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THE FINANCING MODEL FOR GREEN BUILDING PROJECTS WITH THE GOVERNMENTAL GUARANTEE BASED ON CER (Certified Emission Reduction)

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ABSTRACT: Along with the growing interest in greenhouse gas reduction, the effect of energy reduction from green buildings is gaining interest as well. However, green buildings may have difficulties in financing due to their high initial construction costs. With this in mind, the objective of this study is to suggest a financing model for green building projects with a governmental guarantee based on CER (Certified Emission Reduction). In other words, in the financing model, the government provides a guarantee for the increased costs of a green building project in return for CER. The suggested financing model was tested and found feasible for implementing green building projects. In addition, the model in this study is applicable to private projects because guarantee has its return. To utilize CER as a return for a financial guarantee, however, certification of CDMs (Clean Development Mechanism) for green buildings must be vitalized.

Keywords: Green building; Governmental guarantee; CER (Certified Emission Reduction); Real options

1. INTRODUCTION

An overwhelming body of scientific evidence now clearly indicates that climate change is a serious and urgent issue. The Earth's climate is rapidly changing, mainly as a result of increases in greenhouse gases caused by human activities (Stern, 2007). Excessive emissions of carbon dioxide from the use of fossil fuel for energy generation have created unprecedented environmental pollution and health risks (Zhang, 2010). Sustainable and renewable energy technologies are solutions to reduce the use of fossil fuel and to meet energy demands (Sims et al., 2003). Buildings consume a lot of energy, and thus, minimizing their negative impacts on the environment is an important issue. From this perspective, green buildings, to which sustainable and renewable energy technologies are applied, minimize the impacts of buildings on the environment (Yudelson, 2008).

In tune with the global trend, Korea began to emphasize low carbon dioxide emissions and green growth as its national growth paradigm and there is a growing interest in green buildings for energy reduction. However, a green building generally has greater initial construction costs than other buildings do (de T'serclaes, 2007). With uncertainties in the future value of a project, increased costs may have negative effects on financing. Therefore, the government needs to take the necessary measures for smooth financing to vitalize green buildings. In other words, the government needs to share the risks with the private sector or to provide means to hedge the risks. PPP (Private-Public Partnership) is a way to share risks through governmental guarantees (Takashima et al., 2010; Zhang et al., 2005). In this way, using governmental guarantees can help private financing for green building projects. However, when the government participates in green building projects as a party to risk sharing, it is sensitive to the risk of project failure and may be passive in providing guarantees. Accordingly, proper levels of guarantees need to be determined, based on the social benefits from green building projects.

This study suggests a financing model for green building projects with governmental guarantees based on CER (Certified Emission Reduction).

2. BACKGROUND

2.1 The importance of green building in Korea

Korea was ranked 10^{th} in carbon emissions according to the announcement by the IEA (International Energy Agency) (IEA, 2010). The Kyoto Protocol mandates reduction of green house gas emissions and for this, Korea has set low carbon dioxide green growth as a national top priority.

To reduce CO_2 emissions, building energy consumption needs to be reduced. According to the IEA, buildings account for 40% of the world's final energy consumption and 24% of CO_2 emissions. The IEA referred to commercially available, renewable technologies as a means to improve the efficiency of buildings' energy systems and to reduce a large portion of the energy consumption (de T'serclaes, 2007). Further, according to statistics by KEEI (Korea Energy Economics Institute), buildings account for about 22% of the total energy consumption and 25% of the total CO_2 emissions as of 2007 in Korea. From this perspective, aggressively utilizing green building projects is an urgent matter in Korea.

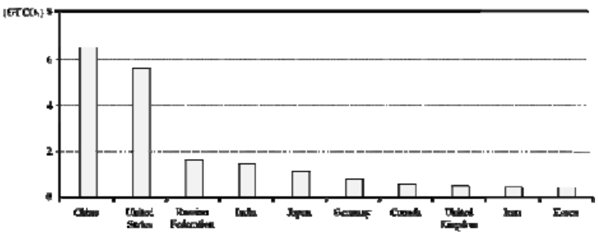

Fig.1. The top 10 CO_2 emitting countries

2.2 Difficulties in financing for green building projects

Investors' primary goal is to make money or to get a return on investment. This rate of return can be determined by three different indicators: payback time, the return on investment and the internal rate of return (de T'serclaes, 2007). Generally, a green building project has three downsides. Investment in a green building project, generally, can be returned in about 7-8 years because the benefit of energy reduction occurs in the operation stage (IEA, 2006). As investors prefer a short-term payback time, they are relatively passive in investing in green building projects with their long-term payback time. Additionally, long-term payback time tends to be accompanied by uncertainties regarding project success, exposing the projects to greater risks. Accordingly, even if there are investors, interest rates have to be increased because of the risks. This results in greater project costs (de T'serclaes, 2007).

In the end, a green building project has barriers in private financing due to the long-term payback time, relatively high interest rates, and increased initial costs. Therefore, to vitalize green building projects, national levels of governmental supports are necessary to remove such financial barriers.

2.3 Literature review

Environment finance encompasses all market-based instruments designed to deliver environmental quality and to transfer environmental risk (Labatt et al., 2002). In this respect, the financing structure model of this study would fall under environment finance. Due to recent growing global interest in the environment, various environmental issues are changing and shaping investment markets and capital flows (White, 1996). Thus, researches on environment finance have become active.

Peszko et al. (1998) stated that the demand for environment finance is influenced by environmental policy or a company's financing capability, and thus, governmental support needs to be thoroughly reviewed. He specifically referred to measures that effectively attract private investments in environment finance. Actually, Branker et al. (2010) mentioned the important role of government support in large-scale, thin-film solar photovoltaic manufacturing and the feasible financial return on it. Green building projects may have difficulties in obtaining private funding because they have large initial investments to improve energy efficiency, compared to other building projects. Thus, governmental guarantees, to share the risk of project failure with the private sector, can be effective for efficient funding of green building projects.

Chaurey et al. (2009) measured the carbon mitigation potential through SHS (Solar Home Systems) and, based on this, studied the effect of carbon finance. In other words, they regarded carbon, a representative green house gas, as a kind of asset, and using this, tested the effectiveness of their finance model. Lewis (2010) analyzed whether carbon finance is effective in reducing green house gas. Similarly, carbon can be used as a base asset for environment finance. Because carbon, generated from the use of fossil fuel, has a great effect on the environment, a trading market for CER (Certified Emission Reduction) has emerged. The financing model of this study would facilitate the sharing of risks by using governmental guarantees. The government could continue to provide guarantees if there were returns on the risks. Namely, CER is an asset from the perspective of environment finance because of the existence of a trading market. Accordingly, the government could regard CER, predicted carbon emission reduction through the green building project, as a return for the guarantee.

2.4 Real options theory

An option is a security given the right to buy or sell an asset, subject to certain conditions, within a specified period of time (Black & Scholes, 1973). In financial markets, the most common types of options are a call option and a put option. A call option gives the owner the right to buy a stock at a predetermined exercise price on a specified maturity date. A put option gives its owner the right to sell the stock at a fixed exercise price (Cui et. al, 2004). The option pricing theory has been applied in the evaluation of nonfinancial assets or real investments; researchers also called it real options. This dynamic pricing process overcomes difficulties in the discounting approach, such as the NPV method, and computes the value of a strategic investment more realistically (Ho et. al, 2003). Previous studies on real options show that real options are used not only for assessing the value of various tangible assets such as a technology investment (Ho et al, 2003; Ekstrom et al, 2005), infrastructure investment (Garvin et al, 2004; Chiara et al, 2007), and mine production (Mayer et al, 2007), but also for assessing the value of contracts to parties such as material procurement contracts (Ng et al, 2004) and guaranteed contracts (Cui et al, 2008; Cheah et al, 2006).

This study suggests a financing structure model for green building projects having a governmental guarantee agreement based on carbon emissions reduction by reducing energy consumption. The government may face financial difficulties if it shares risk for green building projects with no strings attached. Governmental guarantees and expected profits from CER need to be compared to test the feasibility of the financing structure model. Thus, this study evaluated the value of governmental guarantees using real options, which can consider uncertainties involving the projects.

3. Suggestion of financing model for green building projects

3.1 Proposed framework

As mentioned above, a green building project has increased initial construction costs. In the end, the increased initial construction costs work as a barrier to attracting private funding due to uncertainties about future project value. Thus, governmental support to attract private funding for green building projects is necessary and this study suggests a financing structure model with governmental guarantees for the increased initial construction costs. The following Fig. 2 shows the conceptual diagram for the financing structure model of this study.

Existing building projects are funded by project financing. SPC (Special Purpose Vehicle), invested by a developer (Sponsor), raises funds from lenders using future cash flow of the project and makes construction contracts with a construction company. Here, a green building project generally has greater construction costs than other building projects have. If the government provided guarantees for the increased construction costs, lenders could remove additional uncertainties caused by the increased costs. However, the governmental guarantees mean governmental participation in the project, and thus, the government is also directly affected by the risk of project failure. Further, if the government has to provide guarantees just because a project is a green building project, the government may have to bear a considerable burden. As a result, the government needs to secure return for its guarantee. This return must be defined in terms of assets for which a trading market exists. From this perspective, this study defined CER, benefits from energy reduction in the operational stage, as a return on a green building project. Actually, CER is being traded as an asset through the CDM (Clean Development Mechanism). As a result, after assessing the value of governmental guarantees for green building projects and comparing them to the value of the CER, governments could determine whether to provide guarantees.

3.2 Concept of valuing governmental guarantee using real options

A guarantee contract has a provision to receive a predetermined amount in case the value of an asset goes down below certain levels. This is very similar to the concept of a put option. There are a number of studies, which have applied the concept of put options to the evaluation of various payment guarantees such as valuation of deposit insurance by FDIC (Federal Deposit Insurance Corporation) (Merton, 1977) or Federal Loan Guarantees to corporations(Sosin, 1980).

The process of this study, to value the governmental guarantee using the option theory, is as follows: total costs(C_t) for a green building project can be defined as the sum of costs(C_s) for a building of the same size and additional costs(ΔC_a) for the green building.

$$C_t = C_s + \Delta C_a \qquad \text{Eq(1)}$$

Here, liabilities (L) can be defined as total costs (C_t) less equity (E) invested by a developer (sponsor).

$$L = C_t - E \qquad \text{Eq(2)}$$

For project financing in Korea, equity (E) is generally used to purchase land for the project and liabilities are generally used for actual construction. In other words, additional costs (ΔC_a), for the green building project are lowly relevant to equity (E). Thus, Eq(2) can be simplified as follows:

$$L = (C_s - E) + \Delta C_a \qquad \text{Eq(3)}$$

Let's assume future expected profit from the green building project is S and guarantee for liabilities (L) was provided. This means even if S is less than L, lenders can get L through the guarantee. As in Fig. 3, L is the same as the striking price of put option (X_p). The value of put option (V_p) is the same as the value of guarantee (V_d).

Accordingly, the value of the governmental guarantee (V_g) for the additional costs (ΔC_a) is as in Eq (4).

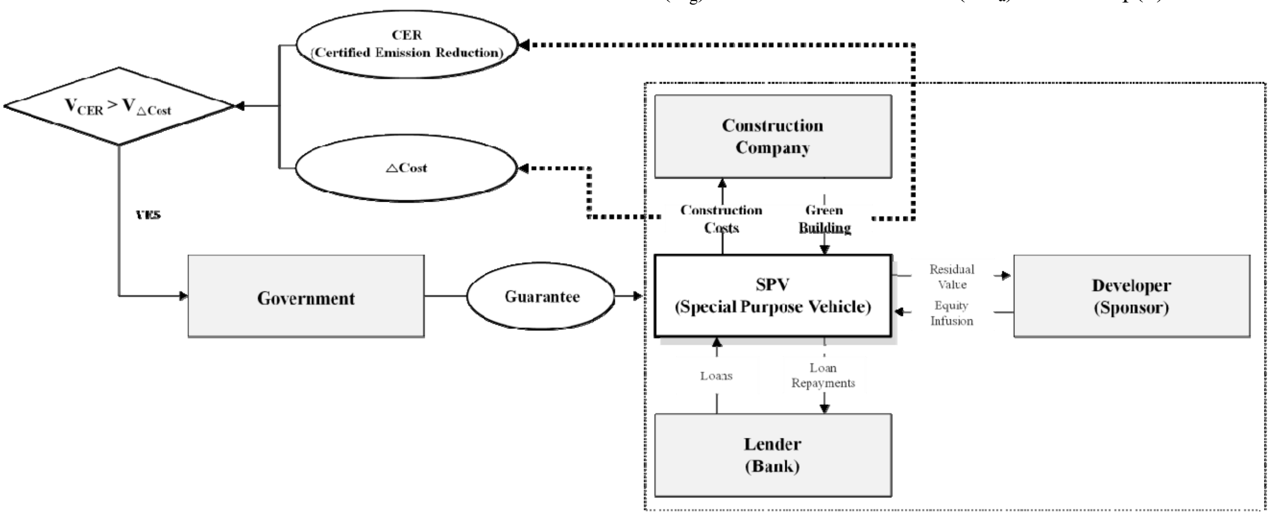

Fig.2. The financing model of this study

$V_g = V_d \times (\Delta C_a / L)$ Eq(4)

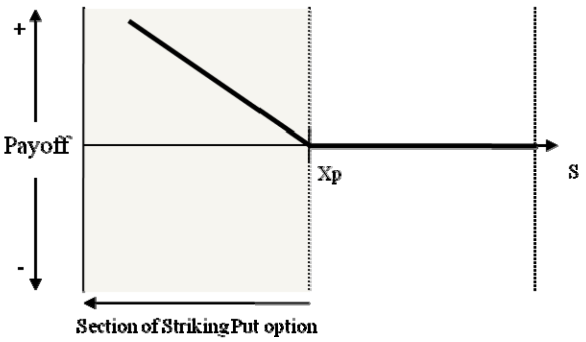

Fig.3. Concept of valuing governmental guarantee

4. Applications

4.1 Data set

This chapter is to test the financing structure model for a green building project having a governmental guarantee agreement based on CER, which is obtainable from energy reduction. Three cases for a residential building project having different equipment for energy reduction were analyzed. Table 1 shows each project's equipment for energy reduction, energy savings (%), and increased costs (US$/3.3m^2). The residential building project of this study was assumed to have three kinds of equipment.

Variables, except construction costs and financing costs for additional construction costs for the residential building project, were assumed to be the same for cash flow. Using the cash flow, the value of the governmental guarantee was assessed. Cash flow for each and the details for variables estimating the value of governmental guarantee are as follows:

Underlying asset value (S_0) is the present value of income and, in this study, was estimated as $221.76 (million US$). As described above, striking price (X_p) is the same as the loan, and thus, for each case, it was estimated at $206.98 (million US$), $207.49 (million US$), or $207.90 (million US$). Sales income was determined by sales price and sales rate. In this study, house price index data from March of 2004 to October of 2010 and sales rates of 50%~100% were used and combined to measure Volatility (σ). Volatility (σ) was about 25.6% interest for a three-year maturity government loan and public bonds were used as a risk-free rate (rf), which was 5.36%. Time step of a ½-year unit was used.

Thus, up-step size (u) of 1.198, down-step size (d) of 0.834, and risk-neutral probability (p) of 0.529 were obtained. Using these, the put option value for liabilities were estimated and using eq (4) the value of the governmental guarantee for the increased construction costs for the green building project was obtained.

CER is currently traded on the EU-ETS(EU Emission Trading Scheme) in the EU and on CCX (Chicago Climate Exchange) in the US. CER prices from January 9, 2006 to November 19, 2010 at the ECX (European Climate Exchange) were used in this study.

Table 2. Cash flow for each case

(unit : million US$)

Project	NPV	Costs				Income
		loans	Direct costs	Financial costs	Sum of other costs	
Base project	6.76	205.89	55.70	24.32	145.03	249.59
Project applied case 1	5.48	206.98	57.03	24.42		
Project applied case 2	4.87	207.49	57.65	24.47		
Project applied case 3	4.39	207.90	58.14	25.51		

Table 3. Parameters to estimate the value of governmental guarantee

Parameters		value
Underlying asset value(S_0 , million US$)		$221.76
Time step (dt)		1/2 year
Volatility (σ)		25.6%
Risk free rate (rf)		5.36%
Up step size(u)		1.198
Down step size(d)		0.834
Risk-neutral probability(p)		0.529
Striking price (X_c ,million KRW)	Application of Case 1	$206.98
	Application of Case 2	$207.49
	Application of Case 3	$207.90

Table 1. Overview of three residential building projects applying energy reduction equipment

Category	Content		Equipment Case 1	Equipment Case 2	Equipment Case 3	Energy saving(%) Case 1	Energy saving(%) Case 2	Energy saving(%) Case 3	Increased costs(US$/$3.3m^2$) Case 1	Increased costs(US$/$3.3m^2$) Case 2	Increased costs(US$/$3.3m^2$) Case 3
Reinforcement of the insulation	Application of the insulating materials	Change of the insulating materials	Neopor thermal insulation ($0.032W/m^2K$)			4.00%			$4.77		
		Change of the insulation thickness of the bedroom and balcony	$0.156W/m^2K$ / 170mm			7.80%			$18.81		
		Change of the insulation thickness of the balcony	$0.432W/m^2K$ / 55mm								
		Change of the insulation thickness of the ground and top floor	-	$0.195W/m^2K$ / $0.175W/m^2K$ 150mm / 150mm(65+85)		-	1.50%		-	$1.05	
		Reinforcement of the pipe insulation	-	Elastomeric flexible cellular insulation		-	0.50%		-	$7.00	
	Application of hi-per windows	Change of windows of the bedroom	$0.97W/m^2K$ / 22mm+16mm(Double glazing) (PVC290)			3.40%			$8.65		
		Change of windows of the balcony	Dry : PVC170(L/S) Wet : PVC130(S/D)			2.20%			$5.00		
		Change of windows of the living room	$1.51W/m^2K$ / 52mm (Triple glass(R183))	$1.18W/m^2K$ / 52mm (Triple glass(PVC220))		4.30%	8.30%		$8.78	$13.28	
		Reinforcement of thermal performance of the windows	-		$1.51W/m^2K$ (Double Window) (PVC16mm+ PVC16mm)	-		1.40%	-		$13.95
		Reinforcement of thermal performance of the front door	-		$0.99W/m^2K$ (Insulation door)	-		0.50%	-		$3.60
		Reinforcement of thermal performance of the door to balcony	-		$2.16W/m^2K$ (Wood door)	-		1.30%	-		$4.50
Application of high efficiency equipments	Boiler	Boiler	Condensing boiler			8.94%			$1.18		
	Application of the private high efficiency equipments	High efficiency lamps (bedroom)	FPL32W			1.05%			$0.10		
		High efficiency lamps (bathroom)	FL28W			0.14%			$0.10		
		High efficiency lamps (front door, balcony)	LED21W/EL15W			1.04%			$1.90		
		Ventilation system	-	Heat recovery ventilator + Heat exchanger		-	7.00%		-	$17.50	
	Application of the public high efficiency equipments	High efficiency lamps (basement garage)	FL29W			1.23%			$0.11		
		Electric transformer	High efficiency electric transformer			1.53%			$2.76		
Renewable energy	Photovoltaic system		0.06kw/housing unit			3.2%			$9.16		
Other equipments	Water treatment system		Water transportation pump			0.12%			$0.07		
	LED signs		LED			0.46%			$0.37		
Total						33.96%	46.96%	50.16%	$61.75	$90.80	$113.85

4.2 Valuing governmental guarantee

To test the financing structure model for a green building project having a governmental guarantee agreement based on CER, the value of the governmental guarantee was obtained using the option theory. As described above, the put option value was obtained to calculate the guarantee value. Building project data are discrete as monthly data, unlike continuous data for other financial assets. Thus, a binomial lattice model was used to estimate the option value, and not the Black-Sholes model, assuming continuous time flow. The following table shows the values of the governmental guarantee for each case, obtained using Eq(4).

As the table shows, additional equipment for energy reduction leads to increased construction cost and increased value of the governmental guarantee. By comparing the obtained value of the governmental guarantee to the value of CER, the feasibility of the financing model for a green building project was tested.

4.3 Comparison of the values of governmental guarantee and CER

First, CO_2 emissions were estimated for the project to compare the values of the governmental guarantee and the CER. The CO_2 emissions were estimated using the following Eq(5) suggested by the IPCC and table 5 shows the results.

Table 6 shows energy saving (%) of table 1 and the governmental guarantee of table 4 for each case.

CER prices at ECX (European Climate Exchange) from January 9, 2006 to November 19, 2010 were used in this study. This study used the highest price of unit CER as the best scenario, the lowest price of it as the worst scenario, and the average of the both as the moderate scenario. As a result, table 7 shows payback periods for the value of governmental guarantees using CO_2 emission reduction, guarantee value, and CER price for each case and each scenario.

As in table 7, as the CER unit price goes down, total CER goes down and the payback period becomes longer. Further, as energy saving (%) increases, total CER increases as well. But, as construction costs increase, the value of the governmental guarantee increases as well. However, the increase in the value of the governmental guarantee is greater than that in total CER by increased energy savings (%), and thus, as energy savings (%) increase, the payback period becomes longer. If the efficiency in energy reduction for equipment is improved, however, the payback period would become shortened. Given the forty-year limitation for legal reconstruction in

Table 5. Annual CO_2 emissions for the subject project

Parameters	value
Energy consumption (TOE/m^2 · year)	0.0179
Carbon emission factor (ton C/TOE)	0.812
Burning rate (%)	99
Subject project G.F.A (m^2)	70,825
CO_2 emission (ton CO_2/year)	3,736.82

$$CO_2 \text{ emission (ton } CO_2) = \text{Energy consumption (TOE)} \times \text{Carbon emission factor (ton C/TOE)} \times \text{Burning rate (\%)} \times (44/12) \qquad \text{Eq(5)}$$

Table 4. Value of guarantee for each case

(unit : million US$)

Classification	Option value(V_d)	Loan(base)	Loan(L)	Increased costs(ΔC_a)	Guarantee value(V_g)
Project applied case 1	16.24	205.89	206.98	1.09	0.09
Project applied case 2	16.40	205.89	207.49	1.60	0.13
Project applied case 3	16.53	205.89	207.90	2.01	0.16

Table 6. The estimated values of guarantee value and CO_2 emission reduction for each case

Classification	Guarantee value(million US$)	Energy saving(%)	CO_2 emission reduction(ton CO_2/year)
Project applied case 1	0.09	33.96%	1269.02
Project applied case 2	0.13	46.96%	1754.81
Project applied case 3	0.16	50.16%	1874.39

Table 7. Total annual CER and payback period for guarantee value for each scenario of CER unit price

	Case 1		Case 2		Case 3	
	Total CER (million US$)	Payback period (year)	Total CER (million US$)	Payback period (year)	Total CER (million US$)	Payback period (year)
Best scenario	0.065	1.31	0.090	1.41	0.096	1.66
Moderate scenario	0.037	2.28	0.052	2.45	0.055	2.89
Worst scenario	0.018	4.70	0.025	5.04	0.027	5.95

Korea, the longest payback period of 6 years for worst scenario shows that the financing model of this study is feasible to implement actual green building projects.

4.4 Discussion

The financing model of this study assumed governmental guarantees for the increased cost, but private guarantees seem to be feasible as well because, in return for the guarantee, the value of the guarantee can be obtained through CER. To vitalize this financing model, private investments have to become active in the market system. Nevertheless, this study assumed the governmental participation to test the feasibility of the financing model. Showing the market the feasibility of the financing model involving governmental participation for a green building project, may induce private investments. Additionally, given the national priority to meet CO_2 emission reduction targets imposed by the Climate Accord, the government needs to take initiative and play an important role in implementing the financing model. To vitalize the financing model in the market, CDM (Clean Development Mechanism) certificates need to become vitalized as well. Current CDM certified projects are mostly plant projects. However, given that buildings account for 40% of the total final energy consumption and 24% of CO_2 emissions in the world according to IEA (International Energy Agency), active implementation of green building projects will be very effective in CO_2 emission reduction. From this perspective, the CDM certificate system for green building projects needs to become active. If the CDM certificate system becomes active for green building projects, various financing methods can be developed based on the financing model of this study and CER.

5. CONCLUSIONS

The Kyoto Protocol, which went into effect in February of 2005, has led to global efforts to reduce CO_2 emissions. Especially in Korea, the government has set low carbon dioxide green growth as its national growth paradigm and there is a grown interest in energy reduction for green buildings. However, green buildings have increased initial construction costs and there may be difficulties in financing for green building projects. To deal with this problem, this study suggests a financing model for a green building project having a governmental guarantee based on CER obtainable from energy reduction. In other words, by providing a governmental guarantee for a green building project, the government can be directly affected by the risk of project failure. If the government provides a number of guarantees for green building projects, the government's financial status could be affected. Accordingly, this study used CER in actual trading markets as a return for the guarantee.

By testing the suggested financing model using the combination of degree of energy reduction and CER price scenarios, the payback period for the worst scenario was about 6 years. Comparing this to forty years of remodeling limitation, the financing model of this study was turned out feasible for actual green building projects.

The financing model of this study used the governmental guarantee for the increased cost. But, there is a return for the guarantee through CER, and thus, private guarantees are feasible as well. Therefore, the financing model of this study can be used in the private sector as well.

However, for the application of the financing model suggested in this study, CDM certificate system needs to be implemented first. To trade CER, corresponding project must be CDM certified. Actually, most CDM certified projects are plant projects. However, given that buildings account for 40% of the final energy consumption and for 24% of CO_2 emissions, the CDM certificate system needs to be applied to buildings as well.

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