Investment Decisions for Clean Development Mechanism under Uncertain Energy Policies using Real Option

Taeil Park [1], Changyoon Kim [2] and Hyoungkwan Kim [3]

[12] Post-doctoral associate, School of Civil and Environmental Engineering, Yonsei University, Korea
[3] Associate professor, School of Civil and Environmental Engineering, Yonsei University, Korea
Correspond to hyoungkwan@yonsei.ac.kr

ABSTRACT: Recently, Korea parliament legislated the Low Carbon Green Growth Act (April, 2012) and approved a bill (May, 2012) to start carbon emission trading system in 2015. It means that for the first time, government would regulate the amounts of carbon emission in private entities, and private entities should attain predefined emission reduction goals by implementing clean development mechanism (CDM) project or buy the Certified Emission Reductions (CERs) from the trading market to avoid penalty. Under these circumstances, it is not easy for them to determine when or how to implement the CDM project because the governmental energy policies about the level of governmental subsidies, periods for free emission allocation, etc. are still under discussion and the future price of the CERs is quite uncertain. Thus, this study presents a real-option based model to assess the financial viability of the CDM project which switches bunker-C oil to liquefied natural gas (LNG). The proposed model is expected to assist private entities in establishing the investment strategy for CDM project under uncertain government energy policies.

Keywords: Clean development mechanism; Real option; Energy policies; Investment decision

1. INTRODUCTION

As the 17th conference of the parties (COP17) ended with the extension of the Kyoto Protocol (December, 2011), Korea parliament legislated the Low Carbon Green Growth Act (April, 2012) and approved a bill (May, 2012) to start carbon emission trading system in 2015. It means that any workplace with annual emission of tCO2 over 25,000 or any company with annual emission of tCO2 over 125,000 should fulfill the emission targets specified by the government. They should buy the certified emission reductions (CERs) from the market or carry a maximum penalty for the difference between the emission target and actual emission at a cost of about USD 90 per tCO2.

Under these circumstances, industries would pay attention to the Clean Development Mechanism (CDM) project, because it not only enables them to reduce the CO^2 emission by implementing the project, but also allow them to sell the surplus CO^2 reductions to other countries. However, it is not easy for them to implement the CDM project because the governmental energy policies about the level of governmental subsidies and periods for free emission allocation are still under discussion and the future price of the CERs is quite uncertain.

The primary objective of this study was to develop a real-option based model to evaluate the financial viability of the CDM project under different implementation scenarios and to investigate how governmental energy policy could affect the value of the CDM project. The findings and recommendations are included the last section of the paper.

2. THEORETICAL BACKGROUND

2.1 Clean Development Mechanism

When the Kyoto protocol came into effect in 2005, it introduced three market-based mechanisms (Kyoto mechanism) which provide a methodology to sell and buy the right to emit the greenhouse gas (GHG) between countries. The Kyoto mechanism includes emission trading (ET), joint implementation (JI), and clean development mechanism. According to the United Nations Framework Convention on Climate Change (UNFCC), CDM is defined as "emission-reduction projects in developing countries in order to earn certified emission credits" [1]. The earned CERs would be calculated as the difference between GHG emissions from the baseline project and that of CDM project. Here, the baseline project implies the business-as-usual scenario and the CDM project represents the project that could generate extra benefits for the crediting period [2].

2.2 Real option analysis

A "real option" is the right, but not the obligation, to maximize the benefits of the investments. It allows the valuation of managerial flexibilities in the implementation of the project and thus would be a proper method for the evaluation of the CDM project under uncertain future conditions such as the price of the CERs and the direction of the governmental energy policies. For

decades, the real option analysis was widely used to evaluate the investment in various ways. It was applied to evaluate the impact of contractual terms and conditions on the project investment [3], [4], [5], [6], [7], [8], [9]. It was also applied to evaluate the value of design flexibility [10], [11], [12]. Although these studies have greatly advanced the state of the art in the valuation of contractual agreements and flexible design of the project, the impact of the governmental policies on the value of the project has never been well addressed. Thus, this study investigates how future uncertainties about energy policies and market conditions could affect the investment decision.

3. IMPLEMENTATION OF THE FUEL SWITCHING PROJECT FROM BUNKER-C OIL TO LNG UNDER UNCERTAIN ENERGY POLICIES

3.1 Conceptual framework for the valuation of the fuel switching project

In 2007, LG chemical in Naju got approval for their fuel switching project from bunker-C oil to LNG as a CDM project from UNFCC. That was the first time for private company to get a CDM approval in Korea. After that, two more companies got approval for their fuel switching project from bunker-C to LNG as CDM project, and many companies progressively paid attention to the CDM project. This phenomenon is because the CDM project produces CERs and the company could sell the CERs to other developed countries. In addition, the CDM project is also comparable with the global trends of green and sustainable development.

When private entities want to implement the CDM project, they should recognize the risks associated with the project, because the risks are the key factors which control the success of the CDM project. In this fuel switching project from B-C oil to LNG, the key variables are the initial costs, fuel costs, O&M costs and GHG emission, more specifically, the differences of the initial costs, fuel costs, O&M costs and GHG emission between baseline project and CDM project. These key variables are presented in Fig 1. The initial costs are the implementation costs required to implement the CDM project (to change the system from B-C oil to LNG); the initial costs of the baseline project would not be considered, because the baseline had been already installed. O&M cost and fuel costs could be different after adopting the CDM project. The GHG emission difference would be CERS from the CDM project. As shown in Fig 1, when the benefits (CERs) are greater than the initial costs and additional costs, the private entity would implement the CDM project.

From the private entity's point of view, primary future uncertainties are as follows: prices of B-C oil and LNG, market price of the CERs, and governmental energy policies. The prices of B-C oil and LNG show certain trends that can be deduced from historical data. However, the CERs price is quite uncertain because the market is not existent until 2015. In addition, energy polices about the governmental subsides and periods for the free emission allocation are still under discussion. Consequently, a practical and wise approach for private entity would be to wait until these uncertainties are resolved.

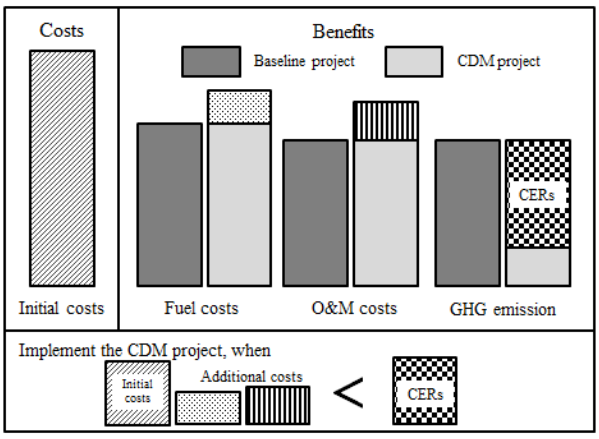

Fig 1. Key variables for the implementation of the CDM project

3.2 Valuation of wait option for the implementation of CDM project

When, due to the various future uncertainties, a private entity has difficulty in determining whether or not to invest with currently available information, wait option allows the private entity to wait until the investment climate is favorable and to establish an investment strategy by estimating the opportunity costs for postponing the investment. As mentioned above, one of the most critical variables for the decision making in the CDM project is the price of CERs. The price of the CERs at Intercontinental Exchange (ICE) in EU has sharply dropped for the last three years, as presented in Fig 2.

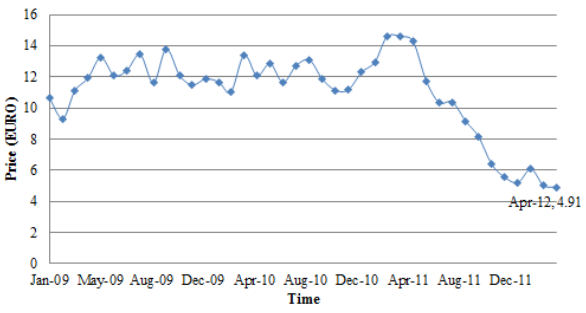

Fig 2. Historical CERs price in ICE (EU)

Under this circumstance, it is natural for a private entity to hesitate the implementation of the CDM project, especially when the emission market in Korea does not show any track record about CER prices. This uncertainty could be well reflected in the valuation of the CDM project by introducing the Market Asset Disclaimer approach of the real option analysis. MAD approach allows decision makers to use subjective estimation of the project [13], [14]. For the calculation of the wait option using MAD approach, three inputs can be estimated. The inputs are the value of the CDM project in moderate, best, and worst case.

Value of the CDM project

2012	2013	2014	2015	
V_o	V_u	V_{uu}	V_{uuu}	V_{uuu}= worst case of accumulated CERs value + differences in O&M and fuel costs
V_o= moderate case of accumulated CERs value + differences in O&M and fuel costs	Vd	Vud	V_{uud}	
		Vdd	V_{udd}	V_{ddd}= worst case of accumulated CERs value + differences in O&M and fuel costs
			V_{ddd}	

Wait option value of CDM project

2012	2013	2014	2015
Option value = $\frac{q*h + (1-q)*i}{(1+rf)}$	$h = \frac{q*e + (1-q)*f}{(1+rf)}$	$e = \frac{q*a + (1-q)*b}{(1+rf)}$	Max (V_{uuu}-EP,0) =a
	$i = \frac{q*f + (1-q)*g}{(1+rf)}$	$f = \frac{q*b + (1-q)*c}{(1+rf)}$	Max (V_{uud}-EP,0) =b
		$g = \frac{q*c + (1-q)*d}{(1+rf)}$	Max (V_{udd}-EP,0) =c
			Max (V_{ddd}-EP,0) =d

$q=(1+r_f-d)/(u-d)$, where r_f= risk free interest rate

EP: Implementation costs for the CDM project

Figure 4 Valuation of the CDM project using MAD approach

If we projected three scenarios (moderate, best, and worst; Fig 3) for the price of CERs in Korean emission market, then the binomial model for the valuation of the CDM project could be established as shown in Fig 4.

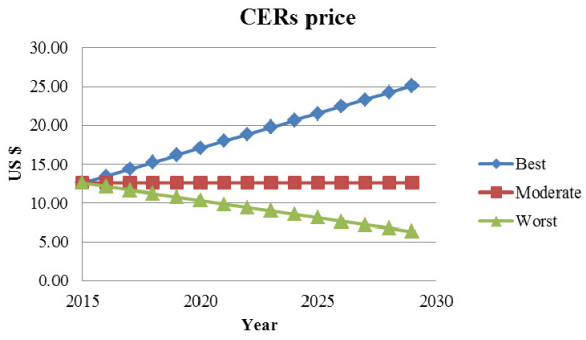

Fig 3. Example of the projection for future CERs price

The current value of the CDM project (V_o) would be the value of the CDM project with the moderate case of CERs price scenario, which is the differences of O&M costs and fuel costs between baseline project and CDM project plus summation of the moderate case of accumulated CERs value. The other two values are those of the best (V_{uuu}) and worst case (V_{ddd}). Then, using the equation 1, 2 and 3, the rise rate (u), fall rate (d) and risk-neutral probability of the rise (q) were calculated, respectively. Then, the value of wait option for the CDM project could be obtained as shown in Fig 4.

$$u = \sqrt[3]{\frac{V_{uuu}}{V_o}} \quad (1)$$

$$d = \sqrt[3]{\frac{V_{ddd}}{V_o}} \quad (2)$$

$$q = \frac{(1+r_f)-d}{u-d} \quad (3)$$

The expected impacts of the governmental policies on the value of CDM project are as follows. If the government provided subsidies such as the tax reductions and half coverage of initial costs for the CDM project, it would result in the reduction of the exercise price and if the government planned for period for free emission allocation, it would increase the time steps of the wait option. For example, if government allowed two years for free emission allocation, then the private entity could wait and see until 2017.

4. CONCLUSIONS

This paper presented a real option based framework for the valuation of the CDM project. The proposed framework contributed to the existing body of knowledge in that it could properly address the future uncertainties such as future prices of the fuels, CERs, and governmental energy policies, which are key items for the successful implementation of the CDM project.

Consequently, this study provided a methodology for valuing the CDM project and for establishing the investment strategy for CDM projects under uncertain government energy policies. The accuracy improvement for the perdition of the future CERs price will be an important area of future study.

ACKNOWLEDGMENT

This work was supported by grants (2010-0014365 and 2011-0030841) from the National Research Foundation and Ministry of Education, Science, and Technology of Korea.

REFERENCES

[1] UNFCCC (1998). *Kyoto protocol to the United Nation framework convention on climate change*, United Nation, New York.
[2] Greiner, S. and Michaelowa, A. (2003). "Defining Investment Additionality for CDM projects – practical approaches". Energy Policy, 31, 1007–1015.
[3] Rose, S. (1998). "Valuation of interacting real options in a toll road infrastructure project." Quarterly Review of Economics and Finance 38, 711-723. — Special Issue.
[4] Ho, S. P., and Liu, L. Y. (2002). "An option pricing-based model for evaluating the financial viability of privatized infrastructure projects." *Construction Management and Economics*, 20(2), 143–156.
[5] Garvin, M. J., and Cheah, C. Y. J. (2004). "Valuation techniques for infrastructure investment decisions." *Construction Management and Economics*, 22(4), 373–383.
[6] Cheah, C. Y. J., and Liu, J. (2006). "Valuing governmental support in infrastructure projects as real options using Monte Carlo simulation." *Construction Management and Economics*, 24(5), 545–554.
[7] Chiara, N., Garvin, M. J., and Vecer, J. (2007). "Valuing simple multiple-exercise real options in infrastructure projects." *Journal of Infrastructure Systems*, 13(2), 97–104.
[8] Cui, Q., Johnson, P., Quick, A., and Hastak, M. (2008). "Valuing the warranty ceiling clause on new mexico highway 44 using a binomial lattice model." *Journal of Construction Engineering and Management*, 134(1), 10–17.
[9] Brandao, L.T.E., and Saraiva, E. (2008). "The option value of government guarantees in infrastructure projects." *Construction Management and Economics*, 26(11), 1171–1180.
[10] Ford, D., Lander, D., and Voyer, J. (2002). "A real option approach to valuing strategic flexibility in uncertain construction projects." *Construction Management and Economics,* 20(4), 343–51
[11] Zhao, T., and Tseng, C. (2003). "Valuing flexibility in infrastructure expansion." Journal of Infrastructure Systems, 9(3), 89–97.
[12] Dobbes, L. (2010). Notes on Applying 'Real Options' to Climate Change Adaptation Measures, with Examples from Vietnam. Crawford School of Ecconomics and Government, Centre for Climate Economics & Policy. Canberra: Australian National University.
[13] Garvin, M.J. (2005). "Real options analysis: can it improve infrastructure development decisions, *in Proceedings of the Construction Research Congress*, 501-506.
[14] Schneider, M., Tejeda, M., Dondi, G., Herzog, F., Keel, S. and Geering, H. (2008). "Making real options work for practitioners: a generic model for valuing R&D projects, *R&D Management*, 28(1), 83–106.