P4-2

ESTABLISHMENT OF CDM PROJECT ADDITIONALITY THROUGH ECONOMIC INDICATORS

Kai. Li.[1], **Robert Tiong L. K.**[2], **Maria Balatbat**[3] **and David Carmichael**[4]

[1] PhD Research Student, School of Civil and Environmental Engineering, Nanyang Technological University, Singapore
[2]Associate Professor, School of Civil and Environmental Engineering, Nanyang Technological University, Singapore
[3] Senior Lecturer, School of Accounting, University of New South Wales, Australia
[4] Professor, Department of Engineering Construction and Management, University of New South Wales, Australia
Correspond to 141053776@ntu.edu.sg, 0065-96757027

ABSTRACT: Carbon finance is the investment in Greenhouse Gas (GHG) emission reduction projects in developing countries and countries with economies in transition within the framework of the Kyoto Protocol's Clean Development Mechanism (CDM) or Joint Implementation (JI) and with creation of financial instruments, i.e., carbon credits, which are tradable in carbon market. The additional revenue generated from carbon credits will increase the bankability of projects by reducing the risks of commercial lending or grant finance. Meantime, it has also demonstrated numerous opportunities for collaborating across sectors, and has served as a catalyst in bringing climate issues to bear in projects relating to rural electrification, renewable energy, energy efficiency, urban infrastructure, waste management, pollution abatement, forestry, and water resource management. Establishing additionality is essential for successful CDM project development. One of the key steps is the investment analysis. As guided by UNFCCC, financial indicators such as IRR, NPV, DSCR etc are most commonly used in both Option II & Option III. However, economic indicator such as Economic Internal Rate of Return(EIRR) are often overlooked in Option III even it might be more suitable for the project. This could be due to the difficulties in economic analysis. Although Asian Development Bank(ADB) has given guidelines in evaluating EIRR, there are still large amount of works have to be carried out in estimating the economic, financial, social and environmental benefits in the host country. This paper will present a case study of a CDM development of a 18 MW hydro power plant with carbon finance option in central Vietnam. The estimation of respective factors in EIRR, such as Willingness to Pay(WTP), shadow price etc, will be addressed with the adjustment to Vietnam local provincial factors. The significance of carbon finance to Vietnam renewable energy development will also be addressed.

Keywords: *Carbon Finance, CDM, Additionality, EIRR*

1. INTRODUCTION

Climate change is the greatest environment challenge facing the world today. A variety of approaches are being implemented to reduce Greenhouse Gas (GHG) emission, such as voluntary reduction of individual or corporate climate footprints, carbon reduction initiatives at city, state, regional levels, as well as governments' commitments to emission reduction in 1997 Kyoto Protocol, followed by 2008 Bali negotiation, and in coming 2009 Copenhagen Protocol.

The emerging carbon market, including both allowance markets and project-based markets with corresponding 2007 values of USD 50.4 billion and 13.6 billion respectively, has proven its success as a key instrument in the drive to reduce GHG emission.

Carbon finance is the investment in GHG emission reduction projects in developing countries and countries with economies in transition within the framework of the Kyoto Protocol's Clean Development Mechanism (CDM) or Joint Implementation (JI) and with creation of financial instruments, i.e., carbon credits, which are tradable in carbon market. The additional revenue generated from carbon credits will increase the bankability of projects by reducing the risks of commercial lending or grant finance. Meantime, it has also demonstrated numerous opportunities for collaborating across sectors, and has served as a catalyst in bringing climate issues to bear in projects relating to rural electrification, renewable energy, energy efficiency, urban infrastructure, waste management, pollution abatement, forestry, and water resource management.

CDM, both primary and secondary, accounts for the vast majority of the project based emission reduction (at 87% of volume and 91% of values).

Establishing additionality is important for successful CDM project registration. In the demonstration and assessment of additionaly, investment analysis is more challenging than the rest three steps. In most CDM projects, simple cost analysis (Option I) is less encountered. As CDM projects are often financed by private investors, the projects without any financial/economic benefits other than CDM related income will not be favored by private investors. Therefore, majority of the projects are either using investment comparison analysis (Option II) or benchmark analysis (Option III).

In both Option II and Option III, financial indicators such as IRR, NPV, DSCR etc are widely adopted to demonstrate the economically non-viable projects becoming viable as a direct result of CDM revenues, i.e., the additionality. The reasons could be due to the easiness for project developers to work from their initial financial analysis compared with the large amount of works involved in the economic analysis. And of course, greater control in the financial projection figures by project developer could also be another reason. This also explains the rising public scrutiny of registered CDM projects.

However, it should be noted that in Option III, economic indicator such as EIRR, although often been overlooked, can also be used to demonstrate additionality. Indeed, both financial analysis and economic analysis are closely linked. The heavily reliance on financial indicators may result in failure to demonstrate additionality whereas economic indicator can do, in particular for public infrastructure projects where economic benefit is the major gain from project. Meantime, it is also a standard practice for Asian Development Bank(ADB) to use EIRR as investment criterion.

This paper will present a case study of a recent development of 18MW hydro power plant with carbon finance option in central Vietnam. The estimation of respective factors in EIRR, such as Willingness to Pay(WTP), shadow price etc, will be addressed with the adjustment to Vietnam local provincial factors. Additionality using both financial indicator and economic indicator has been demonstrated and assessed.

2. ECONOMIC ANALYSIS

Economic analysis attempts to assess the overall impact of a project on improving the economic welfare of the citizens of the country concerned. It assesses a project in the context of the national economy, rather than for the project participants or the project entity that implements the project.
Economic analysis includes all members of society, and measures the project's impacts in terms of willingness to pay(WTP) for units of increased consumption. Willingness to pay(WTP) is used rather than prices actually paid or received because

- Many of the project impacts that are to be included in the economic analysis either will be non-marketed, for example, biodiversity preservation, or incompletely marketed, such as, water supply and sanitation benefits. Thus, some form of non-market value must be estimated.
- Many project impacts that are marketed will be bought and sold in markets where prices are distorted by various government interventions, by macroeconomic policies, or by imperfect competition.

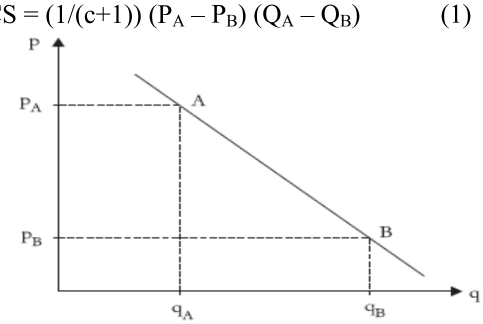
Shadow prices may be used in estimating the willingness to pay in the face of these market absences and market imperfections. Shadow prices are also used to take into account the major impacts of a project where economic values differ from financial values. In many developing member countries, many prices paid and received in the project accounts may come from relatively complete markets where the major impacts are captured in the transaction between buyer and seller, and are reflected by the prices paid and received.

In summary, the most important factors in the economic analysis are the measurement of both the Economic Benefits (EB) and Economic Cost. These will determine the Economic Internal Rate of Return (EIRR) which is often used as key parameter for economic viability.

Economic Costs has two components, i.e. tradable and non-tradable commodities. For tradable commodities, it is valued at the border price at the prevailing exchange rate. Non-tradable commodities are valued through shadow price using standard conversion factor and specific conversion factors for different sectors. It should be highlighted that economic cost should be at constant prices of a year.

The main Economic Benefit for an electricity projects is to meet the consumers' demand. However, in practice the electricity demand models are seldom employed for measuring willingness to pay (WTP) because of insufficient data, in particular in developing countries. The usual approach is to calculate consumer surplus(CS) on the basis of a linear electricity demand function.

$$CS = (1/(c+1)) (P_A - P_B) (Q_A - Q_B) \qquad (1)$$



However, there are two principal weakness of this approach to measuring WTP. First, there is no theoretical basis for the linear demand function and the use of it is essentially a matter of convenience. Second, the assignment of a value to the parameter c is often arbitrary and leads to an arbitrary valuation of CS.

Therefore, Asia Development Bank (ADB) has recommended the Measuring Willingness to Pay for Electricity model as a Semilog Demand Function. [1]

$$ln q^e = \alpha + \beta p^e \qquad (2)$$

Where upper boundary of electricity demand is given by e^α and β is the price semi elasticity of demand. This functional form has a desirable property that WTP rises exponentially as demand falls as suggested by economic theory. The parameter α depends on income, prices of other energy forms and other variables.

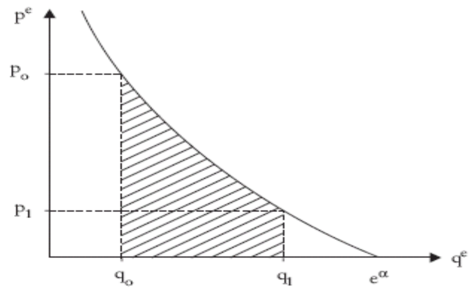


Fig 2. Semilog Demand Function for Electricity

The function form (2) readily lends itself to calculating the economic benefits(EB) of electricity. The economic benefit is simply the area beneath the demand curve (shaded area in Fig 2), i.e.

$$EB = \int_{q_0}^{q_1} p^e dq^e \qquad (3)$$

Integrating with respect to q^e results an EB of

$$EB = q_1(p_1 - 1/\beta) - q_0(p_0 - 1/\beta) \qquad (4)$$

Although this econometric approach requires at least 20 years of time series data on electricity sales, marginal price of electricity sold, economic data such as income, weather and demographic data. Sufficient data are often not available. In practice, survey approach is normally adopted to find the “with” and “without” case to determine the incremental consumption to estimate β value as:

$$\beta = (ln q_1 - ln q_0)/(p_1 - p_0) \qquad (5)$$

And EB will then be estimated by (4).

3 BAN COC HYDRO POWER PROJECT

3.1 Project Overview

The Ban Coc Hydropower Project involves the construction of a 18 MW power plant consisting of 3 units of 6 MW each on the Nam Giai stream, Chau Kim Commune, Que Phong District, Nghe AnProvince Vietnam. The estimated annual gross power generation is about 75 million kWh and about 74 million kWh will be fed to the national grid.

The objective of the Ban Coc Hydropower Project is to generate renewable electricity utilizing hydroelectric resources and sell the generated power to Electricity Corporation of Vietnam (EVN-Who is responsible for national grid management).

The project activity will reduce greenhouse gas (GHG) emission by avoiding electricity generation and CO_2 emissions from national electricity grid. Total expected CO_2 emission reduction from the proposed project has been estimated to 558,050 tCO_2 in the crediting period of 10 years.

The project will stimulate and accelerate the development of renewable energy technologies in order to reduce GHG emissions, to protect the environment, to conserve the country energy resources while responding to increasing energy demand and energy resource diversification imperatives necessary for national sustainable economic growth. It is in line with energy policies of Vietnam; therefore it satisfies the sustainable development criteria for CDM project, established by Designated National Authority (DNA) of Vietnam.

3.2 Financial Analysis

The project started construction in 2005 and completed in 2007 with an operation life of 25 years. The total investment sums up to USD 19.24 million with a 30-70 Equity-Debt ratio. Discount rate is 10% with a 3-year grace period during construction period and 10years payback period. Annual operation and maintenance cost is 1.5% of the total investment.

Revenue generated is solely electricity sales in case of absence of carbon finance. The average electricity sales price to Electricity Corporation of Vietnam is US 4cents/kwh (2.0 Cent/kWh in rainy season and 4.5 Cent/kWh in dry season). That will generate annual revenue of USD2.96 million during the 25years operation life.

With carbon finance, the CER credit is estimated to be traded at price of USD 8/tCO_2 in the primary market. That will generate additional annual revenue of USD0.44 million during the 10years crediting period. This is based on primary sales price.

The internal rate of return (IRR) calculated for with and without carbon finance are 10% and 7.6% respectively. Compared with discount rate of 10%, the project financing plan without carbon finance is not feasible whereas with carbon finance, the project is less attractive with a NPV of 0.

3.3 Economic Analysis

3.3.1. Estimation of Costs

Economic costs are at 2005 constant prices and are expressed in domestic currency. For simplicity, the capital cost has been valued through shadow price for heavy industry which is typically as 1.09[2]. The capital costs were also adjusted to eliminate price inflation, interest during construction, and taxes.

3.3.2. Estimation of Benefits

The main economic benefit of Ban Coc project is power generation to meet the electricity demand of end users. Analysis used conservative estimates of the actual benefits—lower forecast for generation, plant use of 1%, formed the basis for the incremental net energy supply from Project to the end users. The 18 MW installed capacity is estimated to provide about 74 gigawatt-hours per year to end users, which represents about 47.5% load factor or an average load of about 8.5 MW. Incremental benefits were quantified based on end users' willingness-to-pay (WTP).

Economic benefit was calculated using a semilog electricity demand function. β is determined as -28.75 based on the current Vietnam electricity demand-price relation. In equation (5), the p_0 is USD 0.065 with corresponding q_0 of 2.5 Giga kWh. These are the annual average Vietnam electricity purchase price and quantity from China. The final result of USD 0.051 /kWh was used for all economic benefit calculations.

3.3.3 Estimation of the Economic Internal Rate of Return

The basis for project evaluation is a comparison of benefits and costs between the with-project (base) case and the without-project (alternative) case. The project analysis period is 25 years following expected full operation by 2008. The project construction period is 3 years, beginning in 2005 to the end of 2007. The economic internal rate of return (EIRR) was calculated at 11.4% if without carbon revenue, indicating that project is not economically viable as compared with ADB's guideline of 12% EIRR in Vietnam.

A complete quantification and estimation of all benefits from the Project was not possible due to various factors including time and resources. Thus, the total benefits estimated in this analysis can be interpreted as conservative estimates. There are large positive environmental benefits from the avoided pollution such as improved human health from avoided morbidity and mortality from fine particulates and improved human welfare due to improved visibility and reduced damage to materials from avoided air pollution. The most prominent one is the carbon reduction of 55,805 t carbon dioxide (CO_2) per year which will generate income from sales of CERs which will bring the EIRR up to 13.9% and establish the addtionality of this project.

4. CONCLUSIONS

Carbon finance will have great impacts to project financing feasibility study. The trading or sales of carbon credit, CERs, will generate additional revenue during the early stage of project operation period which will in turn have noticeable contribution to the project net present value(NPV). The total revenue generated from carbon credit commonly will be 15-20% of the total investment. Therefore carbon finance plays an important role in financial assessment.

Apart from the financial benefits, carbon finance also encourages development of clean energy in host countries. These will bring both social and economic gains to the country. A key parameter is the Economic Internal Rate of Return(EIRR) which measures the national economy and which is also can be used to demonstrate addtionality of CDM projects. The economic analysis relies on accurate host country's economic parameters. These include shadow price, WTP, conversion factors in commodities and the right approach to obtain the Economic Benefits in the local context.

REFERENCES

[1] Peter Choynowski, "Measuring Willingness to Pay for Electricity", ERD Technical Note Series No. 3, Asia Development Bank, July 2002.
[2] Pham, Q.N. et al. "Optimal Choice of Ownership Structure in Vietnam", Oct 2004.