftop area is estimated to be 4,740 MW. Total electricity generation from rooftop PV will equate to 7,130 GWh, which accounts for 20% of Seoul's electricity consumption in 2006 (41.8TWh).

The economics of PV systems can be greatly enhanced by a combination of the City's SEU financing mechanism and its current feed-in-tariff (FIT) scheme. Supported by an SEU loan (covering 50% of the initial capital cost) and the FIT, the payback period for a 3kW PV system is 10 years, and the internal rate-of-return (IRR) is 8.3%. Given the relatively high IRR, one may fairly conclude that the system can attract investment. There may be several mechanisms to share the savings for the PV project between the developers and the rooftop estate providers depending on their respective portion of the initial costs and the apportioned responsibility for maintenance. For example, the developer and the rooftop estate provider can form a contract to

share the initial capital costs and net savings equally. By doing so, each party will receive US$4,570 after the recovery of the investment cost. The IRR declines to 6.2%, but it is still sufficiently high to make this project commercially feasible.

The Potential Impact of the Seoul SEU

The potential energy efficiency improvements in the building sector in Seoul can be assumed from a comprehensive study conducted by the Joint Institute for a Sustainable Energy and Environmental Future (JISEEF) in 2004. According to this research, the energy saving potential through cost-effective measures for the residential and commercial sectors in Korea is 34% and 36%, respectively, by 2020 compared to the government's business-as-usual scenario. Seoul's SEU renewable energy target can be suggested from the policies and experiences that are already widely observed in other countries. For example, Colorado requires its investor-owned utilities to include 20% renewable electricity in their generation portfolio by 2020. Of the electricity from renewable energy, at least 4% is required to be generated from solar electric technologies (Database of State Incentives for Renewable & Efficiency[DSIRE], 2008). Nevada requires 20% of electricity sold in 2015 to come from renewables, with 5% to be generated or acquired from solar resources (DSIRE, 2008). Delaware and New Jersey also set a renewables target of 20% by 2019 and 22.5% by 2021, with 2% PV carve-out programs, respectively (DSIRE, 2008). To prepare an impact assessment of a Seoul City SEU, it is assumed as follows:

- The City of Seoul's GDP will continue to grow as it has been growing for the past 5 years (2000-2005).
- Electricity and natural gas use associated with economic growth will continue to increase in the City as they have for the past 5 years except for expected technology improvements (which modestly reduce the rate of demand growth).[5]
- The City will launch an SEU in 2009 with the aim of reducing residential and commercial building electricity and city gas use by 30% by 2020.
- By 2020, the City's SEU will have reached a 33% participation rate for its building-focused programs.
- A 10% City renewable energy target by 2020 will be adopted, including a 3% PV carve out, in order to offset conventional electricity use.[6]

With these assumptions and taking into account 11 years of Seoul's GDP, electricity and natural gas use, and carbon emissions data (enlisted to establish trends), it becomes possible to project the potential energy and carbon impacts of a Seoul City SEU. In this regard, calculations reveal that the SEU can be anticipated to create real, measurable, and verifiable energy savings. Without the SEU in place, conventional electricity and natural gas use in Seoul is likely to grow by 10.8 MTOE through 2020. This represents a 26% increase from the 2006 level of 7.96 MTOE. Through a rigorous SEU program, Seoul will be able to reduce building sector use of conventional fuels by 1.49 MTOE, which accounts for about 50% of energy in the building sector by 2020 despite continued economic growth of 2.71% per year (Figure 3). The CO_2 savings from the implementation of an SEU are also significant, as a Seoul SEU can offset 1.67 MTC by 2020. This represents a 57% reduction from the 2020 business-as-usual forecast of Seoul's building sector emissions from electricity and natural gas use (see Figure 4).

Conclusion

Power liberalization has been implemented in four East Asian countries in the past two decades. Compared to other countries that underwent full-blown reforms, the liberalization process in the four East Asian countries was either relatively slow or suspended abruptly due to various sociopolitical and economic conditions. These included great concerns about energy security in Japan and political inclinations toward a state-centered administration for strategic sectors like the electricity industry in China and strong opposition from labor and environmental civil society groups in Korea. The prospects of power liberalization in these countries remain uncertain at this point. In addition, unequal results of power liberalization worldwide have added more uncertainty as to whether these countries will take further steps toward power liberalization.

Is the current partially liberalized structure in these countries self-sustaining? Chao (2006) argued that a "Third Way," a balance between government regulation and market competition, would probably achieve the original reform agenda of lower costs, improved reliability, and appropriate stimulus for investment. A "single-buyer model" in China and Korea to date is often acclaimed as an alternative model, rather than a transitory one, because it may provide greater opportunities for reliability and efficiency of the system compared to governmental monopoly and the standard prescription of wholesale or retail competition (Belyaev, 2007). However, as the conventional wisdom in

Figure 3
Potential Energy Impacts of a Seoul Sustainable Energy Utility

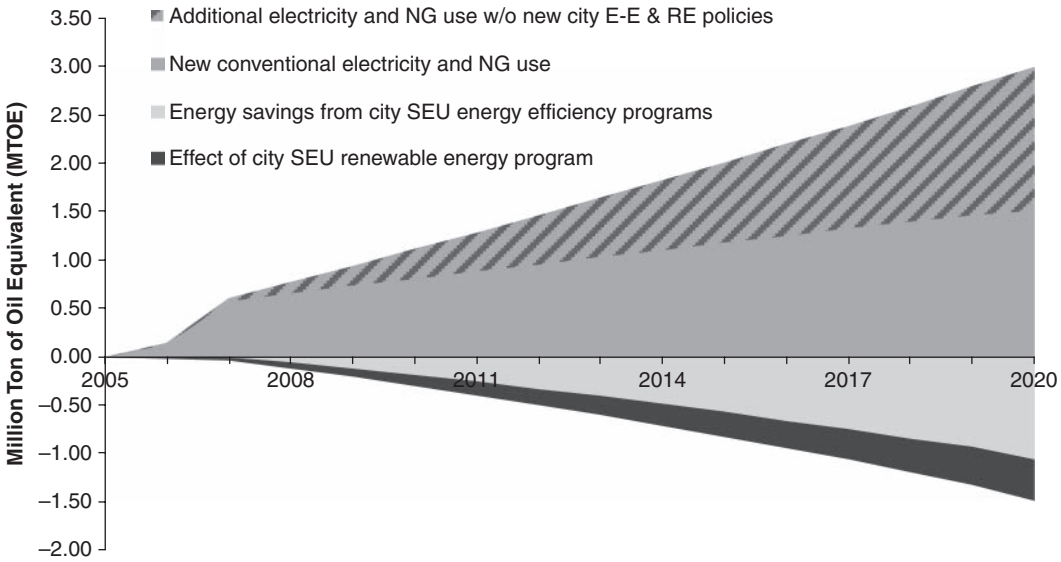
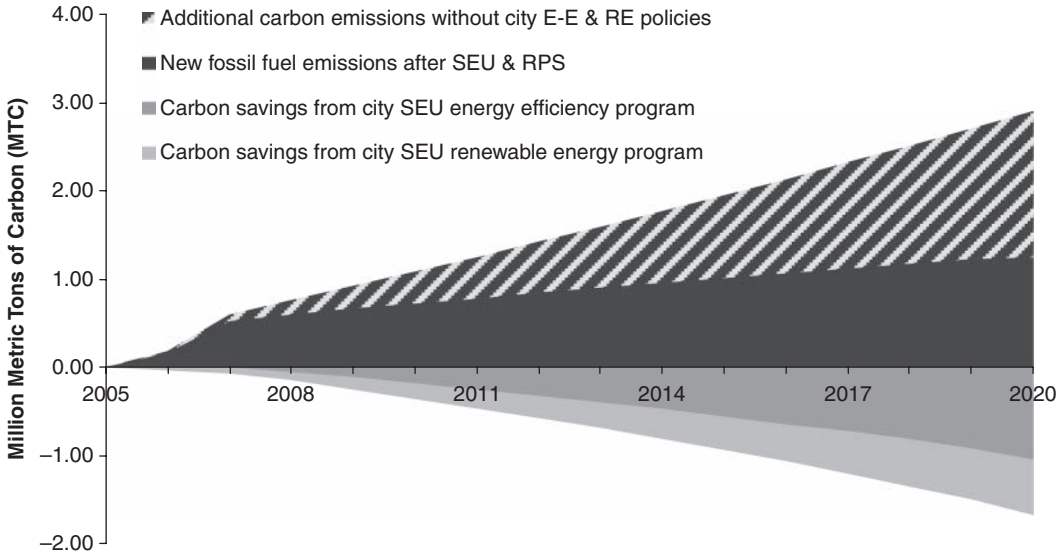


Figure 4
Potential Carbon Impacts of a Seoul Sustainable Energy Utility



support of a cheap and abundant supply of energy is still unchanged, the current hybrid system would not adequately address the important environmental and sociopolitical agenda embedded in the electricity system.

In this regard, the model of a sustainable energy utility (SEU) can serve as a meaningful alternative to the conventional dichotomy of regulation (state) or competition (market), or the combination of both, in the electricity system. Rather, the SEU affords an opportunity to restore to prominence a sustainable local energy system, one that encourages less energy use rather than more, generates energy from local resources rather than through dependence on centralized and often distant technology, and allows greater freedom of choice and participation—a vaunted goal of liberalization that in practice has often failed to

materialize. The potentially significant and concrete benefits of such a model, as applied to the case of Seoul, Korea, suggest the imperative for acting now to capture the widest available benefits of an increasingly decentralized, renewable, fiscally responsible, and locally oriented energy future.

Notes

1. This section is based on research for a Seoul SEU as conducted by the author for the Seoul Development Institute in 2008. Please see "CEEP. (2008). *Sustainable Energy Utility Design: Options for the City of Seoul*." Available at www.ceep.udel.edu. The author gratefully acknowledges the contribution of Lado Kurdgelashvili, who helped energy and carbon saving analysis of the Seoul SEU implementation.

2. Seoul has higher cooling degree days but lower heating degree days, which means that Seoul is hotter in the summer but with milder temperatures in the winter, compared to Washington D.C.

3. The average 2005 retail electricity price for residential use was 9.3 and 9.2 cents per kWh in Seoul and Washington DC, respectively (EIA, 2007c). The residential natural gas price in Seoul was US$0.51/m^3, and US$0.60/m^3 that same year in Washington DC (EIA, 2008c).

4. In 2005, although the per capita GDP of Seoul approximated US$14,300, the per capita GDP of Washington DC approximated US$50,000 (note that Seoul's GDP is pegged at 2000 won value, whereas DC's is based on the 2001 U.S. dollar value).

5. Economists sometimes refer to this phenomenon as "automatic energy efficiency improvements" because a measure of continuous technology change is considered endogenous to the modern economy. Estimates of the U.S. AEEI vary, but are typically in the range of 0.5% to 1.0% per year (see Hassol, Strachan, & Dowlatabadi, 2002). A deduction for AEEI of 0.75% per year is made for the impact projections for Seoul.

6. A renewable energy target is assumed to be applied to only electricity use in this analysis.

References

Asano, H. (2006). Regulatory reform of the electricity industry in Japan: What is the next step of deregulation? *Energy Policy, 34*, 2491-2497.

Beder, S. (2003). *Power play*. New York: The New Press.

Belyaev, L. S. (2007). Electricity markets: Comparing competitive and single buyer markets. *IEEE Power & Engineering Magazine, 5*(3), 16-26.

Besant-Jones, J. (2006). *Reforming power markets in developing countries: What have we learned?* (Energy and Mining Sector Board Discussion Paper No. 19). Washington DC: World Bank.

Bird, L., & Swezey, B. (2006). *Green power marketing in the United States: A status report* (9th ed.). (Technical Report NREL/TP-640-40904). Washington, DC: National Renewable Energy Laboratory. Retrieved May, 2007, from http://www . eere.energy.gov/greenpower/resources/pdfs/40904.pdf

Blumsack, S. A., Apt, J., & Lave, L. B. (2006). Lessons from the failure of U.S. electricity restructuring. *Electricity Journal, 19*(2), 15-32.

Byrne, J., Glover, L., Lee, H.-S., Wang, Y.-D., & Yu, J.-M. (2004). Electricity reform at a crossroads: Problem in South Korea's Power liberalization strategy. *Pacific Affairs, 77*, 493-516.

Byrne, J., Glover, L., & Alrøe, H. F. (2006). Globalization and sustainable development: A political ecology strategy to realize ecological justice. In N. Halberg, M. T. Knudsen, H. F. Alrøe, & E. S. Kristensen (Eds.), *Global development of organic agriculture: Challenges and prospects* (pp. 49-74). Wallingford, UK: CABI.

Byrne, J., & Mun, Y.-M. (2003). Rethinking reform in the electricity sector: Power liberalization or energy transformation? In N. Wamukonya (Eds.), *Electricity reform: Social and environmental challenges* (pp. 48-76). Roskilde, Denmark: UNEP.

Byrne, J, Wang, Y-D, Kim, J-D, Lee, H, & Kim, J-W. (2004). *Energy revolution*. Seoul, Korea: Maeil Business Newspaper.

Byrne, J., Wang, Y-D., & Yu, J-M. (2005). *Lessons from a comparative analysis of California and PJM electricity restructuring model*. Paper presented at the KDI Electricity Restructuring Conference, Seoul, Korea.

Center for Energy and Environmental Policy. (2008). *Sustainable energy utility design: Options for the city of Seoul*. (Final Report prepared for Seoul Development Institute [SDI]). Newark, DE: Author.

Chao, H. (2006). Global electricity transformation: The critical need for integrated market design and risk management research. *Energy, 31*, 923-939.

Clark II, W. W., & Bradshaw, T. K. (2004). *Agile energy systems: Global lessons from the California energy crisis*. New York: Elsevier.

Database of State Incentives for Renewable & Efficiency. (2008). Retrieved October 17, 2008, from http://www.dsireusa.org/

Dubash, N. K., & Williams, J. H. (2006). The political economy of electricity liberalization. In J. Byrne, N. Toly, & L. Glover (Eds.). *Transforming power* (pp. 155-189). New Brunswick, NJ: Transaction.

The Ecologist. (1993). *Whose common future? Reclaiming the Commons*. London: Earthscan.

Energy Information Administration. (2007a). *World total electricity installed capacity*. Retrieved October 29, 2008, from http://www.eia.doe.gov/emeu/international/electricitycapacity.html

Energy Information Administration. (2007b). *World carbon dioxide emissions from the consumption and flaring of fossil fuels*. Retrieved October 29, 2008, from http://www.eia.doe.gov/emeu/international/carbondioxide.html

Energy Information Administration. (2007c). *State electricity profiles 2005*. Retrieved February, 2008, from http://tonto.eia.doe.gov/ftproot/electricity/stateprofiles/05st_profiles/062905.pdf

Energy Information Administration. (2008a). *International energy outlook 2008*. Retrieved October 28, 2008 from http://www.eia.doe.gov/oiaf/ieo/pdf/0484(2008).pdf

Energy Information Administration. (2008b). *Country analysis brief: Taiwan*. Retrieved September 10, 2008, from http://www.eia.doe.gov/emeu/cabs/Taiwan/pdf.pdf

Energy Information Administration. (2008c). *Natural gas summary*. Retrieved February, 2008, from http://tonto.eia.doe.gov/dnav/ng/ng_sum_lsum_a_EPG0_PRS_DMcf_a.htm

Foster, V. & Maria Araujo, M. C. (2004). *Does infrastructure reform work for the poor? A case study from Guatemala*. (World Bank Policy Research Working Paper 3185). Washington, DC: World Bank. Retrieved August 28, 2007, from http://ideas.repec.org/p/wbk/wbrwps/3185.html

Goto, M., & Yajima, M. (2006). A new stage of electricity liberalization in Japan: Issues and expectations. In F. P. Sioshansi &

W. Pfaffenberger (Eds.), *Electricity market reform: An international perspective* (pp. 617-643). Oxford, UK: Elsevier.

Hardin, G. (1968, December). The tragedy of the commons. *Science, 162*, 1243-48.

Hassol, S. J., Strachan, N. D., & Dowlatabadi, H. (2002). Energy efficiency: A little goes a long way. In R. G.Watts (Ed.), *Innovative energy strategies for CO_2 stabilization* (pp. 87-121). Cambridge, UK: Cambridge University Press.

International Panel on Climate Change. (2007). *Synthesis report of the fourth assessment report*. Retrieved October 25, 2008, from http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf

Joskow, P. L. (2006). Markets for power in the United States: An interim assessment. *Energy Journal, 27*(1), 1-36.

Karekezi, S., & Kimani, J. (2004). Have power sector reforms increased access to electricity among the poor in East Africa? *Energy for Sustainable Development, 8*(4), 10-25.

Kim, J.-D. (1991). *The political economy of energy-corporate-urban integration in South Korea*. Unpublished doctoral dissertation, University of Delaware, Newark.

Korea National Statistical Office. (2008). *Gross regional domestic product by region*. Retrieved October 26, 2008, from http://www.kosis.kr/

Lambert, J. D. (2006). *Energy companies and market reform: How deregulation went wrong*. Tulsa, OK: PennWell.

Lee, B.-H., & Ahn, H.-H. (2006). Electricity industry restructuring revisited: The case of Korea. *Energy Policy, 34*, 1115-1126.

Ma, C., & He, L. (2008). From state monopoly to renewable portfolio: Restructuring China's electric utility. *Energy Policy, 36*, 1697-1711.

Ministry of Commerce, Industry and Energy & Korea Energy Economics Institute. (2003-2007). *Yearbook of regional energy statistics*. Retrieved October 5, 2008, from http://www .keei.re.kr/index.html

Mumford, L. (1934). *Technics and civilization*. New York: Harcourt Brace.

Nakano, M., & Managi, S. (2008). Regulatory reforms and productivity: An empirical analysis of the Japanese electricity industry. *Energy Policy, 36*, 201-209.

Nakhooda, S., Dixit, S., & Dubash, N. K. (2007). *Empowering people: A governance analysis of electricity*. Washington DC: World Resources Institute.

Nam, S. J. (2007, 9 April). Seoul environmentally-friendly energy declaration. *Korea Energy*.

Nikomborirak, D., & Manachotphong, W. (2007). *Electricity reform in practice: The case of Thailand, Malaysia, Indonesia and the Philippines*. Paper presented at Intergovernmental Group of Experts on Competition Law and Policy in United Nations Conference on Trade and Development, Geneva, Switzerland. Retrieved May 20, 2008, from http://www .unctad.org/sections/wcmu/docs/c2clp_ige8p25asia_en.pdf

Ostrom, E. (1990). *Governing the Commons: The evolution of institutions for collective action*. New York: Cambridge University Press.

Palmer, K., & Burtraw, D. (2005). *The environmental impacts of electricity restructuring: Looking back and looking forward*. (Discussion Paper FF DP 05-07). Washington, DC: Resources for the Future.

Reddy, A. K. N. (2001). California energy crisis and its lessons for power sector reform in India. *Economic and Political Weekly, 36*, 1533-1540.

Scheer, H. (2004). *The solar economy: Renewable energy for a sustainable global future*. London: Earthscan.

Seoul City. (2008). *Seoul Annual Statistics 2008*. Retrieved October 25, 2008, from http://www.seoul.go.kr/v2007/publicinfo/statistics/data/4_03_4.html

Seymour, F., & Sari, A. P. (2002). Indonesia: Electricity reform under economic crisis. In N. K. Dubash (Ed.). *Power politics: Equity and environment in electricity reform*. Washington DC: World Resources Institute.

Shih, H.-C. (2007). Evaluating the prospective effects of alternative regulatory policies on the investment behaviour and environmental performance of a newly liberalized electricity industry in Taiwan. *Socio-Economic Planning Sciences, 41*, 320-335.

Sihag, A. R., Misra, N. & Sharma, V. (2004). Impact of power sector reform on the poor: Case-studies of South and South-East Asia. *Energy for Sustainable Development, 8*(4), 54-73.

Stiglitz, J. E. (2003). *Globalization and its discontents*. New York: W.W. Norton.

Toda, N. (2005). *Development of the Japanese model in the liberalization of electricity market*. Paper presented at the KDI Electricity Restructuring Conference, Seoul, Korea.

United Nations Population Division. (2008). *World Urbanization Prospects*. Retrieved October 25, 2008, from http://www.un .org/esa/population/unpop.htm

Wamukonya, N. (2003). Power sector reform in developing countries: Mismatched agendas. In N. Wamukonya (Ed.), *Electricity reform: Social and environmental challenges* (PP. 7-47). Roskilde, Denmark: UNEP.

Wang, K.M. (2006). The deregulation of Taiwan electricity supply industry. *Energy Policy, 34*, 2509-2520.

Wolak, F. A. (2005). Lessons from the California electricity crisis. In J. M. Griffin & S. L. Puller (Eds.), *Electricity deregulation: Choices and challenges* (pp. 145-181). Chicago: University of Chicago Press.

Woodhouse, E. J. (2005). *The experience with independent power projects in developing countries: Interim report*. (Working Paper, 39). Stanford University: Program on Energy and Sustainable Development.

Yeh, E. T., & Lewis, J. I. (2004). State power and the logic of reform in China's electricity sector. *Pacific Affairs, 77*, 437-465.

Zarnikau, J., & Whitworth, D. (2006). Has electric utility restructuring led to lower electricity prices for residential consumers in Texas? *Energy Policy, 34*, 2191-2200.

Zhang, C., & Heller, T. G. (2007). Reform of the Chinese electric power market: Economics and institutions. In D. G. Victor & T. C. Heller (Eds.), *The political economy of power sector reform* (pp. 76-108). Cambridge, UK: Cambridge University Press.

Jung-Min Yu is a research associate and doctoral student at the Center for Energy and Environmental Policy of the University of Delaware.