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Energy Taxation and the Coal Tax Reform in Korea

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December 2014

KOREA INSTITUTE OF PUBLIC FINANCE

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Introduction

Economic growth and the rise in the standard of living in any given nation will inevitably increase the demand for energy. Today, we obtain the energy we need from a wide range of sources, including oil, coal, natural gas, nuclear power, solar power, wind, and others. The demand for these diverse sources of energy is subject to the relative price structure (EPS) of each. The EPS plays a key role in ensuring the effective distribution of the demand for and supply of energy. However, the EPS is subject to a number of factors, including such international and macroeconomic variables as international energy prices and foreign exchange rates, and equally important is the domestic taxation policy of a given nation. For instance, in Korea the current electrification of energy demand can be understood by virtue of two domestic policy factors. First, there have been little to no taxes charged on bituminous coal and nuclear power, the two main sources of electricity, in contrast to diverse types of taxes—including excise and environmental taxes—imposed on gasoline, diesel, and natural gas. Second, the government's regulatory practice has always kept the final consumer price of electricity much cheaper than the prices of other types of energy.

One key reason the price of electricity has remained relatively low in Korea is that almost no taxes have been imposed on the main sources of electricity, such as bituminous coals and nuclear power, aside from the value added taxes (VATs) that are attached to all economic transactions that generate added value. In the past, the Korean government began controlling and restricting the price of electricity by not levying any taxes on it, with aim of ensuring that electricity was provided to all households in Korea. This policy decision, however, has caused and reinforced the “electrification” of energy demand, leading to massive interruptions of supplies in Korea’s peak seasons. The policy of not taxing bituminous coals and nuclear power has thus begun to lose validity and legitimacy in the eye of the public.

By contrast, the Korean government has been imposing diverse and high taxes, such as environmental and excise taxes, on other sources of energy, including gasoline, diesel, and natural gas. <Table I-1> summarizes the findings of a study by the Organization for Economic Cooperation and Development (OECD, 2013), and indicates the rates of taxes and the amounts of taxed consumption of diverse energy sources in Korea by type and use. For ease of comparison, this study has unified different units of measure into calories, using the KRW-per-gigajoule (KRW/GJ) for the tax rates and the terajoule (TJ) for the consumed amounts. The main users of energy in Korea include transportation, heating and processing, and electricity. The main types of fuels used are gasoline, diesel, liquefied petroleum gas (LPG), heavy oil, natural gas, coal, and nuclear power.

〈Table I-1〉 **Distribution of Energy Taxes by Use and Fuel Type: In Terms of Calories**

(Units: KRW/GJ for tax rates, TJ for consumed energy amounts)

Use	Fuel type	Tax rate	Consumed amount
Transportation	Gasoline	22,577.69	343,821.40
	Diesel	14,721.99	593,205.00
	LPG	12,307.19	201,294.02
	Other transportation oils	708.02	68,366.34
	Air fuel	0.00	11,214.01
Heating and processing	Diesel	4,281.85	96,265.52
	Kerosene	2,979.55	144,435.21
	LPG	477.51	116,163.80
	Heavy oil	487.24	298,282.58
	Tax-free oil for rural development	0.00	83,367.89
	Tax-free oil for others	0.00	261,728.22

〈Table I-1〉 **Continue**

Use	Fuel type	Tax rate	Consumed amount
Heating and processing	Natural gas (housing)	992.65	346,025.08
	Natural gas (industrial)	992.65	375,076.99
	Natural gas (processing)	992.65	66,048.84
	Other gases	0.00	78,003.15
	Anthracites (housing/industrial)	0.00	267,283.83
	Anthracites (processing)	0.00	358,685.55
	New/renewable	0.00	110,058.22
Power plants (electricity)	Natural gas	822.47	560,542.54
	Oil	205.83	152,359.77
	Coals	0.00	1,936,531.20
	Nuclear/new/renewable	0.00	1,638,178.28

Source: OECD (2013), Figure 19.1, p. 152, http://dx.doi.org/10.1787/888932766624.

From <Table I-1>, we can see that the main transportation fuels, such as gasoline, diesel, and LPG, are subjected to significantly greater amounts of tax than other fuels. In terms of absolute amounts of consumption, however, transportation lags far behind heating and processing and electricity generation. In other words, the current energy taxation system in Korea heavily disfavors certain types of fuels for certain uses. The asymmetry of tax burdens becomes even more glaring when we compare these fuels and uses in terms of their respective carbon dioxide emissions.[1)]

Korea cannot realistically expect to eliminate the asymmetry of tax burdens on energy usage overnight. Its government will need to conduct careful calculations and calibrations on the use of energy before any major reforms are made to taxation policy. But until reforms are made, the gross asymmetry in energy taxes distorts the EPS and thereby distorts the ways in which the entire nation consumes energy. It is time, then, for Korea to begin a serious nationwide debate on how to better rationalize the EPS by employing appropriate

1) For a comparison of energy taxes based on carbon emissions, see Figure 19.2 of OECD (2013), p. 153.

taxation policy measures. The purpose of this report is to present the research findings that are necessary to prompt such a debate.

The Korean government could tax electricity generation in two ways. First, it could tax the end consumers—individuals and businesses—at the time they use electricity. This arrangement allows the government to adjust the excise tax rate on electricity as it sees fit, thereby shaping the consumer price of electricity and signaling to individual and corporate consumers the need to balance and control their demand for electricity. However, such consumption taxes carry the risk of unwittingly increasing the effective tax burden on fuels that are more efficient at generating electricity than on others. Taxes would be imposed on electricity that has already been generated and plants using more efficient fuels would end up paying more taxes than those using less efficient ones. Similarly, plants with more efficient facilities and equipment would pay more taxes than plants with less efficient facilities. In sum, by adopting this consumption or excise tax approach, the government might be better able to send signals to end consumers regarding how they should consume electricity, but at the same time, such a tax will unfairly punish plants that use more efficient fuels and facilities. This tax approach, therefore, is hardly capable of inducing more efficient uses of fuels and energy.

Alternatively, the government could begin taxing at the time of *production*. Examples of this are the taxes imposed on coal used in thermal plants and on uranium used in nuclear plants. As long as the government retains active control over the consumer price of electricity, taxing certain types of fuels ultimately would not as directly and significantly change the consumer price of electricity as excise taxes would. However, refusing to raise the electricity price, even while charging power plants more taxes, would not send meaningful signals to consumers about the proper state of demand. Nevertheless, under this approach, the government could more effectively induce the efficient use of fuels by lessening the tax burden on efficient fuels and levying greater taxes on less efficient ones.

An international comparison of household electricity prices among OECD member states reveals that the electricity price in Korea is significantly lower than for its counterparts worldwide. As of 2012, electricity in Korea cost USD 93.1 per megawatt-hour (MWh), which is less than half the OECD average.

That makes Korea the OECD member state with the lowest electricity price, along with Mexico. Even when we take into account the purchase power parity, this ranking remains the same.

Moreover, in comparison with other OECD member states, the rate of increase in the electricity price in Korea remains quite low. This is because the Korean government actively regulates the price of electricity and imposes little to no taxes on fuels used for electricity generation, while the majority of power plants in Korea use relatively inexpensive sources of energy, such as nuclear power and coal. In the meantime, the rate at which the demand for electricity is growing remains high in Korea, in no small part due to the provision of a low consumer price.

A comparison of OECD member states in terms of effective tax rates on fuels based on calories consumed or carbon emissions generated also reveals that the effective tax rates in Korea remain particularly low, especially in the electricity sector. The OECD average rate is EUR 3.28 per GJ, although it ranges from EUR 0.18 (Mexico) to EUR 6.58 (Luxembourg). The rate in Korea is EUR 1.76 per GJ. The effective tax rates remain noticeably low in Asia and Eastern Europe, but they are high in the European Union (EU) mainly due to the EU Energy Taxation Directive of 2003, which requires EU member states to impose high minimum tax rates on diverse primary and secondary sources of energy.

In order to anticipate how the taxes on fuels at the time of production would affect Korea, this study posits and analyzes possible scenarios of introducing coal and nuclear taxes. As of 2012, coal and nuclear power accounted for 39 percent and 30 percent, respectively, of all electricity generated in Korea. Although the Korean government levies almost no taxes on bituminous coals and nuclear power, the United Kingdom, Japan, and Israel tax the former, while Germany, France, Sweden, and Japan tax the latter.

In the coal tax scenarios, we hypothesize that the government would differentiate and adjust the tax rates it imposes on different uses of fuels and energy by calories consumed or by the amount of carbon emissions generated. The underlying assumption is that the total energy tax revenue would remain the same, as would the tax rate applied to natural gas for non-transportation purposes. In these scenarios, the tax rates on bituminous coals range from KRW

30 per kilogram to KRW 97 per kilogram, with leading power plants using bituminous coals paying from KRW 2.4 trillion to KRW 7.7 trillion in additional taxes. In all these scenarios, the additional tax revenue from bituminous coals are to be used to provide cuts to taxes on other fuels, so that the government would end up earning the same amount of revenue. However, we assume that coal taxes could raise the consumer prices of electricity by 21 percent to 69 percent. We also analyze additional scenarios in which taxes are imposed on bituminous coals for energy and non-energy purposes alike and in which adjusted tax rates are adopted.

In another set of scenarios, we analyze the outcome of adopting nuclear taxes. There are mainly three ways to tax nuclear power. First, we can tax uranium, the main fuel for generating nuclear energy. This is the approach Germany and Japan have adopted. Second, we can tax the electricity produced by nuclear power plants, as does Sweden. Finally, we can charge lump-sum taxes on nuclear power plants, as does France. This study examines scenarios associated with the first and second ways.

In taxing uranium, we assume that the amount of tax imposed would vary in proportion to the price at which uranium is imported. Assuming that the uranium import price of 2012 remains consistent and that the tax rate is 20 percent of the import price, the amount of tax per gram of uranium would reach KRW 191. Increase the tax rate to 100 percent of the import price, and the amount of tax would spike to KRW 954 per gram. This would increase tax revenue by KRW 140 billion to KRW 710 billion. However, the cost of purchasing and importing uranium makes up less than 10 percent of the overall cost of generating nuclear power. Therefore, in order to tax uranium in ways that would substantially affect the consumer price of electricity, Korea would have to impose an even higher tax rate. As an example of this situation, the German government charges a high EUR 145 (or almost KRW 200,000) per gram of uranium or plutonium under its nuclear fuel rod tax scheme.

In another scenario, we posit certain rates of taxes to be imposed per unit of electricity generated by nuclear power. As in the coal tax scenarios, we use the current tax rate on natural gas so that the amount of tax on the calories generated by natural gas remains the same for the same amount of calories of electricity consumed. This gives us a rate of KRW 11 per kilowatt-hour (kWh).

The tax revenue resulting from this rate, based on the amount of nuclear electricity generated in 2012, would amount to KRW 1.7 trillion.

There are four scenarios analyzed in this study. In the first scenario, we apply tax rates of KRW #0 per kilogram of bituminous coal and KRW 954 per gram of uranium. Assuming that power plants would want to compensate for the losses arising from these additional taxes by raising the price of electricity, these rates together would increase the consumer price of electricity by 6.7 percent on average. In the second scenario, we apply rates of KRW 30 per kilogram of bituminous coal and KRW 11 per kWh of electricity generated by nuclear power. In this scenario, if we translate the additional tax burden into increases in the consumer price of electricity, the electricity price would increase by 8.7 percent. For the third and fourth scenarios, we assume that additional electricity consumption taxes would be introduced based on the two foregoing scenarios. Then, we assume that the Korean government decides to abolish taxes on the sources of energy on the production side and replace them with new electricity consumption taxes at rates that would ensure it earns the same amount of tax revenue, i.e., it decides to introduce revenue-neutral tax rates. In the third scenario, where both bituminous coals and uranium are taxed, the revenue-neutral electricity consumption tax rate would have to be KRW 6.6 per kWh. In the fourth scenario, where bituminous coals and electricity generated by nuclear power are taxed, the revenue-neutral electricity consumption tax rate would have to be KRW 8.6 per kWh. In these last two scenarios, we also hypothesize that the increases in the price of electricity would also raise the inflation rate by 0.15 to 0.19 percentage points.

Emphasizing the need to reform the energy tax system in the interest of the sustainable growth of the Korean economy and the overall social cost benefits, Kim and Kim(2010) argue in favor of introducing a carbon tax. In particular, they stress that a carbon tax would continue to internalize the social cost, while also improving fiscal prospects for the nation’s sustainable development in the future. They also argue that a carbon tax should incrementally be merged with an emission trading system.

Jeon, Seong, and Jeon(2012), on the other hand, provide an empirical analysis of how the carbon tax could be introduced and adjusted under an emission trading system, using foreign case studies and a general equilibrium model. The foreign cases that these authors examine show three general patterns. First, governments worldwide are increasingly expanding the taxation standard under their energy tax systems. Second, the rates and amounts of carbon taxes also vary according to the sizes of taxable ranges. Third, the introduction of a carbon tax has not significantly increased the tax revenue in these countries. Considering these patterns, and the plan of the Korean government to launch an emission trading system in 2015, the authors argue that the Korean government should introduce a carbon tax in industries that are not subject to an emission trading system. Noting that the economic growth rate drops briefly after a carbon tax is introduced, but rises again in the intermediate to long run, these authors also argue that the scope of industries subject to a carbon tax should be incrementally broadened.

Heo, Seong, and Kim(2012) make policy recommendations regarding how the energy tax system, tax incentives, and subsidies should evolve in the future. In their study, they make four main arguments: (1) that the scope of fuels or sources of energy subject to energy taxes should be widened to include fuels other than oil; (2) that the energy tax rates should also be appropriately raised; (3) that energy tax incentives should be reduced and oil subsidies be abolished one by one; and (4) that tax incentives for saving energy and the use of eco-friendly energy should be increased.

According to Advani *et al.*(2013), an energy tax system has two main goals, to internalize the social cost of using energy and to secure steady sources of revenue for the government. This view reflects a belief in optimal taxation, or the so-called Ramsey's rule(Ramsey, 1927). According to this rule, a government can minimize economic distortions that collecting taxes might cause by raising the tax rates on inelastic goods and lowering the rates on elastic ones. This is because the more elastic the demand for a good, the more sensitive the demand is to any change in the price of the good. Therefore, the Korean government could discourage people from purchasing and consuming inelastic goods by imposing higher tax rates on them. Of course, in reality, it is nearly impossible to achieve the kind of taxation efficiency that Ramsey advocates, for we have to take into account not only efficiency, but also the principle of tax equity and social justice.

The structure of this study is as follows. Section II provides a summary of the energy tax system in Korea today. Sections III and IV provide analyses of the different scenarios in which coal and nuclear taxes might be adopted. Section V discusses the advantages and disadvantages of taxing fuels and electricity consumption. It also provides a brief hypothesis on how changes in the price of electricity would affect consumer prices.

II

Energy Tax System and Revenue in Korea

1 Energy taxes

Various taxes are involved in the trade and consumption of energy in Korea, including customs and duties on imported fuels, excise taxes, transportation taxes, electricity taxes, environmental taxes, educational taxes, mileage taxes, and VATs. The wide range of consumption taxes specifically applying to oil include the VATs that are uniformly imposed on all goods and services consumed in Korea; transportation, energy, environmental, and excise taxes that are optional in the consumption of certain goods or services; and the educational taxes as surtaxes. There are also automobile taxes levied on road users by local governments.

A. Customs and duties

Customs and duties on imported energy and fuels are decided by multiplying import prices by certain tariff rates. On oils and gases, the going tariff rate is three percent, while there are no customs or duties levied on coal. The Korean government, however, also provides a quota tariff program, which cuts the tariff rate by up to 40 percent in light of domestic and international economic conditions. Accordingly, the effective tariff rate applied to crude oil, for instance, can be as low as 1.8 percent. As of July 2014, the quota tariff rates were zero percent on butane and propane gases and two percent on liquefied natural gas (LNG).

B. Excise taxes

Excise taxes on oils and gases are special duties that are determined by multiplying the quantity of consumption by the given tax rate. As of January 1, 2008, these taxes were renamed from special consumption taxes to excise taxes. Each fuel or source of energy has its own tax rate, while the government retains the right to adjust the tax rate by up to 30 percent or so. For example, the nominal tax rate on butane is currently KRW 252 per kilogram, even though the adjusted (effective/actual) tax rate is KRW 275 per kilogram.

Excise taxes are levied on oils, gases, and bituminous coals, but not on anthracites. The tax reforms of 2013 introduced excise taxes on bituminous coals, with the purpose of preventing the concentration or sudden rise of demand for electricity (generated mostly by bituminous coals) due to the relatively higher prices of other forms or fuels of energy, such as LNG and kerosene.[2] The current excise tax on bituminous coal is KRW 24 per kilogram, but no educational taxes are levied in the interest of keeping a parity of demand with that for LNG. However, collective energy providers using bituminous coals and businesses using these coals for purposes other than generating electricity are exempt from excise taxes.[3]

C. Transportation, energy, and environmental taxes

The Korean government originally introduced the transportation tax on gasoline and diesel in an attempt to secure streams of revenue necessary to sustain and expand Korea's transportation infrastructure. On January 1, 2007, the government renamed the tax to the transportation, energy and environmental (TEE) tax to reflect the new uses of the transportation tax revenue in increasing public transportation services and investing in energy and environmental projects.

2) Article 1.2 of the Excise Tax Act (ETA); Article 2.2 of the Enforcement Ordinance for the ETA.

3) This is applicable to quantities that are reported for importation and/or taken out of the manufacturing site after July 1, 2014, pursuant to Article 1.2 of the ETA and Article 2.2 of the Enforcement Ordinance for the ETA.

The TEE taxes are special duties arrived at by multiplying the quantity of consumption by certain tax rates and then levied on gasoline and diesel. Again, the government retains the right to adjust the nominal tax rate by up to 30 percent. At present, the nominal TEE tax rate on gasoline is KRW 475 per liter, and the adjusted tax rate is KRW 529 per liter. For diesel, the nominal rate is KRW 340 per liter, and the adjusted rate is KRW 375 per liter.

The TEE taxes are special-purpose taxes that will be imposed until the end of 2015. As for the revenue from these taxes, 80 percent is set aside in a special account for transportation facilities; 15 percent in a special account for environmental improvement; three percent, in a special account for energy and resource facilities; and two percent, in a special account for metropolitan and local development.

D. Educational taxes

Educational taxes on energy are surtaxes whose amounts are determined on the basis of the amounts of the TEE and/or excise taxes. As for gasoline and diesel, the educational tax rates are 15 percent of the TEE taxes levied. At present, the rates are KRW 79.35 per liter and KRW 56.25 per liter for gasoline and diesel, respectively. On the other hand, the educational taxes on butane, kerosene, heavy oil, and tar are 15 percent of the respective excise taxes, resulting in rates of KRW 41.25 per liter for butane, KRW 9.45 per liter for kerosene and tar, and KRW 2.55 per liter for heavy oil.

E. Mileage taxes

Road user automobile taxes, also known as mileage taxes, are surtaxes whose amounts are determined on the basis of the TEE taxes levied, and they are collected by local governments. At present, the mileage tax rates for gasoline and diesel are 26 percent of the TEE taxes, or KRW 137.54 per liter and KRW 97.50 per liter, respectively.

F. Value-added taxes

Aside from the anthracites that are duty-free, VATs are levied on all fuels and sources of energy. For fuels and sources of energy, the VAT tax rate is 10 percent of the transaction price. Note that the transaction price on which the VAT is based already includes excise, TEE, mileage, and other taxes. As a result, even if the VAT rate is fixed at 10 percent of the transaction price, an increase in the rate of any of these other taxes will increase the amount of VAT levied on it. However, the Korean government does not collect VATs—at least not until the end of 2015—on energy transactions of certain types, such as oil supplies for agricultural and forestry vehicles, fishing vessels, passenger liners, and household electricity generation on remote islands.

<Table II-1> provides a summary of all the energy taxes in Korea, effective as of July 2014.

〈Table II-1〉 **Energy Tax System in Korea (July 2014)**

Fuel	Unit	Customs/duties (%)		Excise tax (KRW)		TEE tax (KRW)		Educational tax (KRW)	Mileage tax (KRW)	VAT (%)
		Nominal	Quota	Nominal	Adjusted	Nominal	Adjusted			
Gasoline	ℓ	3	–	475	–	475	529	79.35	137.54	10
Diesel	ℓ	3	–	340	–	340	375	56.25	97.50	10
Butane	kg	3	0	252	275	–	–	41.25	–	10
Propane	kg	3	0	20	14[2)]	–	–	–	–	10
LNG	kg	3	2	60	42	–	–	–	–	10
Kerosene	ℓ	3	–	90	63	–	–	9.45	–	10
Heavy oil	ℓ	3	–	17	–	–	–	2.55	–	10
Tar	ℓ	3	–	90	63	–	–	9.45	–	10
Anthracites	kg	Duty-free	–	–	–	–	–	–	–	Duty-free
Bituminous coals	kg	Duty-free	–	24[1)]	19[3)]/17[4)]	–	–	–	–	10
Electricity	kWh	–	–	–	–	–	–	–	–	10

Notes: 1) Limited to bituminous coals used to generate electricity only. Collective energy providers and other businesses using bituminous coals for purposes other than generating electricity are exempt.6
2) Limited to household and industrial uses only.
3) For a good whose net calorific value (i.e., the caloric value minus the calories absorbed by vapors arising from the combustion of the fuel) is 5,000 kilo-calories (kcal) or more per kilogram: KRW 19 per kilogram.
4) For a good whose net calorific value is less than 5,000 kcal per kilogram: KRW 17 per kilogram.

Source: National Legislation Information Center (http://www.law.go.kr).

G. Local resource facility taxes

The local resource facility tax, introduced in 2011, combines what were previously known as local development taxes and collective facility taxes. The local resource facility taxes form a source of revenue for local governments. These taxes can be divided between those imposed on certain resources and fuels and others imposed on certain real estate properties. The former represent the previous local development taxes and the latter the previous collective facility taxes.[4)]

Our focus is on local resource facility taxes imposed on certain resources and fuels. These taxes are collected from those who make use of or exploit local natural resources—such as water for energy generation, groundwater, underground resources and minerals,[5)] containers, nuclear plants, and thermal plants—and are to secure revenue necessary to ensure the conservation and development of local resources. The thermal plant tax was included in the scope of local resource facility taxes after the reform of the Local Tax Act (LTA) on March 29, 2011, and it took effect on January 1, 2014. The aim of the tax was to ensure the equity of taxation between thermal and hydro plants, while also increasing revenue for local governments. As a result, each Korean household has been paying KRW 0.15 per kWh of electricity from thermal plants since January 2014. See <Table II-2> for the local resource facility tax standards and rates applying to different types of tax payers.

4) Local resource facility taxes on certain real estate properties are local taxes that are collected to maintain various public facilities and premises, including fire stations, sewage and waste treatment facilities, and the like. Relevant taxpayers are those who own built premises, racks and/or land that benefit from these public facilities.

5) Minerals subject to these taxes include limestone, kaolin, quartzite and silica, diatomite, talc, graphite, zeolite, ophiolite, and mica, among others. Coals and minerals whose annual sales amounts to KRW 1 billion or less each year are exempt from these taxes, pursuant to Article 3.3 of the Mining Act.

〈Table II-2〉 **Local Resource Facility Taxes: Subject Taxpayers, Standards, and Rates**

Taxable good		Taxpayers	Tax standard	Tax rate (KRW)
Water for energy generation		Parties that generate electricity directly using running water	10m^3 of water used	2
Ground–water	Drinking	Parties that develop and produce drinking, bath, or other types of water out of groundwater	1m^3 of groundwater used	200
	Bath		1m^3 of groundwater used	100
	Other		1m^3 of groundwater used	20
Minerals		Parties that mine minerals	Prices of mined minerals	5/1,000
Containers		Parties whose containers enter and leave piers/ports that accept such containers	TEU	15,000
Nuclear plants		Parties that generate electricity using nuclear power	kWh of electricity generated	0.5
Thermal plants		Parties that generate electricity using fossil fuels	kWh of electricity generated	0.15

Source: LTA, National Legislation Information Center (http://www.law.go.kr/main.html).

Taxpayers required to pay local resource facility taxes are parties that generate electricity using water; that gather and develop groundwater to produce drinking, bath, or other types of water; that mine minerals; that move containers in and out of piers/ports open to containers; that generate electricity using nuclear power; or that generate electricity using fossil fuels, such as coals, oil, and natural gas. The applicable local resource facility tax rates are KRW 2 per 10 cubic meters of water used to generate electricity; KRW 200 per cubic meters of groundwater gathered for drinking water (KRW 100 for bath water and KRW 20 for other uses); 0.5 percent of the price of minerals mined; KRW 15,000 per TEU of containers; KRW 0.5 per kWh of electricity generated by nuclear plants; and KRW 0.15 per kWh of electricity generated by thermal plants.

2 Energy tax revenue

Table II-3 shows a year-by-year summary of energy tax revenue in Korea. The *Annals of National Tax Statistics*, however, indicate only the amounts of taxes levied on the goods released from manufacturing sites in Korea. For tax statistics on natural gas, butane (LPG), and other such fuels that are mostly imported, see <Table II-4>. <Table II-5> shows year-by-year trends in local resource facility taxes.

〈Table II-3〉 **Energy Tax Revenue**

(Unit: KRW 100 million)

	National taxes					National tax total	Local taxes		Local tax total	Grand total
	Excise tax (on oil)		TEE tax		VAT (on oil)		Mileage tax	Local resource facility tax		
	Amount	Educational tax	Amount	Educational tax						
2006	16,664	2,446	110,965	16,551	36,145	182,771	27,098	714	27,812	210,583
2007	14,822	2,179	114,558	17,128	35,553	184,240	32,703	806	33,509	217,749
2008	10,673	1,614	107,118	15,984	43,133	178,522	30,814	821	31,635	210,157
2009	10,595	1,545	123,860	18,495	35,857	190,352	32,871	807	33,678	224,030
2010	10,526	1,530	129,530	19,354	44,322	205,262	31,691	854	32,545	237,807
2011	9,413	1,376	129,922	19,488	46,939	199,829	32,411	815	33,226	233,055
2012	8,296	1,202	132,298	19,845	59,167	220,808	33,452	840	34,292	255,100

Notes: 1. The amounts of excise and TEE taxes are based on the amounts of goods released from manufacturing sites.
2. The local resource facility taxes are accompanying taxes levied on water for electricity generation and nuclear energy.

Sources: National Tax Service, *Annals of National Tax Statistics*, each year (for national taxes other than the VATs on oil); Korea Automotive Manufacturers Association (KAMA), *Automotive Industry in Korea*, each year (for VATs on oil); Ministry of Safety and Public Administration (MOSPA), *Annals of Local Taxes*, each year (for mileage and local resource facility taxes).

〈Table II-4〉 **TEE and Excise Tax Revenue (reported in 2012)**

(Unit: KRW 100 million)

Fuel	2011			2012		
	Released from manufacturer	Imported	Total	Released from manufacturer	Imported	Total
TEE tax	129,922	729	130,651	132,299	3,221	135,520
Gasoline	58,090	1	58,091	59,731	78	59,809
Diesel	71,832	728	72,560	72,568	3,143	75,711
Excise tax (on oil)	9,443	30,345	39,788	8,296	30,207	38,503
Kerosene	3,579	64	3,643	3,064	34	3,098
Heavy oil	986	495	1,481	551	822	1,373
Butane	4,408	7,339	11,747	4,222	7,265	11,487
Propane	167	438	605	157	376	533
Tar	131	–	131	127	0	127
Natural gas	172	22,009	22,181	175	21,710	21,885

Note: The tax revenue refers to the sum of taxes levied on quantities both released from manufacturers and imported.
Source: Ministry of Strategy and Finance (MSF).

〈Table II-5〉 **Yearly Trend in Local Resource Facility Taxes Imposed**

(Unit: KRW 100 million)

Year	Taxed resources (1)						Taxed real estate properties (2)	Total (1) + (2)
	Water for energy generation	Ground water	Minerals	Containers	Nuclear plants	Subtotal		
2000	89	60	14	730	–	894	3,607	4,502
2001	66	76	14	708	–	864	3,661	4,525
2002	83	72	15	784	–	954	3,889	4,843
2003	114	79	16	829	–	1,038	4,290	5,328
2004	102	76	16	912	–	1,105	4,885	5,990
2005	91	77	16	917	–	1,101	4,718	5,818
2006	87	79	34	923	627	1,750	5,415	7,165
2007	90	87	31	80	716	1,003	5,663	6,666
2008	82	79	29	–	739	929	6,145	7,074
2009	75	75	30	–	732	911	6,174	7,085
2010	93	74	28	–	761	957	6,759	7,715
2011	102	70	32	–	713	917	7,477	8,394
2012	86	75	34	–	754	949	8,149	9,099

Sources: MOSPA, *Annals of Local Taxes*, each year.

Ⅲ

Introducing the Coal Tax

In this section, we shall analyze different scenarios in which excise taxes are introduced on the use of bituminous coals in generating electricity. The scenarios assume that the overall energy tax levels or rates would be adjusted once the new coal tax is introduced. Before analyzing the coal tax scenarios, we will first survey how other countries have made use of the coal tax.

1 Coal taxes in benchmark countries

The governments of the United Kingdom, Japan, and Israel have introduced coal taxes. The United Kingdom and Japan levy taxes both on the coals used to generate electricity and on the consumption of electricity. Israel, on the other hand, levies taxes on the coals used to generate electricity only. France also directly taxes consumption of electricity, as do the majority of the EU member states, according to the EU Energy Taxation Directive. France is therefore a handy representative case of other EU member states.[6)]

6) The EU Energy Taxation Directive defines the minimum tax rates to apply to different uses and fuels of energy that the government of each member state must consider. According to the Directive, the minimum recommended tax rates for electricity and coals are EUR 0.54 per MWh and EUR 2.04 per GJ, respectivel y. Note that the Directive recommends a coal tax rate based not on quantity (kilogram), but on calorific outpu t (GJ). (See http://ec.europa.eu/taxation_customs/taxation/excise_duties/energy_products/legislation.)

The British Parliament imposes the climate change levy (CCL) and the carbon price floor (CPF) to control the use of coal on both the supply and demand sides. As of April 2013, the CCL rate was GBP 5.24 per MWh, while the CPF on bituminous coals for generating electricity was 44.264 pence per GJ. Britain's parliament has announced its intention to keep raising these rates in the future. It is important to note that these rates are based not on the quantities of bituminous coals used, but on the calories they generate.

In addition to levying taxes on coals used to generate electricity, the Japanese government also collects an electric power development promotion tax on the consumption of electricity. It also intends to raise coal tax rates in the future, along with the anti-global warming tax rates. As of April 2014, the coal and electric power development promotion tax rates were JPY 1,140 per ton and JPY 0.375 per kWh, respectively.

The Israeli government taxes coal on the production side only, collecting ILS 43.3 per ton as of 2011. France imposes differential tax rates on the consumption of energy, i.e., EUR 15.78 per MWh for industrial use and EUR 23.66 per MWh for household use.

2 Coal tax scenarios

Before we begin to detail and analyze our coal tax scenarios, we need first to compare the current energy tax rates in Korea by use, fuel, calorific output, and carbon emission output. For comparing uses, we divide the energy taxes between those on transportation and others on non-transportation purposes. The latter include energy used in heating/processing and generating electricity. Energy taxes on each type of use are again divided according to the types of fuels used. Transportation energy taxes, for instance, are divided into energy taxes on gasoline, diesel, LPG butane, and compressed natural gas (CNG). CNG is LNG used in transportation settings. As for non-transportation uses of energy, the energy taxes are divided into those on LNG, LPG propane, kerosene, heavy oil, tar, and bituminous coals. Here, the term "bituminous coals" refers strictly to bituminous coals used in electricity generation settings. Bituminous coals from different sources show widely differing calorific output and uses. These coals are also used in steel and cement industries.

<Table III-1> provides a summary of the relative tax rates by use, fuel, calorific output, and carbon emission output. The tax rates listed here reflect the sums of the TEE, excise, educational, and mileage tax rates.7) The calorific output used in this table refers to the net calorific value, which is the calorific value of a unit of a fuel consumed subtracted by the amount of latent heat in the vapor arising from the combustion of that fuel. (The total calorific value therefore includes both the net value and the amount of latent heat in vapor.)

The relative ratios of taxed amounts of energy used for transportation and non-transportation purposes were also calculated. For transportation, the relative ratio was based on the amount of gasoline used (100), and for non-transportation, the relative ratio was based on the amount of kerosene used (100). Gasoline and kerosene are the fuels with the highest tax rates in the transportation and non-transportation areas, respectively. In the discussion following, we shall refer to the tax rate of each fuel relative to those of other fuels as the "relative tax rate"; the relative ratio of the net calorific value of a fuel as the "relative calorific value"; and the amount of carbon emissions from a fuel relative to those from others as "relative emissions." The relative tax rates on fuels for transportation, indicated in <Table III-2>, were calculated using the following formula:

Gasoline : Diesel : Butane : CNG = 100 : 71 : 42 : 8

For the fuels for non-transportation purposes, the following formula was used:

LNG : Propane : Kerosene : Heavy Oil : Tar : Bituminous coals
= 58 : 19 : 100 : 19 : 100 : 0

7) In order to broaden the scope of our analysis, we define "current" energy taxes as those that were effective during the first half of 2014. This allows us to take into account the bill on the excise tax on bituminous coals that passed the National Assembly in December 2013 and which took effect in July 2014. By confining the scope of the "current" period subject to our analysis to the first six months of 2014, we were able to examine the impact of the new bituminous coal tax as part of our overall adjusted energy tax scenario.

Similar ratios are used for transportation and non-transportation fuels with respect to relative calorific values and relative emissions.

〈Table III-1〉 **Tax Rates, Calorific Values, and Carbon Emissions of Fuels: By Use and Type**

Use / type		Current		Calorific value		Carbon emissions	
		Rate	Ratio	Value	Ratio	Amount	Ratio
Transportation	Gasoline	746	100	7,230	100	0.00208	100
	Diesel	529	71	8,420	116	0.00258	124
	LPG (butane)	316	42	10,900	151	0.00285	137
	CNG	60	8	11,780	163	0.00275	132
Non–transportation	LNG	60	58	11,780	144	0.00275	113
	LPG propane	20	19	11,050	135	0.00289	118
	Kerosene	104	100	8,200	100	0.00244	100
	Heavy oil	20	19	9,360	114	0.00300	123
	Tar	104	100	8,200	100	0.00244	100
	Bituminous coals	0	0	5,890	72	0.00229	94

Notes: 1. Gasoline, diesel, kerosene, heavy oil, and tar: KRW/L for tax rates, kcal/L for calorific values, and tCO2/L for emissions.
2. Butane, CNG, LNG, propane, and bituminous coals: KRW/L for tax rates, kcal/L for calorific values, and tCO^2/L for emissions.
3. Relative ratios are based on the amounts of gasoline and kerosene as "100" for transportation and non–transportation uses, respectively.

Source: Korea Energy Management Corporation (KEMCO), *Formulae for Converting Energy Consumption into Calories under the Tax and Energy Laws* (http://co2.kemco.or.kr/toe/toe.aspx).

Now we are ready to review and analyze the adjusted coal tax scenarios, based on the relative tax rates, relative caloric values, and relative emissions indicated in <Table III-2>. The scenarios of our analysis can be divided into two groups. The first group comprising Scenarios 1 through 4 involves the adjustment of the coal tax rates on the basis of either the relative calorific values or relative emissions. The second group comprising Scenarios 5 through 8 involves fixing the relative tax rates on all fuels except bituminous coals to the current relative tax rates, while adjusting the rate on bituminous coals only. In this second-group scenarios, however, we need to keep in mind that the adjusted tax rates on the fuels with fixed relative tax rates may differ from the actual tax rates currently imposed on them. This is because adjusted tax rates can increase or decrease in proportion to relative tax rates. Therefore, the margin of difference between current tax rates and adjusted tax rates will remain consistent across all the fuels.

A. Tax adjustment scenarios based on calorific values and carbon emissions

In Scenarios 1 and 2, we fix the relative tax rates on all transportation fuels to the current relative tax rates, while leaving the relative tax rates on non-transportation fuels to either relative calorific values (Scenario 1) or relative emissions (Scenario 2). In Scenarios 3 and 4, we leave the relative tax rates on fuels of all types and purposes to relative calorific values or relative emissions. In Scenario 3, we posit relative tax rates on fuels in proportion to their respective net calorific values. In Scenario 4, we do the same, but in proportion to their respective emissions of fuels rather than net calorific values. See Table IV-3 for a summary of the assumptions underlying the relative tax rates estimated in these four scenarios.

〈Table III-2〉 **Relative Tax Rates on Fuels Based on Relative Calorific Values and Emissions**

Use / type		Scenario 1	Scenario 2	Scenario 3	Scenario 4
Transportation	Gasoline	100	100	100	100
	Diesel	71	71	116	124
	LPG (butane)	42	42	151	137
	CNG	8	8	163	132
Non–transportation	LNG	144	113	144	113
	LPG propane	135	118	135	118
	Kerosene	100	100	100	100
	Heavy oil	114	123	114	123
	Tar	100	100	100	100
	Bituminous coals	72	94	72	94

In each scenario, we estimate the total amount of revenue from energy taxes on the basis of the current tax rates and the amounts of fuels consumed in 2013. Then, we multiply the relative tax rates of each scenario by an adjustment coefficient to obtain the adjusted tax rates. We then multiply the amounts of fuels consumed in 2013 by these adjusted tax rates to re-estimate the tax revenue. Finally, we calculate the difference between the revenue at the current tax rates and the revenue at the adjusted tax rates. The central assumption underlying this whole process is that the amounts of consumption will remain constant, notwithstanding the changes in the tax rates. In other words, we assume that the fuels listed above are highly inelastic goods, with demand changing very little in response to the differences in tax rates.[8)]

In all the four scenarios, we also explore new tax adjustments that can be made without affecting the total energy tax revenue. Our goal is to find and analyze revenue-neutral tax reforms that might be realistically implemented. In order to satisfy the revenue neutrality condition, any additional revenue that may be gained from taxing non-transportation fuels (e.g., bituminous coals) should be countervailed by lowering the taxes on transportation fuels. In each scenario, we explore how much the tax rates should be adjusted in order to meet this principle, and we determine the required adjustment coefficients on the basis of the following assumptions:

Assumption 1: The total energy tax revenue should remain constant.

Assumption 2: The adjusted tax rates on non-transportation LNG should remain consistent with the current rates.

Assumption 3: The same adjustment coefficient should apply to all fuels of the same use or purpose. However, the coefficients applying to transportation fuels may differ from those for non-transportation fuels.

8) Alternatively, we could attempt to estimate the price elasticity of the demand for different types of fuels and the resulting changes in the amounts of consumption in our scenarios. However, the matter of estimating elasticity for different types of fuels lies outside the central focus and subject of this report.

We can decide on the adjustment coefficient that satisfies the revenue neutrality condition in each scenario only on the basis of these three foregoing assumptions. In each scenario, new relative tax rates are applied to transportation and non-transportation fuels. Pursuant to Assumption 2, we calculate the adjustment coefficient for non-transportation fuels while keeping the adjusted tax rate on non-transportation LNG the same as the current rate, i.e., KRW 60 per kilogram. Given this adjustment coefficient and Assumption 3, we then calculate the adjusted tax rates that are to apply to other non-transportation fuels. In so doing, the current tax rate on non-transportation LNG becomes the adjustment coefficient for each scenario. With this, we can estimate the amount of post-adjustment tax revenue from each fuel, compare it to the current tax revenue from that fuel to determine the difference, and then use that difference to calculate the total amount of revenue from non-transportation energy taxes.

In Scenarios 1 through 4, additional revenue arises from the taxes imposed on non-transportation fuels. Revenue on some fuels may be lost, while incremented on others depending on the scenario. Nevertheless, the introduction of the new tax on bituminous coals increases the revenue from non-transportation fuels overall.

However, because our total energy tax revenue must remain constant, we need to countervail the increase in revenue from non-transportation fuels by making cuts to the revenue from transportation fuels. Pursuant to Assumption 3, we decided to apply the same adjustment coefficient to all fuels in each category of use or purpose. This makes it possible to find the adjustment coefficient for transportation fuels that would keep the tax revenue intact, if we make cuts to the transportation energy tax revenue that corresponds to the amount of increase in non-transportation energy tax revenue. Only on the basis of such an adjustment coefficient can we determine the adjusted tax rates to apply to transportation fuels, and subsequently, the adjusted revenue from these fuels.

See the following tables for the specific adjusted tax rates, along with the resulting changes in tax revenue, in each scenario. Note that these figures are all based on energy consumption in 2013 and include the amounts of duty-free fuels consumed as well. Because the amount of oil consumed includes the amount of duty-free oil consumed, the total revenue estimate may be significantly larger than the actual amount of revenue. However, our goal is to determine how the adjustment of the energy tax rates would affect the amount of revenue relatively, not to arrive at the exact amount of revenue. So long as the amount of duty-free oil consumed remains consistent before and after the energy tax adjustments, no change would occur in the margin by which the tax revenue increases or decreases.

〈Table III-3〉 **Scenario 1 Analysis**

Fuel	Current tax rate	Consumed quantity	Tax revenue	Relative tax rate	Adjustment coefficient	Adjusted tax rate	Consumed quantity	Tax revenue	Revenue difference
	A	B	C=A*B	D	E	F=D*E	G=B	H=F*G	I=H–C
Gasoline	746	11,672	8,705,986	100	6.62	662	11,672	7,731,628	–974,357
Diesel	529	22,738	12,022,666	71	6.62	470	22,738	10,677,112	–1,345,554
LPG butane	316	5,108	1,615,426	42	6.62	281	5,108	1,434,630	–180,795
CNG	60	1,007	60,431	8	6.62	53	1,007	53,667	–6,763
Transportation subtotal			22,404,509					19,897,038	–2,507,470
LNG	60	40,279	2,416,738	144	0.42	60	40,279	2,416,737	0
LPG propane	20	3,028	60,551	135	0.42	56	3,028	170,397	109,846
Kerosene	104	2,992	309,621	100	0.42	42	2,992	124,943	–184,679
Heavy oil	20	7,372	144,114	114	0.42	48	7,372	351,432	207,318
Tar	104	256	26,496	100	0.42	42	256	10,692	–15,804
Bituminous coals (plants)	0	79,693	0	72	0.42	30	79,693	2,390,790	2,390,790
Non–transportation subtotal			2,957,521					5,464,991	2,507,470

Notes: 1. Gasoline, diesel, kerosene, heavy oil, and tar units: KRW/L for tax rates, 1,000,000L for consumed quantity, and KRW 1,000,000 for revenue.
2. Butane, CNG, LNG propane, and bituminous coal units: KRW/L for tax rates, 1,000,000L for consumed quantity, and KRW 1,000,000 for revenue.
3. The tax rates represent the sums of the TEE, excise, educational, and mileage tax rates.
4. Consumed quantities are from 2013.

〈Table III-4〉 **Scenario 2 Analysis**

Fuel	Current tax rate	Consumed quantity	Tax revenue	Relative tax rate	Adjustment coefficient	Adjusted tax rate	Consumed quantity	Tax revenue	Revenue difference
	A	B	C=A*B	D	E	F=D*E	G=B	H=F*G	I=H−C
Gasoline	746	11,672	8,705,986	100	6.03	603	11,672	7,040,035	−1,665,951
Diesel	529	22,738	12,022,666	71	6.03	428	22,738	9,722,045	−2,300,621
LPG butane	316	5,108	1,615,426	42	6.03	256	5,108	1,306,303	−309,123
CNG	60	1,007	60,431	8	6.03	49	1,007	48,867	−11,564
Transportation subtotal			22,404,509					18,117,250	−4,287,259
LNG	60	40,279	2,416,738	113	0.53	60	40,279	2,416,738	0
LPG propane	20	3,028	60,551	118	0.53	63	3,028	190,902	130,350
Kerosene	104	2,992	309,621	100	0.53	53	2,992	159,257	−150,364
Heavy oil	20	7,372	144,114	123	0.53	65	7,372	482,502	338,388
Tar	104	256	26,496	100	0.53	53	256	13,629	−12,867
Bituminous coals (plants)	0	79,693	0	94	0.53	50	79,693	3,981,752	3,981,752
Non-transportation subtotal			2,957,521					7,244,779	4,287,259

Notes: 1. Gasoline, diesel, kerosene, heavy oil, and tar units: KRW/L for tax rates, 1,000,000L for consumed quantity, and KRW 1,000,000 for revenue.
2. Butane, CNG, LNG propane, and bituminous coal units: KRW/L for tax rates, 1,000,000L for consumed quantity, and KRW 1,000,000 for revenue.
3. The tax rates represent the sums of the TEE, excise, educational, and mileage tax rates.
4. Consumed quantities are from 2013.

〈Table III-5〉 **Scenario 3 Analysis**

Fuel	Current tax rate	Consumed quantity	Tax revenue	Relative tax rate	Adjustment coefficient	Adjusted tax rate	Consumed quantity	Tax revenue	Revenue difference
	A	B	C=A*B	D	E	F=D*E	G=B	H=F*G	I=H−C
Gasoline	746	11,672	8,705,986	100	4.19	419	11,672	4,889,789	−3,816,196
Diesel	529	22,738	12,022,666	116	4.19	488	22,738	11,093,567	−929,100
LPG butane	316	5,108	1,615,426	151	4.19	632	5,108	3,226,203	1,610,777
CNG	60	1,007	60,431	163	4.19	683	1,007	687,480	627,049
Transportation subtotal			22,404,509					19,897,039	−2,507,470
LNG	60	40,279	2,416,738	144	0.42	60	40,279	2,416,737	0
LPG propane	20	3,028	60,551	135	0.42	56	3,028	170,397	109,846
Kerosene	104	2,992	309,621	100	0.42	42	2,992	124,943	−184,679
Heavy oil	20	7,372	144,114	114	0.42	48	7,372	351,432	207,318
Tar	104	256	26,496	100	0.42	42	256	10,692	−15,804
Bituminous coals (plants)	0	79,693	0	72	0.42	30	79,693	2,390,790	2,390,790
Non−transportation subtotal			2,957,521					5,464,991	2,507,470

Notes: 1. Gasoline, diesel, kerosene, heavy oil, and tar units: KRW/L for tax rates, 1,000,000L for consumed quantity, and KRW 1,000,000 for revenue.
2. Butane, CNG, LNG propane, and bituminous coal units: KRW/L for tax rates, 1,000,000L for consumed quantity, and KRW 1,000,000 for revenue.
3. The tax rates represent the sums of the TEE, excise, educational, and mileage tax rates.
4. Consumed quantities are from 2013.

〈Table III-6〉 **Scenario 4 Analysis**

Fuel	Current tax rate	Consumed quantity	Tax revenue	Relative tax rate	Adjustment coefficient	Adjusted tax rate	Consumed quantity	Tax revenue	Revenue difference
	A	B	C=A*B	D	E	F=D*E	G=B	H=F*G	I=H−C
Gasoline	746	11,672	8,705,986	100	3.76	376	11,672	4,386,634	−4,319,352
Diesel	529	22,738	12,022,666	124	3.76	466	22,738	10,599,735	−1,422,931
LPG butane	316	5,108	1,615,426	137	3.76	515	5,108	2,630,427	1,015,001
CNG	60	1,007	60,431	132	3.76	497	1,007	500,453	440,023
Transportation subtotal			22,404,509					18,117,250	−4,287,259
LNG	60	40,279	2,416,738	113	0.53	60	40,279	2,416,738	0
LPG propane	20	3,028	60,551	118	0.53	63	3,028	190,902	130,350
Kerosene	104	2,992	309,621	100	0.53	53	2,992	159,257	−150,364
Heavy oil	20	7,372	144,114	123	0.53	65	7,372	482,502	338,388
Tar	104	256	26,496	100	0.53	53	256	13,629	−12,867
Bituminous coals (plants)	0	79,693	0	94	0.53	50	79,693	3,981,752	3,981,752
Non-transportation subtotal			2,957,521					7,244,779	4,287,259

Notes: 1. Gasoline, diesel, kerosene, heavy oil, and tar units: KRW/L for tax rates, 1,000,000L for consumed quantity, and KRW 1,000,000 for revenue.
2. Butane, CNG, LNG propane, and bituminous coal units: KRW/L for tax rates, 1,000,000L for consumed quantity, and KRW 1,000,000 for revenue.
3. The tax rates represent the sums of the TEE, excise, educational, and mileage tax rates.
4. Consumed quantities are from 2013.

We shall now examine how the adjusted tax rates of each scenario affect the prices of fuels. In Scenario 1, the relative tax rates of transportation fuels were fixed, while only the relative tax rates of non-transportation fuels were left to vary with relative calorific values. Here, the adjusted tax rate on non-transportation LNG was fixed at KRW 60 per kilogram, yielding an adjusted tax rate of KRW 30 per kilogram on bituminous coals (because the relative calorific value of bituminous coals is half that of LNG). Assuming that the rise in the tax on bituminous coals would be translated into an increase in the price of the fuel (which was imported at KRW 140 per kilogram in 2012), the price of bituminous coals would rise by 21.4 percent. The tax rates on propane and heavy oil, already quite low, would be adjusted in light of the relative calorific values of these fuels, leading to increases in both tax rates and prices.

With respect to all the other fuels, however, both tax rates and prices would decrease, because the revenue neutrality condition mandates that tax rates on other fuels be lowered to countervail the increases in revenue from taxes on bituminous coals, propane, and heavy oil. As the tax rates on transportation fuels were fixed to the current relative tax rates, the rates on these fuels all decrease by 11.2 percent. However, given the differing prices of these fuels and the differing margins by which their tax rates change, the price variation rates of these fuels all differ from one another. The price of gasoline would drop by the largest margin of 4.2 percent, while the prices of diesel and butane would decrease by 3.3 percent and 2.3 percent, respectively.

〈Table III-7〉 **Changes in Fuel Prices under Scenario 1**

Use / type		Avg. price	Current tax rate	Adjusted tax rate	Tax rate difference	Tax rate variation rate (%)	Price variation rate (%)
		A	B	C	D=C−B	E=(D/B)×100	F=(D/A)×100
Transportation	Gasoline	1,986	746	662	−83	−11.2	−4.2
	Diesel	1,806	529	470	−59	−11.2	−3.3
	LPG (butane)	1,573	316	281	−35	−11.2	−2.3
	CNG	858	60	53	−7	−11.2	−0.8
Non−transportation	LNG	858	60	60	0	0.0	0.0
	LPG propane	1,514	20	56	36	181.4	2.4
	Kerosene	1,394	104	42	−62	−59.6	−4.4
	Heavy oil	1,084	20	48	28	143.9	2.6
	Tar	1,394	104	42	−62	−59.6	−4.4
	Bituminous coals	140	0	30	30	−	21.4

In Scenario 2, the relative tax rates of transportation fuels remain the same as the current relative tax rates, while the relative tax rates of non-transportation fuels were determined by relative emissions. With the tax rate on non-transportation LNG fixed at KRW 60 per kilogram, the adjusted tax rate on bituminous coals would be KRW 50 per kilogram, given the latter's relative emissions. (LNG emits 2.75 kilograms of carbon dioxide for every kilogram combusted, while bituminous coals emit 2.29 kilograms or 83 percent of LNG's emission.)[9] Assuming that this tax on bituminous coals would be translated into the price of the fuel, the price of bituminous coals would increase by 35.7 percent. As in Scenario 1, the tax rates and prices of both propane and heavy oil would also increase, as the current tax rates on these two fuels are already significantly low.

With respect to all the other fuels, however, both tax rates and prices would decrease, because the revenue neutrality condition mandates that tax rates on other fuels be lowered to countervail the increases in revenue from taxes on bituminous coals, propane, and heavy oil. The tax rates on the other fuels would all decrease by 19.1 percent. The price of gasoline would drop by the largest margin of 7.2 percent, while the prices of diesel and butane would decrease by 5.6 percent and 3.8 percent, respectively. Of the non-transportation fuels, kerosene would see its tax rate drop by KRW 50 per liter and price drop by KRW 3.6 percent.

In Scenario 3, the relative tax rates were pegged to the relative calorific values of the fuels. The calorific value of gasoline becomes the reference for the relative calorific values of other transportation fuels, while the calorific value of kerosene serves as the reference for the relative calorific values of other non-transportation fuels. The tax rate of non-transportation LNG is, again, fixed at KRW 60 per kilogram. This adjusts the tax rate on bituminous coals to KRW 30 per kilogram. The tax on bituminous coals, in turn, would raise the price of the fuel by 21.4 percent, as in Scenario 1, because the same calorific value standard is used in both scenarios.

9) As already mentioned, bituminous coals produce half the calorific value of LNG. The relative emissions ratio of bituminous coals to LNG is therefore 166 : 100. In other words, in order to produce the same calorific value as that of LNG, bituminous coals would emit 66 percent more carbon dioxides than LNG.

〈Table III-8〉 **Changes in Fuel Prices under Scenario 2**

Use / type		Avg. price	Current tax rate	Adjusted tax rate	Tax rate difference	Tax rate variation rate (%)	Price variation rate (%)
		A	B	C	D=C−B	E=(D/B)×100	F=(D/A)×100
Transportation	Gasoline	1,986	746	603	−143	−19.1	−7.2
	Diesel	1,806	529	428	−101	−19.1	−5.6
	LPG (butane)	1,573	316	256	−61	−19.1	−3.8
	CNG	858	60	49	−11	−19.1	−1.3
Non-transportation	LNG	858	60	60	0	0.0	0.0
	LPG propane	1,514	20	63	43	215.3	2.8
	Kerosene	1,394	104	53	−50	−48.6	−3.6
	Heavy oil	1,084	20	65	46	234.8	4.2
	Tar	1,394	104	53	−50	−48.6	−3.6
	Bituminous coals	140	0	50	50	−	35.7

With respect to all the transportation fuels, however, significant differences from the results of Scenario 1 are observed. The adjusted tax rate on gasoline, for instance, would drop from KRW 746 per liter to KRW 419 per liter, or by 43.8 percent. This would also lower the price of gasoline by 16.5 percent. As for diesel, the tax rate and the price would both drop by 7.7 percent and 2.3 percent, respectively. In the meantime, the tax rates adjusted according to relative calorific values would significantly raise the prices of butane and CNG, as the two fuels enjoy considerably low tax rates today. In Scenario 3, the tax rate and price of butane would increase by 99.7 percent and 20.0 percent, respectively, while at the same time those of CNG would rise dramatically by 1037.6 percent and 72.6 percent, respectively. As a transportation fuel, CNG is not subjected to energy taxes at present, except for the tax rate of KRW 60 per kilogram that applies uniformly to LNG of all uses.

〈Table III-9〉 **Changes in Fuel Prices under Scenario 3**

Use / type		Avg. price	Current tax rate	Adjusted tax rate	Tax rate difference	Tax rate variation rate (%)	Price variation rate (%)
		A	B	C	D=C–B	E=(D/B)×100	F=(D/A)×100
Transportation	Gasoline	1,986	746	419	–327	–43.8	–16.5
	Diesel	1,806	529	488	–41	–7.7	–2.3
	LPG (butane)	1,573	316	632	315	99.7	20.0
	CNG	858	60	683	623	1,037.6	72.6
Non–transportation	LNG	858	60	60	0	0.0	0.0
	LPG propane	1,514	20	56	36	181.4	2.4
	Kerosene	1,394	104	42	–62	–59.6	–4.4
	Heavy oil	1,084	20	48	28	143.9	2.6
	Tar	1,394	104	42	–62	–59.6	–4.4
	Bituminous coals	140	0	30	30	–	21.4

In Scenario 4, the tax rates were adjusted in proportion to the relative emissions of the fuels. The carbon emissions of gasoline became the reference for the relative emissions of other transportation fuels, while the carbon emissions of kerosene served as the reference for the relative emissions of other non-transportation fuels. The tax rate of non-transportation LNG is, again, fixed at KRW 60 per kilogram. This adjusts the tax rate on bituminous coals to KRW 50 per kilogram. The tax on bituminous coals, in turn, would raise the price of the fuel by 35.7 percent, as in Scenario 2, because the same emissions standard is used in both scenarios.

By contrast, the changes occurring with respect to transportation fuels show opposite patterns. The tax rates and prices of gasoline and diesel would drop, while those of butane and CNG would rise. The tax rate of gasoline would plummet by KRW 370 per kilogram or 49.6 percent, while the tax rate of diesel would decrease by KRW 63 per kilogram or 11.8 percent. Accordingly, the prices of gasoline and diesel would also decrease by 18.6 percent and 3.5 percent, respectively.

〈Table III-10〉 **Changes in Fuel Prices under Scenario 4**

Use / type		Avg. price	Current tax rate	Adjusted tax rate	Tax rate difference	Tax rate variation rate (%)	Price variation rate (%)
		A	B	C	D=C−B	E=(D/B)×100	F=(D/A)×100
Transportation	Gasoline	1,986	746	376	−370	−49.6	−18.6
	Diesel	1,806	529	466	−63	−11.8	−3.5
	LPG (butane)	1,573	316	515	199	62.8	12.6
	CNG	858	60	497	437	728.1	50.9
Non-transportation	LNG	858	60	60	0	0.0	0.0
	LPG propane	1,514	20	63	43	215.3	2.8
	Kerosene	1,394	104	53	−50	−48.6	−3.6
	Heavy oil	1,084	20	65	46	234.8	4.2
	Tar	1,394	104	53	−50	−48.6	−3.6
	Bituminous coals	140	0	50	50	−	35.7

B. Taxing bituminous coals with fixed tax rates for other fuels

In the following scenarios, we examine how introducing a new tax on bituminous coals only, while the relative tax rates of all the other fuels are fixed, would affect the price of the fuel. In all the four scenarios, only the relative tax rate of bituminous coals changes, while the relative tax rates of all the other fuels remain the same as the current relative tax rates.

In Scenario 5, the relative tax rate of bituminous coals is 29, relative to the 59 for LNG based on relative calorific values. In Scenario 6, the rate of bituminous coals rises to 72, relative to the 100 for kerosene based on relative calorific values. In Scenario 7, the tax rate on bituminous coals becomes 48, relative to the 58 for LNG based on relative emissions. In Scenario 8, the tax rate on bituminous coals rises to 94, relative to the 100 for kerosene based on relative emissions. It should be noted that kerosene and LNG are the two non-transportation fuels with the greatest shares of non-transportation energy tax revenue.

In sum, in Scenarios 5 through 8, the current relative tax rate scheme is retained, with only the rates of bituminous coals changing relative to the relative calorific values and relative emissions of kerosene and LNG. See Table IV-12 for a summary of the assumptions underlying the tax rates in these scenarios.

〈Table III-11〉 **Relative Tax Rates on Bituminous Coals, Based on Relative Calorific Values and Emissions**

Use / type		Scenario 5	Scenario 6	Scenario 7	Scenario 8
Transportation	Gasoline	100	100	100	100
	Diesel	71	71	71	71
	LPG (butane)	42	42	42	42
	CNG	8	8	8	8
Non–transportation	LNG	58	58	58	58
	LPG propane	19	19	19	19
	Kerosene	100	100	100	100
	Heavy oil	19	19	19	19
	Tar	100	100	100	100
	Bituminous coals	29	72	48	94

The assumptions underlying Scenarios 1 through 4 equally apply to Scenarios 5 through 8. To reiterate, the four central assumptions are as follows. First, the quantities of fuels consumed would remain the same as those in 2013, before and after the tax rates are adjusted. Second, the total energy tax revenue would also remain constant. Third, the adjusted tax rate on non-transportation LNG would be fixed at the current rate of KRW 60 per kilogram. Fourth, the same adjustment coefficient should apply to the relative tax rates of all fuels used for the same purpose. Once the relative tax rates of the fuels are arrived at based the first three assumptions, the tax rates can then be adjusted.

The main difference between this second group of scenarios and the first group is that in the second, the adjusted tax rates on non-transportation fuels except bituminous coals remain the same. Therefore, the revenue from these fuels also remains constant. The relative tax rates on non-transportation fuels other than bituminous coals remain the same as the current relative tax rates, while the adjusted tax rates on bituminous coals remain on a par with the current tax rates in these scenarios. As a result, Scenarios 5 through 8 produce estimates not so different from those of the first four scenarios.

Now we are ready to estimate how the adjusted tax rates on different types of fuels would alter their prices using these new scenarios.

〈Table III-12〉 **Changes in Fuel Prices in Scenario 5**

Use / type		Avg. price	Current tax rate	Adjusted tax rate	Tax rate difference	Tax rate variation (%)	Price variation (%)
		A	B	C	D=C–B	E=(D/B)×100	F=(D/A)×100
Transportation	Gasoline	1,986	746	666	–80	–10.7	–4.0
	Diesel	1,806	529	472	–56	–10.7	–3.1
	LPG (butane)	1,573	316	283	–34	–10.7	–2.1
	CNG	858	60	54	–6	–10.7	–0.7
Non–transportation	LNG	858	60	60	0	0.0	0.0
	LPG propane	1,514	20	20	0	0.0	0.0
	Kerosene	1,394	104	104	0	0.0	0.0
	Heavy oil	1,084	20	20	0	0.0	0.0
	Tar	1,394	104	104	0	0.0	0.0
	Bituminous coals	140	0	30	30	–	21.4

In Scenario 5, the tax rate on bituminous coals is KRW 30 per kilogram, which would increase the price of the fuel by 21.4 percent, assuming that the average import price remains the same. The tax breaks on other fuels introduced to countervail the increase in tax revenue from the coal tax would lower the prices of transportation fuels, i.e., gasoline, diesel, and butane, by 4.0 percent, 3.1 percent, and 2.1 percent, respectively.

In Scenario 6, the tax rate on bituminous coals is KRW 74 per kilogram, which would raise the price of the fuel by 53.1 percent. This, in turn, would decrease the prices of gasoline, diesel, and butane by 9.9 percent, 7.7 percent, and 5.3 percent, respectively.

〈Table III-13〉 **Changes in Fuel Prices in Scenario 6**

Use / type		Avg. price	Current tax rate	Adjusted tax rate	Tax rate difference	Tax rate variation (%)	Price variation (%)
		A	B	C	D=C−B	E=(D/B)×100	F=(D/A)×100
Transportation	Gasoline	1,986	746	549	−197	−26.4	−9.9
	Diesel	1,806	529	389	−140	−26.4	−7.7
	LPG (butane)	1,573	316	233	−84	−26.4	−5.3
	CNG	858	60	44	−16	−26.4	−1.8
Non-transportation	LNG	858	60	60	0	0.0	0.0
	LPG propane	1,514	20	20	0	0.0	0.0
	Kerosene	1,394	104	104	0	0.0	0.0
	Heavy oil	1,084	20	20	0	0.0	0.0
	Tar	1,394	104	104	0	0.0	0.0
	Bituminous coals	140	0	74	74	−	53.1

〈Table III-14〉 **Changes in Fuel Prices in Scenario 7**

Use / type		Avg. price	Current tax rate	Adjusted tax rate	Tax rate difference	Tax rate variation (%)	Price variation (%)
		A	B	C	D=C−B	E=(D/B)×100	F=(D/A)×100
Transportation	Gasoline	1,986	746	613	−133	−17.8	−6.7
	Diesel	1,806	529	435	−94	−17.8	−5.2
	LPG (butane)	1,573	316	260	−56	−17.8	−3.6
	CNG	858	60	49	−11	−17.8	−1.2
Non-transportation	LNG	858	60	60	0	0.0	0.0
	LPG propane	1,514	20	20	0	0.0	0.0
	Kerosene	1,394	104	104	0	0.0	0.0
	Heavy oil	1,084	20	20	0	0.0	0.0
	Tar	1,394	104	104	0	0.0	0.0
	Bituminous coals	140	0	50	50	−	35.7

In Scenario 7, the tax rate on bituminous coals is KRW 50 per kilogram, which would increase the price of the fuel by 35.7 percent. In order to satisfy the revenue neutrality condition, however, we should make appropriate cuts to the tax rates on transportation fuels. These cuts would help lower the prices of gasoline, diesel, and butane by 6.7 percent, 5.2 percent, and 3.6 percent, respectively.

In Scenario 8, the tax rate on bituminous coals is KRW 97 per kilogram, which would increase the price of the fuel by 69.4 percent. Assuming that the tax rates on the transportation fuels are lowered in the interest of revenue neutrality, the prices of gasoline, diesel, and butane would decrease by 13.0 percent, 10.1 percent, and 6.9 percent, respectively.

〈Table III-15〉 **Changes in Fuel Prices in Scenario 8**

Use / type		Avg. price	Current tax rate	Adjusted tax rate	Tax rate difference	Tax rate variation rate (%)	Price variation rate (%)
		A	B	C	D=C–B	E=(D/B)×100	F=(D/A)×100
Transportation	Gasoline	1,986	746	488	–258	–34.6	–13.0
	Diesel	1,806	529	346	–183	–34.6	–10.1
	LPG (butane)	1,573	316	207	–109	–34.6	–6.9
	CNG	858	60	39	–21	–34.6	–2.4
Non–transportation	LNG	858	60	60	0	0.0	0.0
	LPG propane	1,514	20	20	0	0.0	0.0
	Kerosene	1,394	104	104	0	0.0	0.0
	Heavy oil	1,084	20	20	0	0.0	0.0
	Tar	1,394	104	104	0	0.0	0.0
	Bituminous coals	140	0	97	97	–	69.4

3 Conclusion

The adjustments that could be made to the tax rate on bituminous coals, and the estimates on the revenue likely to result, can be summarized as follows.

In Scenarios 1, 3, and 5, the adjusted tax rate on LNG was fixed at the current level, i.e., KRW 60 per kilogram, while the tax rates on both LNG and bituminous coals were made relative to their net calorific values. As a result, the tax rate on bituminous coals rose to KRW 30 per kilogram. This would increase the overall tax revenue by KRW 2.3907 trillion.

In Scenarios 2, 4, and 7, the adjusted tax rate on LNG was fixed at the current level, i.e., KRW 60 per kilogram, while the tax rates on both LNG and bituminous coals were made relative to the amounts of carbon emissions they generate. As a result, the tax rate on bituminous coals rose to KRW 50 per kilogram. This would increase the overall tax revenue by KRW 3.9817 trillion.

In Scenario 6, the tax rate on the bituminous coal was based on the current tax rate of KRW 104 per kilogram applied to kerosene, and it was made relative to the net calorific value that bituminous coals generate. With a coal tax rate of KRW 74 per kilogram, the overall tax revenue would increase by KRW 5.9246 trillion.

In Scenario 8, the tax rate on bituminous coals was based on the current tax rate of KRW 104 per kilogram applied to kerosene, and it was made relative to the amount of carbon emissions that bituminous coals generate. With a coal tax rate of KRW 97 per kilogram, the overall tax revenue would increase by KRW 7.7411 trillion.

In the eight scenarios, we assumed that only the bituminous coals used for the purpose of generating electricity would be taxed. However, bituminous coals are used for other purposes as well in Korea, such as manufacturing steel and cement. We should therefore also consider scenarios in which bituminous coals are taxed for other uses. As of 2013, 79.69 million tons of bituminous coals were used to generate electricity, but the figure rises to 118.83 million tons if we take into account the amounts of coal used for other purposes. <Table IV-21> summarizes the forecasts on revenue increases likely to result from applying the coal tax rates of Scenarios 1 through 8 to bituminous coals in all uses.

〈Table III-16〉 **Increases in Tax Revenue at Different Coal Tax Rates: Coal Taxes on Generating Electricity and Other Purposes**

(Tax rate unit: KRW/kg, Revenue unit: KRW 1,000,000)

Scenario	Tax rate	Revenue from generating electricity	Revenue from other activities
1	30	2,390,790	3,564,990
2	50	3,981,752	5,937,328
3	30	2,390,790	3,564,990
4	50	3,981,752	5,937,328
5	30	2,390,790	3,564,990
6	74	5,924,640	8,834,436
7	50	3,981,752	5,937,329
8	97	7,741,162	11,543,116

The coal tax rates of KRW 30 per kilogram (Scenarios 1, 3, 5), KRW 50 per kilogram (Scenarios 2, 4, 7), KRW 74 per kilogram (Scenario 6), and KRW 97 per kilogram (Scenario 8), imposed on bituminous coals in all uses, would increase the revenue by KRW 3.5649 trillion, KRW 5.9373 trillion, KRW 8.8344 trillion, and KRW 11.5431 trillion, respectively.

Article 1.7 of the Excise Tax Act (ETA), in the meantime, allows the President of Korea to adjust, with decrees, excise tax rates by 30 percent of the nominal rates. These adjusted tax rates can be introduced when it is necessary for the Korean state to secure additional fiscal resources required for the efficient management of the national economy, by adjusting the business cycle, by stabilizing consumer prices, by balancing demand and supply, and/or by providing subsidies in response to changing oil prices.

In Scenarios 1 through 8, we sought to forecast changes in the fuel prices and revenue by assuming different nominal tax rates. However, introducing too high a tax rate on bituminous coals, which have so far been untaxed when used to generate electricity, would ultimately impose significant burdens on thermal power plants and ordinary consumers of electricity. Therefore, we may need to take into account additional scenarios in which coal tax rates are adjusted so as to be lower than nominal rates.

〈Table III-17〉 **Coal Tax Revenue under Adjusted Tax Rates**

(Tax rate unit: KRW/kg, Revenue unit: KRW 1,000,000)

Scenario	Minimum adjusted tax rate	Revenue from generating electricity	Revenue from other activities
1	21	1,673,553	2,495,493
2	35	2,787,226	4,156,130
3	21	1,673,553	2,495,493
4	35	2,787,226	4,156,130
5	21	1,673,553	2,495,493
6	52	4,147,248	6,184,106
7	35	2,787,226	4,156,130
8	68	5,418,814	8,080,181

We could adjust the same nominal rate in a number of different ways in our scenarios. However, we will conclude by delineating the way in which the minimum adjusted tax rate could be applied by focusing on how adjusted tax rates would affect revenue. The minimum adjusted tax rate refers to the lowest possible excise tax rate that could be applied, given the 30-percent leeway that the ETA provides.

<Table IV-22> summarizes different minimum adjusted tax rates applied to different scenarios, and the differences in revenue they would create. In Scenarios 1, 3, and 5, the minimum adjusted tax rate of KRW 30 per kilogram is KRW 21 per kilogram. Applying this rate to bituminous coals used to generate electricity would increase tax revenue by KRW 1.6735 trillion, and applying it to bituminous coals in all uses would increase revenue by KRW 2.4954 trillion.

In Scenarios 2, 4, 7, the minimum adjusted tax rate of KRW 50 per kilogram is KRW 35 per kilogram. Applying this rate to bituminous coals used in electricity generation only would increase revenue by KRW 2.7872 trillion, and applying it to bituminous coals in all uses would increase revenue by KRW 4.1561 trillion.

The minimum adjusted tax rate of KRW 74 per kilogram in Scenario 6 is KRW 52 per kilogram. Applying this rate to bituminous coals used to generate electricity would increase revenue by KRW 4.1472 trillion, and applying it to bituminous coals in all uses would increase revenue by KRW 6.1841 trillion. The minimum adjusted tax rate of KRW 97 per kilogram in Scenario 8 is KRW 68 per kilogram. Applying this rate to bituminous coals used to generate electricity would increase revenue by KRW 5.4188 trillion, and applying it to bituminous coals in all uses would increase revenue by KRW 8.0801 trillion.

IV

Introducing the Nuclear Tax

1 Nuclear taxes around the world

A. Nuclear energy and taxation around the world

As of August 2014, there were 31 nations around the world operating a combined total of 436 nuclear reactors, with 71 more reactors under construction (International Atomic Energy Agency [IAEA], 2014). Nuclear energy accounts for 12.3 percent of all electricity generated worldwide, and today there are 13 nations that rely on nuclear energy to generate more than a quarter of their electricity.

Countries with the greatest dependency on nuclear energy include the United States, France, Russia, South Korea, China, Canada, and Germany, in that order. The United States and France are unsurpassed leaders by far, generating 790.2 TWh and 405.9 TWh of electricity using nuclear power, respectively.

〈Table IV-1〉 **Nuclear Energy Worldwide**

	Nuclear reactors in operation	Nuclear power plant capacity (MW)	Amount of electricity generated (TWh)	Nuclear share in power generation (%)
U.S.	104	102,657	790.2	19.4
France	58	63,130	405.9	73.3
Russia	33	23,643	161.7	17.5
S. Korea	23	20,721	132.5	27.6
China	20	16,038	104.8	2.1
Canada	19	13,500	94.3	16
Germany	9	12,068	92.1	15.4
Ukraine	15	13,107	78.2	43.6
U.K.	16	9,243	64.1	18.3
Sweden	10	9,474	63.7	42.7
Spain	8	7,567	54.3	19.7
Belgium	7	5,927	40.6	52.1
Taiwan	6	5,032	39.8	19.1
India	21	5,308	30.0	3.5
Czech Rep.	6	3,884	29.0	35.9
Switzerland	5	3,308	25.0	36.4
Finland	4	2,752	22.7	33.3
Slovakia	4	1,815	14.6	51.7
Hungary	4	1,889	14.5	50.7
Japan	50	4,421	13.9	1.7
Brazil	2	1,884	13.8	2.8
S. Africa	2	1,860	13.6	5.7
Bulgaria	2	1,906	13.3	30.7
Mexico	2	1,330	11.4	4.6
Romania	2	1,300	10.7	19.8
Argentina	2	935	5.7	4.4
Slovenia	1	688	5.0	33.6
Pakistan	3	690	4.4	4.4
Iran	1	915	3.9	1.5
Netherland	1	482	2.7	2.8
Armenia	1	375	2.2	29.2
Total	441	377,643	2358.9	NA

Source: IAEA PRIS database, 2014.

However, France leads the list in terms of relying on the highest percentage of nuclear generated electricity for its needs, at 73.3 percent of all electricity generated in the country. Belgium, Slovakia, and Hungary rely on nuclear energy for more than half of the electricity they generate, followed by Ukraine, Sweden, and Switzerland.

The majority of these states, including Belgium, Germany, Hungary, Sweden, Japan, and France, also impose nuclear taxes. The French parliament is still considering whether to increase its nuclear tax rate. Joining these countries, Spain introduced its first nuclear tax in 2012.

B. Belgium

Belgium's history of nuclear power generation dates back to 1974. The country currently has seven nuclear reactors in operation at two nuclear power plants. Belgium produces the 12th largest amount of nuclear generated electricity in the world, but boasts the second highest level of dependency on nuclear power (52.1 percent). In 2003, the Belgian legislature enacted legislation for a phased shutdown of the country's nuclear power plants. The legislation forbids the construction of additional nuclear power plants, and it requires that the seven reactors currently in operation be shut down one by one as each reaches its 40-year lifespan maximum. Accordingly, all seven reactors will be shutdown sometime between 2015 and 2025. However, faced with the argument that nuclear reactors should be kept running until energy alternatives that meet the carbon reduction quota are found, the Belgian legislature extended the deadline on reactor Tihange 1 in 2012 by 10 years. Originally scheduled for shutdown in 2015, it will now be shutdown in 2025.

There are three types of nuclear taxes in Belgium today: the nuclear production tax, levied by the national government; the ionizing radiation fees, which are akin to service charges; and the nuclear exploitation nuisance compensations, levied by local authorities.

〈Table IV-2〉 **Nuclear Reactors in Belgium and Deadlines for Shutdown**

Reactor	Capacity	Built in	To be shut down in	
			40th year of operation	Mandated by law in 2012
Doel 1	433 MWe	1974	2014	2015
Doel 2	433 MWe	1975	2015	2015
Doel 3	1006 MWe	1982	2022	2022
Doel 4	1047 MWe	1985	2025	2025
Tihange 1	962 MWe	1975	2015	2025
Tihange 2	1008 MWe	1982	2022	2023
Tihange 3	1054 MWe	1985	2025	2025
Total (7)	5943 MWe			

Source: World Nuclear Association, 2014.

The Belgian government levies a nuclear production tax on nuclear power generation. The government first decides the total amount of revenue to be levied via this tax, and then it imposes taxes on its nuclear power plants in proportion to statistics on the amounts of electricity they respectively generated the previous year. Each year from 2008 through 2011, the Belgian government imposed a EUR 250 million nuclear production tax. In 2012, with the enactment of a new law, the tax amount increased to EUR 550 million annually. In 2012, EUR 479 million was levied from Electrabel and the remaining EUR 70 million from EDF Luminus and EDF Belgium together(Nucnet, 2014). In 2013, the government announced that the total amount of nuclear production tax would be lowered to EUR 475 million(Eurelectric, 2014).

The Belgian government also charges ionizing radiation fees in an effort to secure the fiscal resources necessary for the administrative, research, and investment services intended to protect the public from the dangers of nuclear power. Each year, nuclear power companies are required to pay EUR 2,048 per MW to the government's nuclear safety organization and an additional EUR 637.2818 per MW to the Belgian Federal Department of Internal Affairs.

Local governments of regions that either host or are adjacent to nuclear power plants also levy nuclear exploitation nuisance compensations. The government of Huy, for instance, which is home to the Tihange Nuclear Power Plant, charges EUR 2.96 million each year. Other local governments charge EUR 851,834.9 each year, while also requiring the power plants to pay an additional EUR 740,000 to their local fire safety authorities.

〈Table IV-3〉 **Nuclear Exploitation Nuisance Compensations in Belgium**

Tax authority	Amount
City Government of Huy (Tihange Nuclear Power Station)	EUR 2.96 million/year; to increase with the expanding capacity of the power station.
Other local governments	EUR 851,834.9/year
Local fire safety authorities	EUR 740,000/year

Source: Eurelectric, 2014.

C. Spain

Spain, whose history of nuclear power generation dates back to as early as 1968, currently has seven nuclear reactors in operation. Spain is the world's 11th largest producer of nuclear energy, which accounts for 19.7 percent of all electricity generated in the country. The socialist government, which remained in power until 2011, strenuously opposed further nuclear development, proposing that the existing reactors be shut down after their 40-year lifespans expire. However, the Spanish legislature amended the law in 2011, repealing the mandatory shutdown after a 40-year period. In 2012, the Spanish business community even requested that the deadline be extended by 20 years. The Spanish government is gradually extending deadlines on the nuclear reactors one by one, reflecting its changing political and social climate.

The Spanish legislature enacted an Energy Sustainability Act toward the end of 2012 in an effort to ease its chronic fiscal deficit. The Spanish government had long exercised strict control over the price of electricity such that power companies were unable to break even for many decades. Feed-in tariffs (FITs), introduced in 1998 to promote the development of new and renewable energy, actually worsened the fiscal crisis. Although FITs accounted for almost half of the total nationwide cost of generating electricity (EUR 200 trillion), governmental control over the price of electricity still made it impossible for Spanish industries to bear the increasing cost of generating new and renewable energy. Meanwhile, the FITs continued to rise to EUR 90 trillion in 2012 and to EUR 93 in 2013 (WNA, 2014). In an attempt to overcome this situation, the Spanish legislature introduced four new environmental taxes under the Energy Sustainability Act, while also expanding the scope of consumption taxes. The first environmental tax was levied on the production value of electricity, requiring all power companies to pay seven percent of their sales in tax. The second tax was imposed on hydropower. The remaining two taxes concerned nuclear energy.

〈Table IV-4〉 **Nuclear Reactors in Spain**

Reactor	Capacity (MWe)	Built in	Launched into operation in	Run (owned) by	Deadline
Almaraz 1	947 (1015)	1981	1981	Iberdrola 53%, Endesa 36%, Union Fenosa 11%; CNAT	6/2020
Almaraz 2	956	1983	1984		6/2020
Asco 1	996	1983	1984	Endesa (100%); ANAV	10/2021
Asco 2	992	1985	1986	Endesa (85%); ANAV	10/2021
Cofrentes	1063	1984	1985	Iberdrola (100%); Iberdrola	3/2021
Trillo 1	1003	1988	1988	Iberdrola (48%); CNAT	11/2014
Vandellos 2	1045	1987	1988	Endesa (78%); ANAV	7/2020
Total (7)	7002MWe				

Source: World Nuclear Association, 2014.

Of the two nuclear taxes, the first is levied on the production of used nuclear fuels and radioactive wastes and is based on the amounts of the fuels and wastes that have been permanently removed from the reactors. The second is levied on the storage of used nuclear fuels and radioactive wastes, and it is based on the amounts of the fuels and radioactive wastes temporarily stored at the nuclear power plants.

〈Table IV-5〉 **Radioactive Waste Taxes in Spain**

Tax	Subject	Rate
Tax on the production of used nuclear fuels and radioactive wastes	Used nuclear fuels and high–level radioactive wastes	EUR 2,190/kg of heavy metals
	Medium– to low–level radioactive wastes	EUR 6,000/m^3
	Low–level radioactive wastes	EUR 1,000/m^3
Tax on the storage of used nuclear fuels and radioactive wastes	Used nuclear fuels	EUR 70/kg of heavy metals
	Other high–level radioactive wastes	EUR 30,000/m^3
	Medium– to low–level radioactive wastes	EUR 10,000/m^3
	Low–level radioactive wastes	EUR 2,000/m^3

Sources: Eurelectric, 2014; Rozas, 2014.

The Spanish government introduced these new taxes *in addition* to the four charges that were already in place. Despite the expectation that the new taxes would lower the levels of existing charges, no such adjustment has taken place (Rozas, 2014).

The local governments in Spain also levy taxes on power plants—including nuclear power plants—that exert significant environmental impact in their respective jurisdictions. Tax rates differ by the type of energy source and also by the type of wastes generated.

D. Sweden

Nuclear power generation began in Sweden in 1972. There are currently 10 nuclear reactors in operation, producing 42.7 percent of all electricity generated in the country. In 1980, the Swedish government announced a plan to reduce its dependency on nuclear energy in phases. The national legislature, however, voted down the plan in June 2010. In 1997, the legislature had already decided to extend the deadlines on mandatory nuclear reactor shutdowns that were originally introduced in 1980.

Nevertheless, the Swedish government levies significant amounts of nuclear taxes, amounting to EUR 0.67 per kWh. Its nuclear taxes today make up almost a third of the entire cost of generating nuclear energy.

The government began charging a nuclear tax of SEK 5514 per MWh in the late 1990s, equivalent to 2.8 to 3.0 ore per kWh or EUR 0.3 to 0.32 per kWh. This high tax rate enabled the government to keep the price appeal of nuclear power in check. The tax rate was almost doubled to SEK 10,200 per MWh or EUR 0.6 per kWh in January 2006, and it was increased further by 24 percent to SEK 12,684 per MWh in 2008, leading to additional revenue of SEK 40 trillion or EUR 435 million. The nuclear tax, originally charged in proportion to the amount of electricity generated prior to 2008, has since been charged in proportion to the capacity of nuclear power facilities(WNA, 2014; Eurelectric, 2014).

E. Germany

The Reichstag introduced a nuclear fuel rod tax as part of the reforms made to its policy on the shutdown of nuclear power plants. In 2010, the German government revised its plan of completely shutting down all 17 nuclear reactors by 2022 to extending the shutdown deadlines by 12 years on average and charging nuclear power companies a new nuclear fuel rod tax. The new nuclear fuel rod tax has been imposed since January 2011—in proportion to the amounts of nuclear fuels stored in nuclear reactors—and will remain in place until January 2016. More specifically, the German government charges EUR 145 (USD 196) per gram of Plutonium 239, 241, and Uranium 233, 235 used in commercial nuclear reactors. The tax is expected to bring in a cumulative total revenue of EUR 13.8 billion, or EUR 2.3 billion a year from 2011 to 2016. However, numerous nuclear power companies in Germany have filed lawsuits against the tax at various courts, with many lawsuits still pending(Korea Institute of Science and Technology Information [KISTI], 2013; Korea Atomic Industrial Forum [KAIF], 2010).

F. Hungary

Nuclear power generation began in Hungary in 1982. There are currently four nuclear reactors in operation, all at Paks Nuclear Power Plant. Hungary relies on nuclear power for 50.7 percent of all electricity in the country, with the Hungarian government actively endorsing and advocating nuclear power. The Hungarian legislature has decided to build two additional nuclear reactors, which will be launched during and after 2023. The Hungarian legislature introduced a nuclear tax in 1998, levied on the disposal and storage of used nuclear fuels and radioactive wastes from nuclear reactors. The tax enables the government to maintain its Central Nuclear Financial Fund, which, in turn, pays the expenses associated with the control and processing of nuclear fuels and radioactive wastes. The Public Limited Company for Radioactive Waste Management (PURAM) exclusively handles the control and processing of radioactive wastes and oversees the fund.

The amount of tax Paks contributes to the fund is determined by the actual demand for the control and processing of nuclear fuels and radioactive wastes. In 2012, Paks Nuclear Power Plant paid MHUF 19,329.4 (EUR 644 million) in total.

G. Japan

Japan levies an electric power development promotion tax on the amounts of electricity generated, while local governments also charge local nuclear power plants nuclear fuel and used nuclear fuel taxes. The nuclear fuel tax was first introduced in the Prefecture of Fukui in 1976, and it had since spread to 13 prefectures and districts as of 2012—known variously as nuclear fuel taxes, nuclear fuel material treatment taxes, etc. There are also two cities that levy used nuclear fuel taxes(Choi *et al.*, 2013). The objective of these taxes is to secure the fiscal resources necessary to ensure the health and safety of local residents living in areas adjacent to nuclear power plants. The average rate of these taxes was around five percent when they were first introduced in the late 1970s, but this has increased steadily since and by 2012 ranged between 8.5 percent and 13 percent of the fuel price.

According to Japan's industry association of electric power companies, the country's nine power companies together paid JPY 24.2 billion in nuclear fuel taxes in 2010. However, the nuclear crisis at Fukushima drastically reduced the amount to JPY 5.9 billion in 2011 and JPY 6.7 billion in 2012.

〈Table IV-6〉 **Nuclear Taxes in Japan (as of April 2012)**

<table>
<tr><th>Subject</th><th>Authority</th><th>Introduced in (rate)</th><th>Current tax rate</th><th>Remark</th></tr>
<tr><td rowspan="11">Nuclear fuel taxes</td><td>Fukui</td><td>1976 (5%)</td><td>① 8.5% of fuel price
② JPY 45,750/1,000 kW (3 mo.)</td><td>Since 2011, charged on installation and operation of nuclear reactors.</td></tr>
<tr><td>Fukushima</td><td>1977 (5%)</td><td>10% of final discounted price; JPY 8,000/kg, volume-based</td><td></td></tr>
<tr><td>Ehime</td><td>1979 (5%)</td><td>13% of fuel price</td><td></td></tr>
<tr><td>Saga</td><td>1979 (5%)</td><td>13% of fuel price</td><td></td></tr>
<tr><td>Shimane</td><td>1980 (5%)</td><td>13% of fuel price</td><td></td></tr>
<tr><td>Shizuoka</td><td>1980 (5%)</td><td>13% of fuel price</td><td></td></tr>
<tr><td>Kagoshima</td><td>1973 (7%)</td><td>12% of fuel price</td><td></td></tr>
<tr><td>Miyagi</td><td>1983 (7%)</td><td>12% of fuel price</td><td></td></tr>
<tr><td>Niigata</td><td>1984 (7%)</td><td>14.5% of fuel price</td><td></td></tr>
<tr><td>Hokkaido</td><td>1988 (7%)</td><td>12% of fuel price</td><td></td></tr>
<tr><td>Ishigawa</td><td>1992 (7%)</td><td>12% of fuel price</td><td></td></tr>
<tr><td rowspan="13">Nuclear fuel material treatment taxes</td><td rowspan="6">Ibaragi</td><td rowspan="6">1978 (5%)</td><td>① 13% of fuel price</td><td rowspan="6">Conversion of nuclear fuel taxes into nuclear fuel material treatment taxes in 1999 increased objects of taxation from four to six.</td></tr>
<tr><td>② JPY 46,000/kg</td></tr>
<tr><td>③ JPY 1,219,000 /m3</td></tr>
<tr><td>④ JPY 1,219,000/本</td></tr>
<tr><td>⑤ JPY 81,100/m3</td></tr>
<tr><td>⑥ JPY 3,900/m3</td></tr>
<tr><td rowspan="7">Aomori</td><td rowspan="7">2004 (10%) (Currently 12%)</td><td>① JPY 19,100/kg</td><td rowspan="7">Objects of taxation have increased from four to seven.</td></tr>
<tr><td>② JPY 9,000/ 1,000 kW (3 mo.)</td></tr>
<tr><td>③ 13% of fuel price</td></tr>
<tr><td>④ JPY 19,400/kg</td></tr>
<tr><td>⑤ JPY 1,300/kg (8,300/kg)</td></tr>
<tr><td>⑥ JPY 27,500/m3</td></tr>
<tr><td>⑦ JPY 845,400/本</td></tr>
</table>

Sources: 日本總務省, 「地方税の概要」, http://mext-atm.jst.go.jp/atomica, quoted in Choi and Lee(2013), p. 64.

H. France

Relying on nuclear power for 73.3 percent of all electricity generated in the country, France is the leader of nuclear energy development worldwide (IAEA, 2014). The French government imposes two nuclear taxes. One is the nuclear installation tax, which is levied during the period between the announcement of the plan for the construction of a nuclear power plant and the completion of the plant's installation. The other tax is on installed electric power and is levied on completed power plants on January 1 of each year. In 2006, three more taxes were incorporated into the nuclear installation tax, i.e., research, accompaniment, and technological broadcasting taxes. In 2011, another tax was added to the list to boost the fiscal resources necessary to support the Institute for Radiation and Nuclear Safety (IRNS).

〈Table IV-7〉 **Nuclear Taxes in France**

Tax		Subject and additional taxes	Tax rate
Nuclear installation tax		Levied during the period between the announcement of the plan for the construction of a nuclear power plant and the completion of the announced construction.	EUR 3.583M × coefficient (1~4) * Different coefficients apply to different types and capacity sizes of plants.
	Research, accompaniment, and technological broadcasting taxes		EUR 0.28M × number of nuclear power plants × coefficient (7.87 in 2012)
	IRNS support tax		EUR 380k/ number of nuclear power plants × coefficient (1.65 in 2012)
Tax on installed electric power		Nuclear/thermal plants, 50MW+	EUR 2.913/kW
		New/renewable energy plants, 100kW+	EUR 7/kW
		Hydro plants, 100kW+	EUR 2.913/kW
		On-land wind plants	EUR 14.113 /kW

Source: Eurelectric, 2014

The tax on installed electric power is levied on each and every type of power plant, but at rates that differ from plant type to plant type. The rate applying to nuclear power plants is EUR 2.913 per kW for every plant with a total facility capacity of 50MW or greater. It was only in 2010 that France began to levy these taxes.

The promise to limit France's dependency on nuclear energy was one of the key issues of the last presidential election. In December 2013, President Hollande's government upheld its pledge to reduce France's nuclear energy dependency rate to 50 percent by 2025 though replacing nuclear power with new/renewable energy and energy-saving measures. The government will need huge increases in revenue and fiscal resources to carry out this plan and improve energy efficiency throughout French society. Its solution is to acquire much of the funding from taxing nuclear power plant sales and carbon emissions. The French government may even introduce yet another tax on nuclear power plants in the future.

2 Scenarios on introducing nuclear taxes

A. Taxing nuclear fuels (uranium)

There are two main ways to tax nuclear energy. The first is to tax the fuel, uranium, used to generate energy, and the second is to tax the amounts of energy generated by nuclear power.

A tax on uranium can be charged in one of two ways, either by weight or as a proportion of the price of the fuel. Both the quantity and price of uranium imported into Korea for electricity generation purposes were steadily increasing from year to year until 2012. The overall quantity of imports dropped in 2012, consequently lowering the import total to USD 695 million.

〈Table IV-8〉 **Imported Quantity of Uranium for Electricity Generation Purposes**

(Units: ton–U (import quantity); USD 1,000,000 (import value);
USD 1,000,000/ton U (average unit import price)

Year	Import quantity (A)	Import value (B)	Average unit import price (C) = (A)/(B)
2005	714	286	0.40
2006	737	339	0.46
2007	823	489	0.59
2008	883	729	0.83
2009	913	722	0.79
2010	824	615	0.75
2011	907	807	0.89
2012	748	695	0.93

Source: *Annals on Energy Statistics*, 2013.

In this report, we first consider taxing uranium in proportion to its unit price, applying the hypothetical rates of 20, 40, 60, 80, and 100 percent of the uranium import price. For instance, the 20 percent tax rate on the average import unit price of uranium, which was KRW 954,231 per kilogram in 2012, is set at KRW 190,946 per kilogram. At 40, 60, 80, and 100 percent, the rates would rise to KRW 381,693, KRW 572,390, KRW 763,385, and KRW 954,231 per kilogram, respectively. The 20 percent tax rate would increase revenue by KRW 142.8 billion, while the 40, 60, 80, and 100 rates would increase revenue by KRW 285.5 billion, KRW 428.3 billion, KRW 571 billion, and KRW 713.8 billion, respectively.

However, the import price of uranium accounts for only 10.2 percent or so of the total cost of generating nuclear energy.[10] Therefore, in order to induce a substantial difference in the price of nuclear electricity, Korea would need to impose higher tax rates. This resembles the solution adopted by the German government, for instance, which charges EUR 145 per gram of uranium in taxes alone.

10) Koh and Jeong, 2012.

〈Table Ⅳ-9〉 **Direct Uranium Taxation Scenarios (Based on Statistics of 2012)**

(Units: ton [import quantity], KRW 1,000,000 [import value and revenue], KRW 1/kg [unit price and tax rate])

Import quantity (A)	Import value (B)	Average unit import price (C) = (A)/(B)	Tax rate (D)	Revenue (E) = (D)*(A)
748	713,765	954,231	(20% of unit import price) 190,846	142,753
			(40% of unit import price 381,693	285,506
			(60% of unit import price 572,539	428,259
			(80% of unit import price 763,385	571,012
			(100% of unit import price 954,231	713,765

Note: The total import price of USD 695 million from 2012 was converted into KRW using the exchange rate of KRW 1,027 to USD 1 on July 25, 2014.

Source: *Annals on Energy Statistics*, 2013.

B. Taxing electricity generated by nuclear energy

The second way to tax nuclear energy is to tax the amounts of electricity it generates. An overview of the amounts of electricity generated by nuclear plants, their share in the overall output of electricity, and the unit transaction price from 2005 to 2012 reveals that nuclear energy occupies an increasingly small share of electricity generated in Korea, declining from 40.3 percent in 2005 to 29.5 percent in 2012. Only slight increases were observed in the overall amount of electricity generated and traded by nuclear plants during the same period, with the unit transaction price rising marginally from KRW 39.41 per kWh to KRW 39.61 per kWh. However, if we take into account the inflation rate during this period, the real unit transaction price had in fact decreased.

In order to decide the rate to apply in taxing electricity generated by nuclear energy, we will use the calorific value (tax rate / oil conversion coefficient) we used in determining the tax rates for bituminous coals earlier. The oil conversion coefficient is 0.211. Applying this coefficient to the existing tax rates on other fuels, such as LNG, kerosene, and heavy oil, yields the rates of KRW 11, KRW 23, and KRW 4 per kWh, respectively.

〈Table IV-10〉 **Amounts of Electricity Generated and Traded by Nuclear Plants, and Price and Unit Transaction Price of Nuclear Energy**

(Units: GWh [amounts of electricity generated and traded]; % [ratio]; KRW 1,000,000 [price]; KRW 1/kWh [unit transaction price])

Year	Total electricity generated (A)	Nuclear energy generated (B)	Nuclear share (C = B/A)	Nuclear energy traded (D)	Nuclear energy price (E)	Unit transaction price (F = E/D)
2005	364,639	146,779	40.3	140,367	5,532,000	39.41
2006	381,181	148,749	39.0	142,115	5,456,000	38.39
2007	403,125	142,937	35.5	137,040	5,400,000	39.40
2008	422,355	150,958	35.7	144,255	5,642,000	39.11
2009	433,604	147,771	34.1	141,123	5,030,000	35.64
2010	474,660	148,596	31.3	141,894	5,633,000	39.70
2011	496,893	154,723	31.1	147,763	5,793,000	39.20
2012	509,574	150,327	29.5	143,548	5,686,000	39.61

Source: *Annals on Energy Statistics*, 2012.

We will appropriate the converted tax rate on LNG, i.e., KRW 11 per kWh, as the reference tax rate for nuclear energy in our scenarios. Assuming that the rate can be adjusted by up to 30 percent, we will also take into account both the minimum and maximum adjusted tax rates of KRW 8 and KRW 14, per kWh.

〈Table IV-11〉 **Nuclear Tax Rates Based on the Calorific Value**

Calorific value references	Current tax rate (A)	Oil conversion coefficient (B)	C = A/B	Oil conversion coefficient applying to electricity (D)	Electricity tax (KRW/kWh) (E = C*D)
LNG	60	1.178	51	0.211	11
Kerosene	90	0.820	110	0.211	23
Heavy oil	17	0.936	18	0.211	4

Sources: Energy laws; KEMCO Web site; tax laws.

In order to forecast the amounts of revenue attendant upon the different tax rates (based on the calorific value of LNG), we multiplied the amount of electricity generated by nuclear power plants in 2012 by the given tax rates. See Table V-12 for the revenue forecasts. At the reference rate of KRW 11 per kWh, the revenue would amount to KRW 1.6536 trillion. At the minimum adjusted tax rate of KRW 8 per kWh, the revenue would come to KRW 1.2026 trillion; at the maximum adjusted tax rate of KRW 14 per kWh, the revenue would come to KRW 2.1046 trillion.

Numerous researchers are voicing the opinion that nuclear taxes ought to be incorporated in energy tax system reforms(Market Economic Research Institute [MERI], 2013; Park, 2013). The bill on the climate justice tax[11] proposes a nuclear tax rate between KRW 2.5 per kWh and KRW 7.5 per kWh. MERI(2013) suggests KRW 16.55 per kWh. Applying these rates would yield revenue forecasts ranging from KRW 375.8 billion to KRW 2.4879 trillion.

〈Table IV-12〉 **Nuclear Tax Revenue Forecasts (Based on Electricity Generated in 2012)**

(Units: KRW 1/kWh [tax rate]; GWh [electricity generated]; KRW 1,000,000 [revenue])

		Tax rate (A)	Electricity generated (B)	Revenue (C = A*B)
Reference tax rate (based on LNG calorific value)	Reference	11	150,327	1,653,597
	Min. adjusted	8		1,202,616
	Max. adjusted	14		2,104,578
Climate justice tax (2013)	10% target	2.5		375,818
	20% target	5		751,635
	30% target	7.5		1,127,453
MERI (2013)		16.55		2,487,912

Sources: Electric Power Statistics of KEPCO, 2013; MERI, 2013; Park, 2013.

11) National Assemblyman Park Won-seok's Office, 2013

3 Conclusion

We have explored what the two ways of taxing nuclear energy entails in terms of tax rates and revenue forecasts. A direct tax on nuclear fuel has the benefit of meeting the principle of equity of taxation, as it is compatible with taxes imposed on other types of fuels used in electricity generation. However, to induce a substantial difference in the price of nuclear energy, we would have to impose very high a tax rate on nuclear fuel. Also, given the nature of nuclear energy, the quantity of fuel imported does not always correspond to the quantity of fuel actually used to generate electricity in a given time period. On the other hand, the other way of taxing the electricity generated by nuclear energy is, technically speaking, an indirect approach to taxing. However, because such a tax will be attached to the actual amount of electricity generated, it can directly affect the price of nuclear energy.

Applying either tax rate will lead to an increase in the unit transaction price of nuclear energy on the electricity market. This, however, is based on the assumption that the nuclear taxes will be directly and without loss translated into increases in the nuclear energy price.

〈Table IV-13〉 **Changes in the Unit Transaction Price of Nuclear Energy Due to Nuclear Taxes (Based on Electricity Generated in 2012)**

	Tax rate	Unit transaction price (A) (KRW 1/kWh)	Margin of increase (B) (KRW 1/kWh)	Rate of increase (B/A)
Nuclear fuel taxes	(20% of unit import price) KRW 190,846/kg	39.61	0.95	2.4%
	(40% of unit import price) KRW 381,693/kg		1.90	4.8%
	(60% of unit import price) KRW 572,539/kg		2.85	7.2%
	(80% of unit import price) KRW 763,385/kg		3.80	9.6%
	(100% of unit import price) KRW 954,231/kg		4.75	12.0%
Nuclear electricity taxes	(Min. adjusted) KRW 8/kWh		8.00	20.2%
	(Reference) KRW 11/kWh		11.00	27.8%
	(Max. adjusted) KRW 14/kWh		14.00	35.3%

source:

Pegging the nuclear tax rate to 20, 40, 60, 80, and 100 percent of the uranium import price would increase the unit transaction price of nuclear energy by 2.4, 4.8, 7.2, 9.6, and 12.0 percent, respectively, from the current KRW 39.61 per kWh. If we convert the tax rates on the basis of the calorific value of LNG, and apply the reference rate of KRW 11 per kWh, as well as the minimum and maximum adjusted rates of KRW 8 and KRW 14 per kWh, the unit transaction price would also increase by 20.2, 27.8, and 35.3 percent, respectively.

V

Comprehensive Analysis and Implications

1 Composite energy tax scenarios

In this section, we shall consider scenarios that mix both coal and nuclear taxes and analyze the differences in tax rates, electricity prices, and revenue amounts when we convert the individual fuel taxes into electricity consumption taxes. <Table V-1> summarizes the key features of each scenario. In Scenario A, taxes are introduced on bituminous coals and uranium at KRW 30 per kilogram and KRW 954 per gram, respectively. In Scenario B, the same rate of tax still applies to bituminous coals, but the tax rate on nuclear energy is adjusted to KRW 11 per kWh of electricity generated. In Scenarios C and D, electricity consumption taxes replace fuel taxes, and we also try to determine the revenue-neutral electricity consumption tax rates into which the coal and uranium taxes can be converted. The resulting consumption tax rates are what could be imposed on the amounts of electricity consumed. The increase in revenue from the taxes on bituminous coals and uranium in Scenario A were divided by the amount of electricity consumed in order to determine the increase in the unit price of electricity. We then used that to determine the proper electricity consumption tax rate. Assuming fixed revenues in all scenarios, we calculated the revenue-neutral electricity consumption tax rates in Scenarios C and D, and the results were KRW 6.62 per kWh and KRW 8.63 per kWh, respectively.

〈Table V-1〉 **Energy Tax System Scenarios**

	Features	Subjects			Taxing method
		Bituminous coals	Nuclear energy	Electricity	
Scenario A	KRW 30/kg for bituminous coals, KRW 996/g for uranium	KRW 30/kg	KRW 954/g		Taxes on amount of bituminous coals consumed and amount of uranium imported.
Scenario B	KRW 30/kg for bituminous coals, KRW 11/kWh for nuclear energy	KRW 30/kg	KRW 11/kWh		Taxes on amount of bituminous coals consumed and amount of nuclear energy generated.
Scenario C	Revenue–neutral electricity consumption tax of Scenario A	N/A	N/A	KRW 6.62 / kWh	Tax on amount of electricity consumed.
Scenario D	Revenue–neutral electricity consumption tax of Scenario A	N/A	N/A	KRW 8.63 / kWh	Tax on amount of electricity consumed.

In order to understand how the different energy tax rates will affect the price of electricity, we need an understanding of the steps and activities involved in generating and distributing electricity. Power companies import the fuels they need from abroad and introduce them into the production phase at their power plants. Electricity generated in power plants is then traded and distributed via the Korea Power Exchange (KPX), after which purchased electricity is transmitted to consumers. Therefore, fuel taxes would amount to additional costs borne at the time of importing and consuming fuels. Electricity generation taxes, in turn, would increase the cost of generating electricity. Electricity consumption taxes and others that are levied at the time of sale are added to the unit price of electricity sold.

2 Production and distribution of electricity, and price impact

In the following scenarios, we proceed with our analysis on the basis of the assumptions that the increases in taxes would be entirely translated into increases in cost, and that the increases in the cost of electricity generation, in turn, would be entirely translated into increases in the price of electricity. In other words, we assume that the rate of variation in the unit transaction price of electricity will be entirely translated into the purchase price of electricity. In order to ensure a consistency of analysis results across these scenarios, we base our analysis on statistics from 2012.

[Figure V-1] Production, Distribution, and Sale of Electricity

Fuel imported → Electricity generated → Electricity traded → Electricity transmitted → Electricity sold

Electricity transactions can be divided between those taking place on the electricity market or exchange and others taking place pursuant to power purchase agreements (PPAs). Electricity generated in large quantities by nuclear energy, bituminous coals, anthracites, oil, natural gas, combined cycle, hydro, and others are usually traded on the electricity exchange. Combined-cycle thermal, district, bio, and solar energies, on the other hand, are traded according to PPAs. In 2013, 479,287 gigawatts of electricity was traded on the exchange and only 16,892 gigawatts pursuant to PPAs. The exchange accounts for 96.6 percent of all electricity transactions. The unit transaction prices of electricity are KRW 88.23 per kWh on the exchange and KRW 187.1 per kWh under PPAs on average.

The process of determining the impact of the variation in the unit purchase price of electricity on its sale price is a bit more complex. The price of electricity in Korea today is fixed at a level that is required only to compensate for the total amount power plants have spent in generating electricity. However, power plants cannot freely change their prices without first consulting the government, and the current electricity price structure is so rigid that it barely permits any variations sufficient to satisfy the rising total cost.

〈Table V-2〉 **Electricity Purchases and Sales (2008-2013)**

	Electricity purchases						Electricity sales	
	On electricity exchange		Under PPAs		Total			
	Purchased amount (MWh)	Unit price (KRW/kWh)	Purchased amount (MWh)	Unit price (KRW/kWh)	Purchased amount (MWh)	Unit price (KRW/kWh)	Sold amount (MWh)	Unit price (KRW/kWh)
2008	392,430,651	68.50	12,389,202	179.86	404,819,853	71.91	385,070,137	78.76
2009	405,689,921	66.47	9,476,411	159.10	415,166,332	68.58	394,474,637	83.59
2010	440,863,017	73.29	14,228,337	154.27	455,091,354	75.82	434,160,228	86.12
2011	462,356,727	79.69	14,638,439	172.78	476,995,166	82.54	455,070,261	89.32
2012	471,799,913	90.32	17,400,164	186.70	489,200,078	93.75	466,592,949	99.10
2013	479,286,615	88.23	16,892,263	187.10	496,178,878	91.60	474,848,580	106.33

Source: KEPCO, *Korean Electricity Statistics*, 2014, p.112.

The Korean government determines the total cost of electricity generation—in order to determine the price of electricity—according to detailed rules and criteria laid down in the Government Announcement on the Detailed Criteria for Determining the Optimal Cost and Profit Rates of Electricity Generation, the Price of Electricity, the Tolerance for Watt-Hour Meters, and the Operating Tasks of Electricity-Generating Systems(Ministry of Trade, Industry and Energy [MOTIE] Announcement No. 2014-82, May 21, 2014), which is based on Article 7.2 of the Enforcement Ordinance for the Electricity Utility Act.

According to the MOTIE Announcement, the total cost of electricity generation consists of the optimal cost and the optimal return rate on investment. The optimal cost, in turn, consists of the operating cost, the corporate tax, and the non-operating income and losses. The operating cost comprises the sales cost, the selling expenses, and the maintenance cost. The cost of purchasing electricity forms part of the sales cost. Therefore, assuming that the taxes on bituminous coals and nuclear energy are entirely translated into increases in the cost, the cost of purchasing electricity would rise and lead to an increase in the sales cost and, by implication, the total cost.

〈Table V-3〉 **Formula for Determining the Total Cost of Electricity Generation**

- Total cost = optimal cost + optimal return on investment
- Optimal cost = operating cost + corporate tax + non-operating income and loss
- Operating cost = sales cost + selling expenses + maintenance cost
- Optimal return on investment = basic price x optimal return on investment rate

3 Scenario analysis

In order to determine how the increase in energy taxes would affect the price of electricity, we need first to determine the cost increases that would result from introducing these taxes. The increase in cost (C) was calculated by multiplying the amount of fuel consumed/imported or the amount of electricity generated using fuel (B) by the given tax rate (A). Assuming that the increase in the cost would be translated entirely into the unit price of electricity traded on the market, we divided the increase in the cost (C) by the amount of electricity traded on the market (D) and obtained the increase in the unit transaction price of electricity (E). If we then add the increase in the unit transaction price (E) to the existing unit transaction price of electricity on the market (F), we arrive at the new unit transaction price (G). Alternatively, we can divide (E) by (F) to arrive at the rate of variation in the unit transaction price of electricity on the market.

In Scenario A, where the tax rates of KRW 30 per kilogram and KRW 954 per gram are applied to the amounts of bituminous coals and uranium consumed/imported, the cost would increase by KRW 2.3741 and KRW 713.7 billion, respectively. These increases, in turn, would raise the unit transaction prices of electricity by KRW 12.86 per kWh and KRW 4.75 per kWh to KRW 79.20 per kWh and KRW 44.36 per kWh of electricity generated by bituminous coals and uranium, respectively. In Scenario A, the rates of variation in the unit transaction prices of electricity generated by the two fuels, respectively, are 19.4 percent and 12.0 percent.

〈Table V-4〉 **Variations in the Unit Transaction Price of Electricity in Different Tax Rate Scenarios**

Scenario	Tax rate		Amount of fuel consumed or imported or amount of electricity generated	Additional cost (KRW 1,000,000)	Electricity traded (GWh)	Increase in unit price (KRW/kWh)	Market unit price (KRW/kWh)	Difference in unit prices (KRW/kWh)	Unit price variation rate
	Fuel	A	B	C=A*B	D	E=C/D	F	G=E+F	H=E/F
A	Bituminous coals (KRW/kg)	30	79,136 (per 1,000t)	2,374,080	184,604	12.86	66.34	79.20	19.4%
	Uranium (KRW/g)	954	695 (USD 1,000,000)	713,765	143,548	4.75	39.61	44.36	12.0%
B	Bituminous coals (KRW/kg)	30	79,136 (per 1,000t)	2,374,080	184,604	12.86	66.34	79.20	19.4%
	Nuclear energy (KRW/kWh)	11	50,9574 (GWh)	1,653,597	143,548	11.00	39.61	50.61	27.8%
C	Electricity (KRW/kWh)	6.62							
D	Electricity (KRW/kWh)	8.63							

Note: All the estimates are based on statistics from 2012.
Source: Korea Electricity Statistics, 2014; *Annals of Energy Statistics*, 2013.

In Scenario B, applying tax rates of KRW 30 per kilogram to bituminous coals consumed and KRW 11 per kWh of nuclear energy generated increases costs by KRW 2.3741 trillion and KRW 1.6536 trillion, respectively. This, in turn, entails increases in the unit transaction prices of coal- and nuclear-generated electricity of KRW 12.86 per kWh and KRW 11 per kWh, up from the current prices of KRW 79.20 per kWh and KRW 50.61 per kWh. The rates of variation amount to 19.4 percent and 27.8 percent with respect to electricity generated by bituminous coals and nuclear energy. In comparing Scenarios A and B, we discover that while there is no change in the cost of generating electricity using bituminous coals, the cost of generating electricity using nuclear energy almost doubles in Scenario B.

In Scenarios C and D, the taxes are applied to the final stage, i.e., sales of electricity production and distribution. These taxes therefore would not affect the costs of generating electricity.

Furthermore, we assume that the increases in costs in Scenarios A and B would be entirely translated into increases in the purchase prices of electricity generated by the two fuels. We also assume that the increases in the purchase prices of electricity would be reflected entirely in the total cost. Assuming that electricity providers will want to break even rather than make more profits, we posit that the amount of the total cost would equal the amount of sales revenue. In such a scenario, we can estimate the variation in the price of electricity by dividing the increase in the total cost by the total quantity of electricity sold. In Scenarios C and D, taxes are applied at the point of consumption, i.e., after the sale price of electricity is determined.

In Scenarios A and B, the taxes on bituminous coals and uranium/nuclear energy are reflected in the unit transaction price of electricity from each fuel. Any increases in the unit prices of electricity from bituminous coals and nuclear energy (C) would lead to commensurate increases in the purchase prices of electricity (D). The increases in the purchase prices of electricity on the market (E), in turn, would commensurately affect the final unit price of electricity (J).

When we apply the tax rates of Scenario A, the unit transaction prices of electricity from bituminous coals and nuclear energy rise by KRW 12.86 per kWh and KRW 4.75 per kWh, respectively, bringing the average unit transaction price of electricity on the market up by KRW 6.48 per kWh and the average purchase price of electricity up by KRW 6.25 per kWh. When we apply the tax rates of Scenario B, the unit transaction prices of electricity from bituminous coals and nuclear energy increase by KRW 12.86 per kWh and KRW 11 per kWh, and these in turn raise the average unit transaction price of electricity by KRW 8.38 per kWh and the average purchase price by KRW 8.08 per kWh.

In Scenarios C and D, the taxes are applied to the final stage, i.e., sales of electricity production and distribution. These taxes therefore would not affect the costs of generating electricity.

〈Table V-5〉 **Variations in the Purchase Price of Electricity in Different Tax Rate Scenarios**

(Unit: KRW/kWh)

Scenario		Tax rate	Unit transaction price on market	Additional unit transaction price	Variation in unit transaction price	Variation in purchase price	Purch-ase price	Variation rate in purchase price	Final purchase price
		A	B	C	D=C*ratio of electricity from each fuel traded	E=D*ratio of electricity from each fuel purchased	F	I=E/F	J=E+F
A	Bituminous coals (KRW/kg)	30	66.34	12.86	6.48	6.25	93.75	6.70%	100
	Uranium (KRW/g)	954	39.61	4.75					
B	Bituminous coals (KRW/kg)	30	66.34	12.86	8.38	8.08	93.75	8.60%	101.83
	Nuclear energy (KRW/kWh)	11	39.61	11					
C	Electricity (KRW/kWh)	6.62							
D	Electricity (KRW/kWh)	8.63							

Note: All the estimates are based on statistics from 2012.
Source: Korea Electricity Statistics, 2014; *Annals of Energy Statistics*, 2013.

In order to determine how the different energy tax rates would affect the price of electricity, we also calculate the additional costs resulting from the new taxes in each scenario (B, C). Assuming that the additional costs would be translated entirely into the total cost, we divided the additions to the total cost in each scenario by the amount of electricity sold (D) to arrive at the variation in the sale price of electricity (F). We then used the variation to determine the final and new sale price of electricity (G). As the additions to the cost in each scenario represent increases in the tax revenue, we also add them up to determine the revenue in each scenario.

When we apply the tax rates of Scenario A, the price of electricity increases by KRW 6.62 per kWh, which is 6.7 percent above the current price. The revenue from bituminous coals and uranium also increase by KRW 2.3741 trillion and KRW 713.8 billion, respectively, or by KRW 3.0878 trillion in total. The tax rates of Scenario B, on the other hand, raise the price of electricity by KRW 8.63 per kWh, or by 8.7 percent from the current price. Revenue also increases by KRW 2.3741 trillion and KRW 1.6536 trillion from bituminous coals and nuclear energy, or by KRW 4.0277 trillion in total.

〈Table V-6〉 **Variations in the Sale Price of Electricity in Different Tax Rate Scenarios**

Scenario		Tax rate	Additional cost (fuel / generation)	Additional cost (sales)	Amount of electricity sold	Unit sale price	Variation in unit sale price	Final unit sale price	Revenue
		A	B	C	D	E	F	G=E+F	
A	Bituminous coals (KRW/kg)	30	2,374,080		466,593	99.1	6.62 (6.7%)	105.72	3,087,845
	Uranium (KRW/g)	954	713,765						
B	Bituminous coals (KRW/kg)	30	2,374,080				8.63 (8.7%)	107.73	4,027,677
	Nuclear energy (KRW/kWh)	11	1,653,597						
C	Electricity (KRW/kWh)	6.62		3,087,845			6.62 (6.7%)	105.72	3,087,845
D	Electricity (KRW/kWh)	8.63		4,027,677			8.63 (8.7%)	107.73	4,027,677

Notes: 1. All the estimates are based on statistics from 2012.
2. Units for tax rate, unit sale price of electricity, and final unit sale price of electricity: KRW/kWh.
3. Units for additional cost (fuel/generation), additional cost (sales), and revenue: KRW 1,000,000/
Source: Korea Electricity Statistics, 2014; *Annals of Energy Statistics*, 2013.

Because the tax rates in Scenarios C and D are meant to be revenue-neutral, the revenue estimates in these scenarios are identical to those in Scenarios A and B, as are the rates of variation in the price of electricity (i.e., 6.7 percent and 8.7 percent). However, when the taxes are imposed—at generation or sales—there is a big difference in the level of certainty regarding variation in the price of electricity. In Scenarios C and D, taxes are imposed in the final stage, after the sale price of electricity is determined. Accordingly, the amounts of taxes imposed are translated entirely into increases in the price of electricity. On the other hand, in Scenarios A and B, it is uncertainty how the tax rates imposed will ultimately change the final price of electricity. Under the current system where the transaction prices of electricity are determined according to system-constrained prices on the electricity market, even sizable additions to the costs of generating electricity using bituminous coals and nuclear energy would not make a noticeable difference to the prices of electricity from these fuels, as the fuels are already traded at the lowest possible prices. In the public utilities economy in Korea, producers rarely break even, particularly because of the Korean government's long-standing policy of keeping utility fees and prices as low as possible. Moreover, there are very diverse prices for electricity, including those involving progressive fees and complex fee discount schedules. As a result, different consumers actually pay quite different rates for electricity, which is why additional costs in the form of new taxes would not affect all consumers equally. In other words, taxes on fuels or the amounts of electricity generated from those fuels are hardly capable of serving as price signals that can adjust consumers' demand for electricity.

In contrast, taxing the consumption of electricity directly, as postulated in Scenarios C and D, would directly affect the prices that consumers pay for electricity. Electricity consumption taxes therefore make it possible to more accurately forecast increases in the prices of electricity.

4 Inflation effect

Here we shall examine how the introduction of new coal and nuclear taxes would affect consumer prices in general, using the Input-Output Tables provided by the Bank of Korea. The Input-Output Tables divide the national economy into multiple industrial sectors, detailing the flows of input, output, goods, and services in and among each sector (Bank of Korea, 2009). These tables provide useful information for analyzing how a change in the price of a certain good or service affects the entire national economy. Assuming that the prices of electricity from hydro, thermal, nuclear and other types of power plants will rise by a certain margin (e.g., five percent) on average due to the introduction of new energy taxes, we sought to analyze how these price increases would affect the Consumer Price Index (CPI). In doing so, however, we needed to match the codes on the Input-Output Tables with those of the CPI by applying the weight of each category of goods to the categories of goods used in the Input-Output Tables and the CPI. For more accurate code matching, we used the most detailed Input-Output Tables showing 403 sectors.[12] Here, we apply the following price variation rate formula:[13]

$$\dot{P}^d = (I - A^{d'})^{-1}(A^{m'}\dot{P}^m + A_s^{d'}\dot{P}_s^d + A_s^{m'}\dot{P}_s^m + \dot{V})$$

The main variables are defined as follows:

- $\dot{P}^d$: matrix of the variation rate (%) in the prices of domestic goods
- A^d: matrix of the input coefficient of domestic goods
- P^d: matrix of the prices of domestic goods
- A^m: matrix of the input coefficient of imported goods
- P^m: matrix of the prices of imported goods
- A_s^d: matrix of the input coefficient of domestic goods whose prices have changed
- P_s^d: matrix of the changed prices of domestic goods
- A_s^m: matrix of the input coefficient of imported goods whose prices have changed
- P_s^m: matrix of the changed prices of imported goods
- $\dot{V}$: value-added variation rate (%)

12) The Input–Output Tables used for this study are from 2009.

13) For a more detailed explanation of the formula, see Bank of Korea, 2009, pp. 137–148.

In order to assess how an increase in the price of electricity would affect consumer prices, we assume no changes in the prices of imported goods and in values-added and employ the following formula:

$$\dot{P}^d = (I - A^{d'})^{-1}(A_s^{d'} \dot{P}_s^d)$$

We then postulate the following four hypotheses and seek to determine how each hypothesis would affect consumer prices:14)

- The price of electricity has increased by five percent due to the rise in the energy cost.
- The price of electricity has increased by eight percent due to the rise in the energy cost.
- The price of electricity has increased by 12 percent due to the rise in the energy cost.
- The price of electricity has increased by 15 percent due to the rise in the energy cost.

〈Table V-7〉 **CPI Inflation Effects**

Hypotheses		CPI increase rate (%)
1	5% increase in price of electricity	0.112
2	8% increase in price of electricity	0.180
3	12% increase in price of electricity	0.269
4	15% increase in price of electricity	0.337

We then estimate the inflation effect by estimating the rate of variation in the prices of goods resulting from the increase in the price of electricity and then by multiplying that estimate by the weight of the CPI. The inflation effect under each of the four foregoing hypotheses is indicated in Table VI-6. Increases

14) The following analysis assumes that all these rates of increase in the costs of energy generation at hydro, thermal, nuclear, and other types of plants are translated entirely into the prices of electricity.

in the price of electricity by five, eight, 12, and 15 percent would respectively raise the CPI by 0.112, 0.180, 0.269, and 0.337 percent, respectively.

Recall that our analysis of Scenarios A through D led to the conclusion that the price of electricity, according to the tax rates applied, would increase by 6.7 percent to 8.7 percent on average. These rates of increase, in turn, would raise the inflati rate by 0.15 percentage points to 0.19 percentage points. For instance, an annual inflation rate of two percent could spike to 2.15 to 2.19 percent, if the price of electricity were to increase.

5 Conclusion

By examining and analyzing four different scenarios on the introduction of different types and rates of energy taxes, we were able to make forecasts on the prices of electricity and consumer goods and the amounts of revenue that such taxes would entail. In Scenario A, we applied the tax rates of KRW 30 per kilogram on bituminous coals and KRW 954 per gram on uranium. In Scenario B, we retained the same tax rate for bituminous coal but applied KRW 11 per kWh on nuclear energy generated, instead of the tax rate on uranium per se. In Scenarios C and D, we switch to electricity consumption tax rates, which were determined and adjusted so that the resulting amounts of revenue would be the same as those forecast in Scenarios A and B. Accordingly, the rates applied in Scenarios C and D were KRW 6.62 per kWh and KRW 8.63 per kWh, respectively.

In Scenarios A and B, we applied taxes on fuels or energy at the time of generation, thereby doing justice to the principle of equity of taxation among all fuels and sources of energy. Bituminous coals and nuclear energy together account for 70 percent of all electricity generated in Korea, but the absence of effective taxes on these two sources has led to the distortion of the energy price structure, as there are considerably higher taxes on (and prices of) gas, oil, and other fuels. However, imposing taxes on fuels or at the time of energy generation make it difficult to forecast how the resulting final price of electricity would change on the market, given the rigidity and complexity of the price determination model of Korea’s electricity market today. The government could increase the business cost for power plants by taxing fuels, but that might also inhibit these plants' ability to raise the price of electricity. The resulting price of electricity therefore may not adequately reflect the increased business costs, and consequently it would fail to send signals to consumers regarding the current status of their demand for energy. However, taxing different fuels or sources of energy individually, as in Scenarios A and B, allows the government to impose differential tax rates, thereby reducing the tax burden on the more efficient fuels or sources and thus inducing more efficient use and production of energy.

On the other hand, electricity consumption taxes like the ones postulated in Scenarios C and D directly and clearly affect the resulting price of electricity. If the government's goal is to control the excessive demand for electricity, consumption taxes should be most favored (and more effective) as a policy choice. If the goal is to reduce the demand for electricity by raising its price, the tax rates proposed in Scenarios B and D would work effectively by significantly raising the price of electricity. In these two scenarios, the government can not only directly influence the final consumer price of electricity, but can also send price signals to businesses and consumers alike. However, electricity consumption taxes can disfavor the more efficient fuels or sources of energy by increasing the effective tax burdens on them by a greater margin than on less efficient ones. Applying a uniform consumption tax rate to electricity from all fuels or sources would thus unfairly penalize power plants with more efficient facilities. This, in turn, may undermine the government's ability to induce more efficient use and production of energy.

Increases in the price of electricity also affect the national economy in diverse ways, at the very least by increasing consumer prices. Our analysis based on the Input-Output Tables from the Bank of Korea revealed that increases in the price of electricity by five, eight, 12, and 15 percent, would raise the CPI by 0.112, 0.180, 0.269, and 0.337 percent, respectively. An increase in the price of electricity, ranging between 6.7 percent and 8.7 percent, would also raise the inflation rate by 0.15 percentage points to 0.19 percentage points. Of course, an increase in the price of electricity can reduce the demand for electricity, but this last matter is beyond the scope of this study. Subsequent research is needed to address the issue of diverse ripple effects on various industries resulting from the changing prices of electricity.

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