Analysis of an Investment Decision in the Carbon Market: The EcoSecurities' VAM Project

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Abstract — In a world where greenhouse gases (GHG) carry a price, organizations can create financial instruments that are tradable on the carbon market by investing in projects that reduce GHG emissions. The purpose of this study is to critically analyze this sector specificities by evaluating an investment project from EcoSecurities, developed to mitigate the emissions of methane from a coalmine located in China's Sichuan province. This project generates carbon credits that are later sold to governments and organizations under the Kyoto Protocol. In order to evaluate this investment, we conducted an analysis centred in its net present value, but affected by the financial situation of EcoSecurities and by external economic variables. This study concludes that EcoSecurities project investment has a positive impact on its strategy and financials as it increases revenues and fosters efficiency of assets turnover, and provides a solid structure for investment decisions on this sector.

Index Terms — Investment Analysis, Carbon Market, EcoSecurities

1 Introduction

Interest in the voluntary carbon markets and carbon offsets accelerated dramatically with the global climate change [1]. Kyoto Protocol was the first international treaty to address global climate change by directly regulating human-caused greenhouse gas (GHG) emissions. Hence, developing countries that ratified the Kyoto Protocol had to cut 5.2% of their GHG emissions [2]. Regulated governments and firms can fulfil emissions reduction obligations by purchasing credits generated by projects that reduced emissions in industrialized nations [3]. These projects can be implemented through the Kyoto Protocol's Clean Development Mechanism (CDM) [2]. And once approved by United Nations (UN), they could earn one carbon credit called Certified Emission Reduction (CER) for each tonne of carbon dioxide (or its equivalent in another GHG) reduced [1].

One striking result of the Kyoto protocol was the market opportunity to source, develop and trade carbon credits from greenhouse gas emission reduction projects. Foreseeing this trend, EcoSecurities (ECO) was formed in the same year that the Kyoto Protocol was adopted (1997) with the purpose to facilitate the acquisition of carbon credits by firms. This was done by steering projects through the UN approval process and purchasing the resultant CERs from projects owners.

The purpose of this study is to critically analyze a specific investment project from ECO, named Ventilation Air Methane (VAM). VAM would generate carbon credits by mitigating emissions of methane from a coalmine located in China's Sichuan province. Later these carbon credits would be sold to governments and organizations under the Kyoto Protocol [4]. This leads to the following research question: *should EcoSecurties invest in the Ventilation Air Methane project?*

Projects with the objective of trading carbon credits by sequestering, storing or preventing the release of GHG to the atmosphere will tend to increase in the near future [5]. Despite the interest, investment analyses in the carbon market have been lacking. Therefore, our contribution is to offer some guidance to companies or institutions that want to invest in similar projects. It is expected that this study offers a critically reasoning on how to invest in projects that create financial instruments that are tradable on the carbon market.

The organization of this study is centred on the analysis section, divided in two main parts. The *first part* examines the financial and

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economic situation of ECO, based on its risk and profitability and how this situation relates to the specificities of its sector and how affects investment decisions. The *second part* appraises the project investment. It focuses on profit value, incorporates risk into the decision and performs a sensitivity and scenario analysis in order to understand the decision maturity. Finally, grounded on these two parts, the study analyzes the project impact on ECO's strategy, and how ECO's capital structure and financing properties affect the investment decision.

2 LITERATURE REVIEW

International energy agency (IEA) analyzed emissions trading and its possible impacts on investment decisions in the power sector, by synthesizing the implications of carbon emission cost on market prices and generation costs and their longer impact on investment decisions.

Josef Janssen's [2] presents benefits that can be seized by bank and insurance companies when raising funds to implement projects subjected to Kyoto mechanisms.

The context of methane-reduction projects can be consulted in [6]. In particular, the challenges and consolidated data for the VAM project, the first submitted to the UN using *ventilated* methane, are presented in [4].

VAM project ventilates and drains methane from Sichuan coalmine province. Removing methane from the coalmine fosters control over the methane dumped from the mine and thus, not only relevant to Kyoto's protocol but also essential to miners' safety [6].

VAM project is a three-way partnership between ECO, the coalmine owner and Tecterra which provides the machinery to convert the mixed methane stream into CO_2 and water (see appendix 0.2). Sector specific aspects are introduced in [4] and include the time horizon of the negotiations among these parties (as Kyoto protocol ends by 2012). Cost structure specificities must also be carefully assessed, as they comprises costs with studies by independent UN-accredited organizations, UN registration fees and project data monitoring (see appendix 0.4). Literature [4,5,7] also refers to diverse uncertainties associated to Chinese government and UN approvals, certification eligibility of the drained gas supply, CERs price and cost overruns (see appendix 0.5).

3 RESEARCH METHODOLOGY

This study follows a case-based research that uses a concrete project to depict the dynamics of an increasingly important sector. Research methodology will follow four main steps: *i*) evaluation of the financial constraints of the company that undertakes a project on the carbon market, *ii*) design of the project environment using different assumptions and multiple scenarios (that may be raised for similar projects), *iii*) evaluation of the profitability and risk of the project, and *iv*) confrontation of the fit of this output with the targeted company dynamics.

4 ANALYSIS

4.1 Financial situation of EcoSecurities

For the analysis of the economic and financial situation of ECO, the study took into consideration the financial reporting of the company (see tables 5 and 6 in appendix). Since the evaluation of the VAM project investment takes place in late 2007, the study uses financial information of December of 2007 and from the two previous years. A set of ratios, used to quantify the different aspects of the ECO business, are benchmarked against: *i*) the two previous years and *ii*) the correspondent ratios of industry. According to Reuters Group, a former financial market data provider, ECO belongs to the Industrials sector and it operates in the Environmental Services Industry[4]. Reuters provides financial ratios for this industry, however just provides this information for the last financial year (2008) (see table 7 in appendix) [4]. This study assumes that these environmental services industry ratios remained approximately constant during the years under analysis.

This study does not deeply exploit the company situation, but presents a set of few factors that *i*) provides interesting information about the company that can be useful to support our research decision; and *ii*) illustrates, in a high-level way, the ECO profile (e.g. financial strength, management effectiveness, firm efficiency).

Less constraints in acquiring debt in this sector [2] over the years explain the positive value for the working capital of ECO, which (despite the high profit losses) maintain at a good level the company cash needs. Second reason is an under-exploitation of current

4. Accessed via http://www.reuters.com/sectors/industries/ November 25, 2009

assets, as due to the growing nature of ECO and debt-facilities may function as a buffer for following projects.

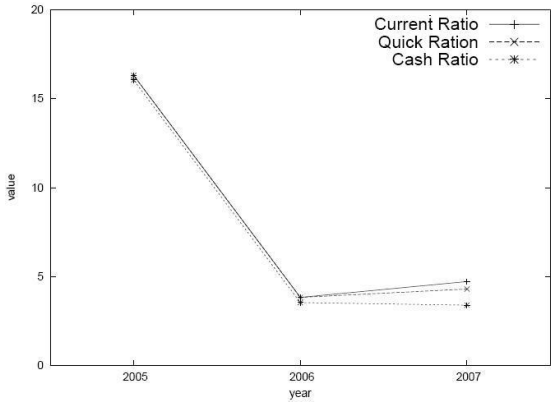

Fig. 1. Liquidity Ratios

Liquidity ratios are relatively high in comparison with the industry average (current ratio of 2.43 and quick ratio of 2.75). This means that ECO should not have problems meeting its short-term debt needs. It also reveals that ECO is not efficiently using its funds, as for this industry cost of debt is higher than equity interest rate. 2005 higher values may result from a great amount of borrowing not yet used to acquire assets. Note that receivables affect more the liquidity (quick ratios minus cash ratios) than inventories (current ratios minus quick ratios). However, there is sub-optimization of assets profitability as both receivables and inventory are still reduced when compared with cash.

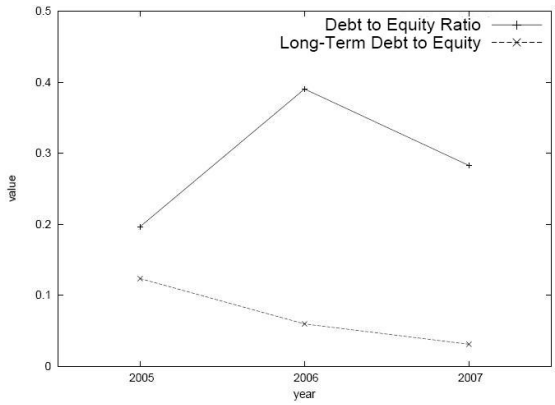

Fig. 2. Debt Ratios

The environmental services industry is aggressive in financing its growth with debt (debt to equity ratio of 26.69). However, the same is not happening with ECO which presents a very inferior debt-to-equity ratio over the years (see figure 2). A similar analysis can be done regarding the long term debt to equity. There are two interesting topics to analyze in this case. First, the long term debt to equity is lower than the current debt to equity which means that the temporal financing of ECO is of a short-term nature (which is in proportion with its cash buffer. Second, long term debt has been decreasing over the years as a result of the slower growth rate of ECO.

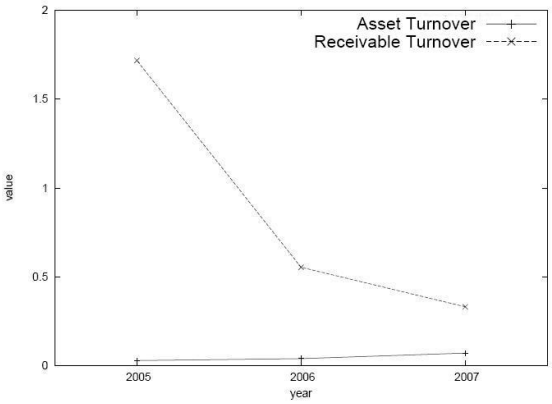

Fig. 3. Activity Ratios

The assets-turnover is below industry ratio (0.09) (see figure 3), enforcing the fact that ECO is not yet efficiently using its assets to generate revenue. However, efficiency has been improving over the last two years. Contrary, the accounts receivable turnover has been decreasing. And, in 2006 and 2007 this ratio is lower than the respective industry ratio (0.7) which may indicate that ECO payment terms are too lenient or that ECO extension of credit and collection of accounts receivable is not efficient.

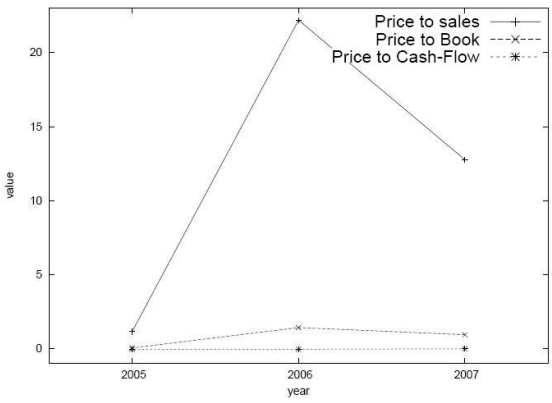

Fig. 4. Market Ratios

Regarding market ratios, the dividend yields are zero between 2007 and 2009 since the enterprise is not able to generate profits. EcoSecurities has a high P/S ratio relatively to the industry average (0.17) which is not attractive for the investor since the investor is paying more for each unit of sales. However, sales don't reveal the whole picture, especially if we take into consideration that EcoSecurities is unprofitable.

Contrary, EcoSecurities presents low P/B ratios in comparison with the industry average (1.84), may meaning that the stock is undervalued or that something is fundamentally wrong with the company. The price-to-cash-flow ratio has been increasing over the years, leading to an increase of the market's expectations for future financial-health. However, it is still a negative value and highly lower than the respective industry ratio (low market's expectations).

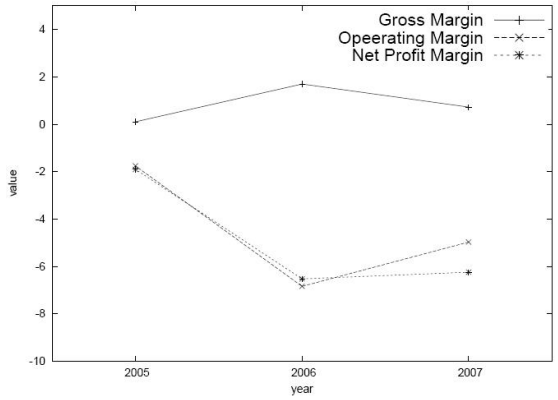

Fig. 5. Profitability Ratios (part I)

ECO revenue has grown since 2005 due to an increasing in CERs commercialization. However, this increasing in revenue is not reflected in the gross margin of 2007. This can be explained by the price of CERs allocated to cost of sales. The operating profit and net profit in 2006 and 2007 decreased in comparison with 2005 due to an expansion in headcount, an increasing in the number of offices and in administration costs. Administrative expenses growth can help to explain these negative profits which differ from the low positive net operating and net profit values of the industry.

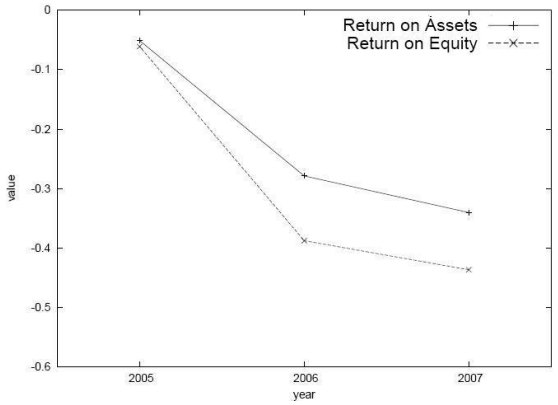

Fig. 6. Profitability Ratios (part II)

Since ECO's net profit is negative, the ROA and ROE of the firm are also negative and significantly below the industry ROA and ROE values. At this initial stage of existence, ECO is neither efficiently managing its assets to generate profit (negative ROA, explained by the time window between the obtaining and selling of CERs) and nor generate value for the shareholders (negative ROE). Additionally, ROA and ROE values have been decreasing since 2005 till 2007 due to the sharp net profit decreases resultant from high management costs derived from the effort required around ECO's portfolio of investments.

From these evidences can be drawn the following conclusions. First, liquidity and activity ratios indicate that ECO is not using efficiently its operational assets. In particular, the high cash ratio reveals slow decision-making process over investment projects. Second, debt ratios indicate that ECO should re-assess its credit policies in order to ensure the timely collection of imparted credit that is not earning interest for the firm. And third, ECO projects are still not generating a positive net income, what leads to the importance of underlying duration of the project break-even, in order to ECO pay its obligations against debtors. Cash must be properly invested and new projects may require quicker cash in-flows in order to ECO generate net income and continue attractive for its financers (note that banks constraints-relaxing to companies in this sector is not an long-lasting reality).

4.2 Investment Decision

The analysis of the VAM's project decision is grounded on the information provided by Perold [4]. The evaluation of the maturity of the ECO's investment decision will be done separately from VAM's financing concerns, i.e., we will analyze VAM project using an estimated value for cost of capital, as information is lacking on cost-of-debt and uncertainty affecting other variables. For simplification purposes, the reader can assume that the project is all equity-financed.
This section is structured as follows. First, the cash-flows statement of the project will be calculated over a set of assumptions. Second, we will use a relevant set of indicators to evaluate the investment decision. Finally, a section at the end will undertake briefly a separate analysis of financing based on the previous data.

4.2.1 Initial Investments

Initial investments comprise the acquisition of FOVOC machine and the construction of a local factory to supply the machine (see appendix 0.2). The development of FOVOC requires an investment of $5.000.000 by

Tecterra. Tecterra accepts the project only for a 20% pre-tax internal rate of return (IRR) on its investment. Nothing is referred regarding the required payment conditions for this deal. However, according to Perold [4], ECO had to propose a lease fee to Tecterra's that would be charged over constant payments until 2018. Assuming a lease fee of 10%, a cost of capital investment of \$6M $(5{,}000{,}000 \times (1 + 02))$ will be paid in 11-year period (2008-2018), i.e., $(6{,}000{,}000/11) \times 1{,}1^i$ with i = 0_{2008},1_{2009},...,10_{2018}.

Another limitation of the data used is that the upfront costs to install FOVOC are mixed with the factory development by ECO, which difficult the calculus of the factory depreciation.

Both costs sum \$750,000, assuming that both local factory and FOVOC installations effort are inputted in ECO assets. A table that summarizes initial investments can be consulted in appendix Table 8.

4.2.2 Revenues and Variable Costs

The process of obtaining the number of CERs per ton of methane emitted per year is presented on appendix Table 9. To obtain this value we estimate the coalmine emissions of methane and then decreased: the machine emissions, the efficiency of combustion, the tons of methane not handled due to maintenance times and huge concentrations of methane. Additionally, we decreased a percentage of the total number of CERs to cover the support with countries vulnerable to climate risks (in line with Kyoto's regulation [2]), for the coalmine owner and for the Chinese government. From the initial number of 21 CERs per ton of methane we obtain a liquid value of 13 689 CERs per ton of methane, and from the initial 20000 tons of methane emissions only 50% is considered, resulting in a total of 136,890 of CERs a year.

Annual fee per CER to cover United Nations administration costs depends on the accumulated number of CERs. Thus, we have to separate 2008 and 2009-2012 fees, with 2008 UN fee being $15000tons \times 0.1 + (136{,}890 - 15{,}000)tons \times 0.2 = 25{,}878$ and 2009-2012 UN fee: $136{,}890 \times 0.2 = 27378$.

In 2007, the price of CERs for 2008-2012 and 2012-2018 was uncertain. Despite we have at this moment some more information we will ignore these additional data and evaluate ECO's decision maturity with its same instruments at 2007. The estimation of CERs price for 2008-2018 assumes those values based on two variables: *i)* trends from 1998-2007 and *ii)* the ECO estimated value for 2012 (CER price = 20\$). In order to obtain the values we defined a function (using Excel) based on the discrete set of price values 1998, 1999, .., 2006, 2007, 2012, and we retrieve the price values for 2008-2011 range of years.

Not so clear is the value of CERs from 2012 to 2018 due to Kyoto expiration. There will be new regulation? Does it preserve the actual design? News, from 2007, provides some information on this topic, claiming for an approximated continuation to justify project efforts. We used information in [5] as the input to support our choice of values.

In order to derive CER profits there are two assumptions. First, all the CERs acquired are sold. Second, all the CERs obtained during a year are priced with the value estimated at the beginning of that year. The estimated value per CER and the total CER profits (CERs*price – fee) are summarized in the appendix table 10.

4.2.3 Other Expenses

Initial costs with the project comprise the technical documentation and negotiations with Chinese government (\$55,000) and an UN-accredited organization validation (\$15,000).

Annual costs are divided in two main topics: *i)* annual operations (monitoring and data collection) and maintenance (totalizing \$362,500/year) and *ii)* payment to an UN accredited company to monitor and verify reductions (totalizing \$50,000/year). Table 11 in appendix presents all fixed costs per year.

4.2.4 Depreciation

We assume that investments follow a 5-year straight-line depreciation. Thus, for the assets investments, $750{,}000 + 6{,}000{,}000 = 6{,}750{,}000$, we will have the depreciation per year of $6{,}750{,}000/11 = \$613{,}636.36$. The possibility to renovate the contract with Tecterra and the coalmine owner continuing to use the FOVOC macinhe, gives to FOVOC a considerable residual value. We will assume that it will be close to \$2,000,000 in 2018.

Note that we also apply the *modified accelerated cost recovery system* using the 10-year depreciation rates information presented in [8] (*pags*. 214-222). However, not significant differences are obtained capable to change the final evaluation (NPV increased 3%).

4.2.5 Risk incorporation

Risk may here seen as not only affecting the ECO's cost of capital, but expressively translated into the VAM project cash flows.

The uncertainty factors that characterize this sector must not be only affecting the cost of capital.

There are five main risks. The *first* reflects the possibility of VAM project to not be registered by UN or approved due to Chinese government issues. This would lead ECO to not issue CERs of anymore from VAM project. Nevertheless, in voluntary market, a new type of credits can be sold from $5 to $13 (see [4]). The probability of this occurrence rounds 20%. We assume that this new value for VAM's credits can be obtained with a curve of Gauss with a mean of $9.

Second risk comprises the fact that VAM is using drained methane component (50%) for which available technology exists. This can lead to the possibility of UN only finance ventilated emission, which would represent less 50% of emissions and, consequently, of CERs profits. We assume that this scenario has 30% of chance to occur.

Table 12 summarizes the calculation of a new value for the CERs profits based on this information, i.e., recurring to the formula: $CERs \times (Probprice1 \times CERprice1 + Probprice2 \times CERprice2 + Probprice3 \times CERprice3) = CERs \times (0.8 \times 0.7 \times p1 + 0.2 \times p2 + 0.8 \times 0.3 \times p3)$.

Third, we need to incorporate risk that comes from the possibility to sell energy produced by FOVOC. Selling FOVOC energy represents an opportunity to increase the project value, but can turn more difficult the UN approval (because the project's revenues must only come from the sale of carbon credits). Also, if this energy would be to supply hot water for the coalmine and the employees who live on site, not selling the energy can facilitate the Chinese government approval. Therefore, we assume that energy selling benefits must not be considered for the calculation of NPV.

Fourth, there is the chance that negotiations and approvals delay substantially the process, leading to a clear loss of CERs in the first year in result of that. We consider an average of the probability of each delay (1 month, 2 months...) to occur and its impact on CERs (loss of 1/12 CERs, 2/12 CERs...). We assume that the probability to these delays occur is 30% and that the impact of such delays comprises the loss of 1/6 CERs in the first year. Therefore, the new value for the profits of the first year: $0.3 \times (1-1/6) \times 2{,}919{,}994 + 0.7 \times 2{,}919{,}994 = 2{,}773{,}995$.

Finally, based on [4], we allocate an initial $50000 contingency reserve to cover financial risk associated costs overruns.

4.2.6 Working Capital

As any other project, VAM entails an additional investment in working capital. Nevertheless, here we don't have investment in inventories, because ECO only issues CERs and we can assume that FOVOC does not consume significantly any raw material. Moreover, from the opposite perspective, ECO customers are the buyers of CERs. Therefore, they cannot delay payments because to acquire a CER they need to pay promptly. In order to accurately define this parcel we consider that the time for ECO obtaining a CER and selling it in the market is 6 months, i.e., only half of the CERs obtained in a year will be sold only next year. This assumption defines the values considered for working capital as presented in table 13.

4.2.7 After-tax Income

Thus, using all the information that we had been collected, it is possible to determine the taxes to pay (based on: CERs profits – other costs –depreciation). The tax rate used was 12,5% in conformance with [4] assumptions. It is important to note that a negative tax payment here means a cash inflow, i.e. we are assuming that ECO can use this tax loss to shield income from other projects. See table 1 (sample) and table 14 in appendix.

TABLE 1
AFTER-TAX PROFIT

Year	2007	2008	2009	...	2018	2019
Capital Invest.	750000	545454	600000	...	1414769	0
CERs Profits	0	2773995	3011580	...	1336046	0
Depreciation	0	613636	613636	...	613636	0
Other Costs	120000	412500	412500	...	412500	0
△Working Cap.	0	-1386997	-1505790	...	0	668023
Pretax profit	-120000	1747859	1985444	...	309910	0
Tax (12,5%)	-15000	218482	248180	...	38739	0
Profit after tax	-105000	1529376	1737263	...	271171	0

4.2.8 Net Present Value of project VAM

At this time, all the conditions to determine the project cash flows are joined. After setting the project cash flow from operations, we determine the net cash flow (by comprising the amounts in capital investment, disposal and in working capital), and compute the discount factors. Here, the interest rate for ECO shareholders considered is 15% [4] (so discount factors will simply be $1/(1{,}15^i)$, with i = $0_{(2007)}$,$1_{(2008)}$,..,$12_{(2019)}$). See table 2 (sample), and table 15 in appendix.

TABLE 2
NET PRESENT VALUE

Year	2007	2008	2009	...	2018	2019
Capital Investment	750000	545454	600000	...	1414769	0
Invest. in Work.Cap.	0	-1386997	-1505790	...	0	668023
Depreciation	0	613636	613636	...	613636	0
Prof. after Tax	-120000	1747859	1985444	...	309910	0
CF from Ops	-105000	2143013	2350899	...	884808	0
Net Cash Flow	-855000	210561	245109	...	1450365	1110145
Discount factor	1	1,15	1,322	...	4,652	5,350
Present Value	-855000	183096	185338	...	-113912	498673

With a $NPV = \$2{,}569{,}083$
First impression leads to a concordance with the ECO's decision, i.e., the project should be accepted. However, we need to enrich our analysis with additional concerns and perspectives (sections 3.9-3.12).

4.2.9 Factors affecting the investment

External aspects that were not quantified also play an important role. Other factors that can influence ECO's decision comprise:

- *demand for CERs*. Although volatile, there is a clear trend to increase (and surpass our estimations based on historical data);
- *commitment of UE and US to long-term values to reach goals*. If it happens, it can substantially increase CERs value;
- *congestion of other sectors*. It can lead to an exploitation with the emergent ventilated sector, and supports the choice of VAM's project in case of NPV>0 as projects in other areas may have more difficult to succeed;
- *partnership with Tecterra*. In case of success this partnership can be used strategically;
- *possibility to renew the contract*. If the project extends its life-duration, there will be continuous profits generated from credits and a reduced value of FOVOC's depreciation that it is traduced in cash-flows with positive values;
- *first-mover advantage*. Facility to exploit this market and to seize contracts can represent a big impact on ECO's overall strategy.

4.2.10 An analysis on other indicators

In VAM's project, the profitability index adds information to NPV since it clarifies its magnitude. For VAM's project we have *PI* $= (2{,}569{,}083.095 + 6{,}750{,}000)/6{,}750{,}000 = 1.38$. As it is not too close to 1, we can say that the project can sustain a higher interest rate than the considered 15%. Moreover this is an important metric if we perceive ECO as a company who has a "hard rationing" to finance its projects. Does ECO actually have problem in financing its projects?

We can observe that ECO has a level of liabilities much greater than its equity (when compared with other companies of the sector), this can denote some difficulties (although the companies in the energy sector have facilities to contract loans). If this is the case the ECO's choice decision must not be based only on the NPV value but also on the profitability index and the time horizon of the project.

The payback period ratio is a trap for the VAM's project as the market knows that from 2012-2018 the price of credits can decrease due to Kyoto protocol expiration while the company has to support the linear amortization of initial investments in FOVOC and in the on-side factory. Thus, we cannot expect an extraordinary performance when the payback period ends in 2011 (see appendix Table 16).

4.2.11 Brief look to ECO's portfolio

Looking to ECO's range of projects under the Kyoto protocol (13) and to their dimension measured in number of Cers (approximately $3195/85 = 37{,}5$ KCers), VAM's project (which produces 10 KCers a year) it is not a source of so many credits as other projects (although we don't know clearly their credits profit margin and capital needs). However, if VAM would be approved by UN it would represent more a less 20% $(10/(10+42))$ of the total portfolio of ECO in China. Considering all NPV limitations, ECO's must continue with the VAM's project as it allows ECO to grow the company visibility in the Chinese sector (ECO's position is still small when compared with other companies [5]). Next table shows the data values estimated for 2008 (based on 2007 running projects) and previsions for 2012.

TABLE 3
FORECASTING CERS

Country	Projs	$KCers_{2008}$	$KCers_{2012}$
China	148	36295	527663
Total	883	113672	1175754
Country	ECO Projs	ECO $KCers_{2008}$	ECO $KCers_{2012}$
China	13	42	9241
Total	85	3195	46056

A closer look to ECO projects portfolio (table above), despite ECO is accustomed to Methane initiatives, reveals that ECO is not only immature in using the ventilated technology (although in line with other companies) but also in running projects in the coalmine sector, where it only has three projects. However, this analysis also leads to the importance of this move in seizing the benefits from three variables: congestion of other sectors, Tecterra's partnership interests and ventilated technology first-mover advantages.

TABLE 4
SIZING METHANE IN ECO PROJECTS PORTFOLIO

Country	Total	Registered	Pipeline
Carbon Dioxide	92	25	67
Methane	104	59	45
Nitrous Oxide	16	0	16
Hydrofuorocarbons	1	1	0
Coalmine	3	0	3
Total	213	85	128

4.2.12 Sensitivity and Scenario Analysis

As the NPV is function of a set of variables, it is relevant to consistently exercise variations of those variables which were estimated, and see to which degree they impact the NPV level. We will use the approval probabilities, the CERs market value and the lease fee to accord with Tecterra as three main variables to study a set of possible scenarios.

Investment Timing Analysis. Decision rule for investment timing, according to [8], is to choose the investment date that result in the highest net present value. There are two options: to immediately run the project or delay its beginning. As it is stated in [4], delays have several impact on the CERs issued (before 2012), thus only degrades project's overall performance.

Therefore, we assume that we want to start immediately the project. Two new options appear: increase or decrease the time duration of the project. Note that if we decrease the period, Tecterra's payment were not altered, only the annual costs and CER's profits (greater than the annual costs) were reduced *n* years, leading to a lower NPV. Thus this work excludes such option. Increasing time implies a renegotiation of FOVOC contractual values with Tecterra and increases the NPV vulnerability due to CERs price uncertainty. This uncertainty is so great, that speculations offset any reliable margin of NPV values for this new time horizon. Said this, the project duration will remain the same.

Hard or Soft Rationing Regime. On the one hand, the ECO balance reveals us dependency on loans to finance projects that can degrade a soft rationing scenario. On the other hand, the amount of projects in execution by ECO (previous section) together with the increasingly ease of financing projects on the green energies sector (see [5]) turns the project appraisal independent from other projects decisions. Thus, it can be assumed that ECO evaluates project according to nearly approximated soft rationing regime.

Approval probabilities. The probability of UN approve the project is 80%, and in this case 30% of only admitting half of the CERs (excluding the drained methane). Fixing the second percentage, we see that the project can sustain a positive NPV if we change the approval percentage until 40% (admitting that CERs can be acquired in the free market for 9$ each one). The second factor refers to the partial approval and has a near effect than the first, here we can increase this variable until 70% and continue obtaining a positive NPV. If we use data mining techniques with all of these factors, we can obtain relations among those variables that sustain a positive NPV.

CERs Price Estimation. Two ranges of prices must be consider: if UN approves or not the project. In the first case, the decrease of the CERs prices is only until 15% (meaning that a $20 CER can only decrease in average until $17) for the project still be approved, i.e., to have a positive NPV. Note that the second hypothesis, as it is less probable to happen, CERs in the free-market can decrease until 50%. This, however, increases strongly the risk of the project; as if VAM is not approved by UN, it will result on a bigger loss for ECO.

Tecterra's lease fee. We found this rate to be of maximum importance for the NPV calculation. We assumed that 10% was accorded. However, if we increase this rate to 17%, no longer ECO can sustain the will of 15% of VAM's project interest rate of return. This is an important variable and, consequently, must be carefully defined during ECO and Tecterra negotiations.

4.3 Financing VAM project

Two major aspects will be briefly reviewed on this section. First, the way financing approximations can be incorporated into the valuation of VAM. Second, assuming that investment decision is done, we need to focus on the best way to finance VAM.

Incorporate Financing into VAM Valuation. To use financing to affect the investment decision we just need to calculate the NPV by discounting at an adjusted rate. We can use the after-tax weight cost of capital to define this rate. Defining r_E and r_D as the expected rate of return demanded by investors in equity securities and in ECO's debt (e.g. 11% as a result of bank loan), and considering that the project is 20% financed by ECO's equity and 80% by debt, we just need to define a new discounting rate: $rD \times (1-tax) \times 0.4 + rE \times 0.6 = 0.11 \times (1-0.125) \times 0.4 + 0.15 \times 0.6 = 0.107$. Note that the percentages of the capital structure (40% *vs* 60%) were obtained based on other ECO projects (see table 8 in [4]).

Despite assuming that capital structure and

r_D values would lead to an increased NPV (since $awcc_{rate}$=10,7% < $interest_{rate}$=15%), the amount of equity exposed to the defined shareholders interest rate would be lower. Since usual $rD \times (1-0{,}125)$ taxes for short-term financing are lower than r_E=15%, the simple introduced example illustrates well what would the most probable analysis: using debt to finance the project increases the NPV but limits the exposure of equity to the shareholders' interest rate.

Financing Choice. To study the financing options of the VAM's project would require a detailed awareness of the major financial institutions that provide loans (and for each one the range of alternatives) and of the wide variety of securities that ECO can issue. Thus, the goal of maximizing the VAM's financing structure is complex due to the huge number of possible combinations. Also, modern capital markets are highly competitive, efficient (prices of stocks, bonds, and other securities react quickly and accurately when new information arrives) and demanding fair terms. Moreover, most of the times spread for loan rates are variable and not anticipatively revealed. Thus, we leave a deepen analysis of financing options and choice for a possible future research.

5. DISCUSSION AND CONCLUSION

The analysis conducted in this paper reveals that ECO's decision was mature, i.e., VAM's project must be accepted. We used the NPV for the VAM's project as the main argument to support this statement. However, we also saw that several variables were of maximum importance, as the project risk, timing alternatives, subcontracting and financing dependencies, strategic fit factors and ECO's rationing role.

We used theory of probabilities to place the risk in our calculus. Main risk sources for VAM's project come from United Nations, Chinese government, coalmine owner, ECO's customers and governments wills. UN determines the certification of credits for emission reductions and the quantity of reductions considered. Chinese government and coalmine owner can determine the project execution and their interests add volatility to the potential profit margin. ECO's customers determine the changes in working capital and their will affect directly the price of credits (either certified or acquired in the free market). Governments' initiatives can also affect the prices of CERs after the Kyoto expiration.

Delay or reduce the project duration were refuted. Benefits from a possible extension of project duration were insignificant and volatile.

A strong dependency between NPV and the equipment supplier interest rate was detected during the sensitivity analysis. This means investing decision must be balanced with this expected rate (¡17%). This work also saw that the project NPV depends on the capital structure and on the interest rate for debt, however it was stated that reasonable values for the debt interest rate would not affect negatively NPV.

Additionally we study how a set of factors could benefit ECO's strategically. Congestion of other sectors, the first-mover advantage and Tecterra's partnership potentialities were pointed as aspects, not contemplated in the NPV value, creating pressure for ECO's to decide positively for the project investment.

The conducted research revealed a facility for ECO's company to finance its projects, which lead to an approximation of a soft rationing scenario. In such a scenario, project alternatives are under-considered when the project under analysis has a positive NPV. This argument supports our evaluation. However, if it is not clear that this is the ECO's scenario, we presented the VAM's profitability index and demonstrated its good performance when compared with other projects from ECO's company.

An analysis of the economic and financial situation of EcoSecurities revealed that ECO is not using efficiently its assets and is not able to generate net profits from its funds. Possible reasons is their growing nature, the time window between the obtaining and selling of CERs or the late cash in-flows nature of their projects (requiring initial higher capital expenditures).

VAM project has a special fit with ECO financials, as it answers to the third reason since Tecterra contract enable periodic payments that lead to a good payback ratio. Additionally, ECO may benefit from reducing their liquid assets and enhance rapid profits by building a portfolio with investments in a different sector.

Several lessons may be applied to similar scenarios within the same sector. First, aspects as an accurate CERs estimation, country and coalmine agreements and the creditation and monitoring processes must play a clear role in the NPV calculation. Second, there must be a project fit within the company (at a strategic, profitability and risk level). As we saw, ECO would neither benefit from a project with late cash in-flows nor impact the short and long-term of its assets when compared to its liabilities structure.

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APPENDIX

0.1 VAM PROJECT CONTEXT

Cheap coal improved the Chinese economy, but thousands of miners were injured or killed by coalmine explosions caused by methane accumulation. To control methane levels, mine owners used ventilators (fresh air introduction) and drainage (collect methane with boreholes drilled in the earth surrounding a mine) systems [4]. Removing methane from coalmines is essential to miners' safety, however polluting the air with methane contributes to global climate change[5] [6]. Nevertheless, the methane dumped from mines in high concentrations could be used to produce energy[6]. Therefore, a few projects using drained methane had been submitted to the UN. However, the Ventilation Air Methane (VAM) Project in Sichuan province would be the first project submitted using ventilated methane [4].

Ventilated and drained methane exited the Sichuan coalmine in similar quantities, totalling approximately 20,000 tonnes of methane per year. To enrich the ventilation stream and increase efficiency of the equipment used, the drained gas would be mixed with the ventilated air stream.

0.2 PROJECT DESCRIPTION

The VAM Project involved a three-way collaboration between ECO, the coalmine owner and Tecterra, a leading international producer of industrial machinery[7], that would provide innovative technology, such as, a giant machine called the FOVOC which would oxidize the mixed methane stream to convert the gas into CO2 and water. The FOVOC would emit 2.95 tonnes of CO2 for every tonne of methane it destroyed. And it was estimated that only 50% of the potential emission reductions would be realized in order to comprise the methane that would escape of the FOVOC due to a combination of downtime for scheduled maintenance, performance uncertainty and methane concentrations that could not be processed by FOVOC.

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5. In 2000, coalmines accounted for 8% of all human-caused methane emissions; other sources included natural gas and petroleum production, landfills, among others [6].

6. Methane accounts for over 20% of global energy consumption [7].

7. Accessed via http://www.ucalgary.ca/news/july2009/tecterra, November 25, 2009

It was forecasted that the project would abate about 10,000 tonnes of methane per year. And that 2% of all CERs generated were drawn into a climate change adaptation fund for communities in countries that were especially vulnerable to climate change risks.

0.3 PROJECT AGREEMENTS

The parties involved in the project tentatively negotiated a ten-year contract with the possibility of renewal beyond 2018. ECO expenses relating to this negotiation and the preliminary evaluation of the project site would amount to $45,000. Upon reaching a deal, it would take seven months for the FOVOC machine to arrive at the project site from a factory, and another month to install.

It was agreed that ECO would pay the mine owner $3.8 per credit and also a $0.20 tax per CER that the mine owner would pay to the Chinese government. Tecterra would be investing heavily in the Project, approximately $5 million to manufacture, ship, install, and insure the FOVOC. ECO had to propose a lease fee that met Tecterra's required rate of return while keeping ECO's overall costs of acquiring the CERs below $18 per credit. Tecterra required a 20% pre-tax internal rate of return on its investment. There was the risk that Tecterra would require ECO to continue to pay the agreed-upon lease fee through 2018, even if the Kyoto Protocol was not renewed in 2013 and CERs lost value.

0.4 PROJECT COSTS

ECO would take several activities, such as, to set up a power and water supply, to construct gas pipes to transport the drained methane to the FOVOC, to clear away a small coal processing factory and to level the land near the ventilation shaft for constructing there a pump room, a low-voltage distribution room, a control room and a janitor's room. These works would cost $750,000.

The cost of drawing the document containing the description, implementation and impact of the project would amount to $55,000. After the official approval by Chinese government, ECO would pay $15,000 for an UN-accredited organization to screen and validate the Project before being submitted to the UN. Once the UN approved and registered the project, it could start earning credits. ECO would have to pay a registration fee based on the expected annual credits to cover UN's costs: for the first 15,000 tonnes of reduced CO2e it would pay $0.10 per tonne and for each tonne thereafter would pay $0.20.

Costs of electricity, maintenance, annual operations and ensuring that machinery and subsequent data was properly monitored would amount to $362,500. In order to verify the accuracy of reported emission reductions a second independent UN approved organization to monitor and verify the data it would be needed and would cost $50,000.

0.5 PROJECT RISKS

There were various uncertainties associated to the VAM project, in particular the approval by the Chinese government and by the UN. There was also the uncertainty about the timing of approval, and delays would be costly. It would be possible that UN would view the drained gas supply as ineligible for certification and thus, was estimated a 20% chance that the UN would issue credits only for reductions of ventilated emissions and not for reductions of drained emissions.

There was also a risk associates with CERs price. By the time of the project analysis, CERs were trading at prices around $26 per tonne of CO2e. However, it would be hard to estimate CERs price after the Kyoto Protocol expired in 2012. Finally, a contingent of $500,000 was reserve for the risk related to cost overruns.

The following assumptions were applied during the project evaluation:

- 12.5% corporate income tax on profits
- 15% discount rate when valuing project cash flows

5-year straight-line depreciation to all capital costs

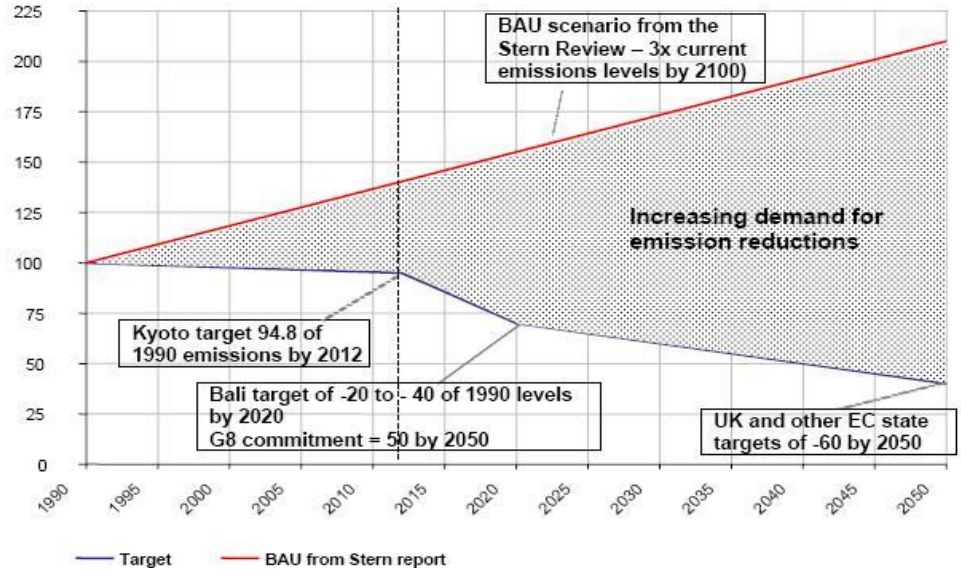

Fig.7. Growing Demand for Emission Reductions [9]

TABLE 5
ECOSECURITIES BALANCE SHEET [10,11]

values in *euros*'000	31-Dec-07	31-Dec-06	31-Dec-05
Assets			
Non-current assets			
Intangible assets	4039	3412	102
Property, plant and equipment	4712	2463	134
Investment in subsidiaries			
Deferred tax assets	229	-	-
Trade and other receivables	834	531	-
Total non-current assets	9814	6406	236
Current assets			
Inventory	10916	-	-
Derivative financial assets	2641	-	-
Trade and other receivables	20973	5020	1320
Cash and cash equivalents	88076	60452	83148
Total current assets	122606	65472	84468
Total assets	132420	71878	84704
Shareholders equity			
Issued share capital	282	232	229
Share premium	173127	76446	75853
Share-based payment reserve	902	664	337
Currency translation reserve	-506	-74	-52
Other reserves	-573	-573	-573
Retained loss	-70019	-25009	-5022
Total shareholders equity attributable to shareholders of the parent	103213	51686	70772
Liabilities			
Non-current liabilities			
Trade and other payables	3040	3040	8753
Deferred tax liabilities	186	58	4
Total non-current liabilities	3226	3098	8757
Current liabilities			
Interest bearing loans and borrowings	-	7582	35
Trade and other payables	12137	8884	5028
Derivative financial liabilities	1505	-	-
Current tax payable	1411	628	113
Provisions	10928	-	-
Total current liabilities	25981	17094	5176
Total liabilities	29207	20192	13933
Total equity and liabilities	132420	71878	84705

TABLE 6
ECOSECURITIES CASH FLOWS STATEMENT [10,11]

values in *euros*'000	31-Dec-07	31-Dec-06	31-Dec-05
Cash flows from operating activities			
Loss for the financial year	-45,079	-20,046	-4318
Income tax expense /(credit)	1,748	573	115
Finance income	-7,043	-2,405	-125
Finance expense	14,464	856	339
Depreciation of property, plant and equipment	587	200	27
Amortisation of intangible assets	137	52	-
Impairment of intangible assets	1,323	-	-
Project costs transferred to inventory	-	125	-
Write-down of inventory 429	-	-	
Loss on disposal of property, plant and equipment	- 139	-	
Net profit on joint ventures	-	-	-498
Share-based payment expense	307	385	276
Foreign exchange movement	-994	-294	-100
Change in inventory	11,345	-	-
Change in trade and other receivables	-8773	-3981	-682
Change in trade and other payables	3,610	9627	2037
Creation of provisions	816	-	-
Interest paid	-334	-428	-270
Tax paid	-974	-	-
Net cash used in operating activities	-51,121	-15197	3047
Cash flows from investing activities			
Interest received	3,262	2170	65
Acquisition of businesses	-170	-	-
Purchase of property, plant and equipment	-2,849	-2673	-131
Investment in intangible assets	-8214	-3487	-3076
Net cash used in investing activities	-7,971	-3990	-3059
Cash flows from financing activities			
Proceeds from the issue of ordinary share capital	100,045	85	83667
Proceeds from issue of new loans	-	-	8745
Payment of share issue transaction costs	-3502	-2222	-5558
Repayment of borrowings	-7,866	-300	-449
Movement in restricted cash deposits	-13136	-5824	-583
Net cash generated from/(used in) financing activities	75,541	-8261	85823
Net increase /(decrease) in cash and cash equivalents	16449	-27448	82476
Cash and cash equivalents at start of year	54,045	82565	77
Effect of foreign exchange rate fluctuationson cash and cash equivalents	-1,865	-1073	13
Cash and cash equivalents at end of year	68629	54045	82565

TABLE 7
THE CALCULATED RATIOS VALUE AND RESPECTIVE INDUSTRY AND SECTOR RATIO VALUE

	2007	2006	2005	Industry	Sector
Liquidity Ratios					
Curent Ratio	4.719063931	3.83011583	16.31916538	2.43	1.41
Quick Ratio	4.298910742	3.83011583	16.31916538	2.75	1.75
Cash Ratio	3.390015781	3.536445536	16.06414219	-	-
Activity Ratios					
Asset Turnover	0.070700643	0.039250999	0.028605302	0.09	0.26
Receivable Turnover	0.331178062	0.553593947	1.718181818	0.7	1.73
Debt Ratios					
Debt to Equity Ratio	0.282977919	0.390666718	0.196871644	29.69	93.8
Long Term Debt to Equity	0.031255753	0.059938862	0.123735376	21.75	66.13
Profitability Ratios					
Gross Margin	0.723	1.699	0.103	4.83	9.52
Operating Margin	-4.97230684	-6.840872112	-1.758377425	0.9	1.49
Net Profit Margin	-6.241899751	-6.523267166	-1.903439153	0.08	0.7
Return on Assets	-0.340424407	-0.278889229	-0.050965716	0.32	0.27
Return on Equity	-0.436756998	-0.387841969	-0.0609987	0.57	0.5
Market Ratios					
Dividend Yield	0	0	0	0.13	0.03
Payout Ratio	0	0	0	4.24	14.3
P/E Ratio	-2.045454545	-3.363636364	-0.592592593	12.84	16.06
Price to Sales	12.75938798	22.20505695	1.13643739	0.17	0.48
Price to Book	0.929157844	1.413517421	0.036472003	1.84	1.28
Price to Cash Flow	-0.017605289	-0.048693821	-0.051417186	1.04	6.34

TABLE 8
INITIAL INVESTMENTS

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
FOVOC	0	545454	600000	660000	726000	798600	878460	966306	1062937	1169230	1286153	1414769
Operationalization	750000	0	0	0	0	0	0	0	0	0	0	0

TABLE 9
REVENUES AND VARIABLE COSTS

	#CERs per $\frac{tonofmethane}{year}$	$\frac{tonofmethane}{year}$	# CERs (or #CO_2 tons)
Coalmine emissions of methane	21	20000	420000
Machine emissions[4]	(1.950)	-	(39000)
Effeciency of combustion	18.05	20000	361000
Tons of methane not handled[5]	-	(10000)	(180500)
Overall Efficiency	18.05	10000	180500
Support to countries vulnerable to climate risks	(0.361)	-	(3610)
Coalmine owner accords	(3.8)	-	(38000)
Chinese government accords	(0.2)	-	(2000)
Total	13.689	10000	136890

TABLE 10
CERS PORTFOLIO

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
CER price	26	29	30	28	25	20	15	14	13	12	12	12
CER Profits excluding fee (| $CERs$ | $*price$)	3969810	4106700	3832920	3422250	2737800	2053350	1916460	1779570	1642680	1642680	1642680	
CER Profits	3943932	4079322	3805542	3394872	2710422	2025972	1889082	1752192	1615302	1615302	1615302	

TABLE 11
FIXED COSTS

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Fixed Costs ($)	70000+50000	412500	412500	412500	412500	412500	412500	412500	412500	412500	412500	

TABLE 12
RISK OF APPROVAL

Situtation	Prob	2008	2009	2010	2011	2012
CER profits with UN total approval	80% * 70%	2208601,922284420,32	1901128,32			
CER profits with UN parcial approval[6]	80% * 30%	470166,48	486233,28	453379,68	404099,28	321965,28
CER profits without UN approval	20%	241226,4	240926,4	240926,4	240926,4	240926,4
CER Profits	SUM	2919994,8	3011580	2825409,6	2546154	
CER Profits (adjusted 2008)	SUM	2773995,06	3011580	2825409,6	2546154	

Situtation	Prob	2013	2014	2015	2016	2017	2018
CER profits with UN total approval	80% * 70%	904569,12	904569,12	904569,12			
CER profits with UN parcial approval[7]	80% * 30%	239831,28	223404,48	206977,68	190550,88	190550,88	190550,88
CER profits without UN approval	20%	240926,4	240926,4	240926,4	240926,4	240926,4	240926,4
CER Profits	SUM	1615302	1522216,8	1336046,4	1336046,4	1336046,4	
CER Profits (adjusted 2008)	SUM	1615302	1522216,8	1336046,4	1336046,4	1336046,4	

TABLE 13
CHANGES IN WORKING CAPITAL

Situtation	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
CERs prod ($)	2773995,06	3011580	2825409,6	2546154	2080728	1615302	1522216,8	1429131,6	1336046,4	1336046,4	1336046,4	0
CERs selling[8]	1386997,53	2892787,53	2918494,8	2685781,8	2313441	1848015	1568759,4	1475674,2	1382589	1336046,4	1336046,4	668023,2
Changes in Wcap	-1386997,53	-1505790	-25707,27	232713	372340,8	465426	279255,6	93085,2	93085,2	46542,6	0	668023,2

TABLE 14
PROFITS AFTER TAXES

Year	2007	2008	2009	2010	2011	2012	2013
Capital Invest.	750000	545454	600000	660000	726000	798600	878460
CERs Profits	0	2773995,06	3011580	2825409,6	2546154	2080728	1615302
Depreciation	0	613636,3636	613636,3636	613636,3636	613636,3636	613636,3636	613636,3636
Other Costs	120000	412500	412500	412500	412500	412500	412500
△Working Cap.	0	-1386997,53	-1505790	-25707,27	232713	372340,8	465426
Pretax profit	-120000	1747858,696	1985443,636	1799273,236	1520017,636	1054591,636	589165,6364
Tax (12,5%)	-15000	218482,337	248180,4545	224909,1545	190002,2045	131823,9545	73645,70455
Profit after tax	-105000	1529376,359	1737263,182	1574364,082	1330015,432	922767,6818	515519,9318

Year	2014	2015	2016	2017	2018	2019
Capital Invest.	966306	1062937	1169230	1286153	1414769	0
CERs Profits	1522216,8	1429131,6	1336046,4	1336046,4	1336046,4	0
Depreciation	613636,3636	613636,3636	613636,3636	613636,3636	613636,3636	0
Other Costs	412500	412500	412500	412500	412500	0
△Working Cap.	279255,6	93085,2	93085,2	46542,6	0	668023,2
Pretax profit	496080,4364	402995,2364	309910,0364	309910,0364	309910,0364	0
Tax (12,5%)	62010,05455	50374,40455	38738,75455	38738,75455	38738,75455	0
Profit after tax	434070,3818	352620,8318	271171,2818	271171,2818	271171,2818	0

TABLE 15
PRESENT VALUE OF CASH FLOWS FROM OPERATIONS

Year	2007	2008	2009	2010	2011	2012	2013
Capital Invest.	750000	545454	600000	660000	726000	798600	878460
Invest. in Working Cap.	0	-1386997,53	-1505790	-25707,27	232713	372340,8	465426
Pretax profit	-120000	1747858,696	1985443,636	1799273,236	1520017,636	1054591,636	589165,6364
Cash Flow from Operations	-105000	2143012,723	2350899,545	2188000,445	1943651,795	1536404,045	1129156,295
Net Cash Flow	-855000	210560,6475	245109,5455	1502293,175	1450364,795	1110144,845	716122,2955
Discount factor (r=15%)	1	1,15	1,3225	1,520875	1,74900625	2,011357188	2,313060766
Present Value	-855000	183096,2152	185338,0306	987782,1487	829250,7791	551938,19	309599,4304

Year	2014	2015	2016	2017	2018	2019
Capital Invest.	966306	1062937	1169230	1286153	1414769	0
Invest. in Working Cap.	279255,6	93085,2	93085,2	46542,6	0	668023,2
Pretax profit	496080,4364	402995,2364	309910,0364	309910,0364	309910,0364	0
Cash Flow from Operations	1047706,745	966257,1955	884807,6455	884807,6455	884807,6455	0
Net Cash Flow	360656,3455	-3594,204545	-191337,4145	-354803,0405	-529960,9691	2668023,2
Discount factor (r=15%)	2,66001988	3,059022863	3,517876292	4,045557736	4,652391396	5,350250105
Present Value	135584,0789	-1174,951841	-54390,03497	-87701,88531	-113911,5186	498672,6129

TABLE 16
PAYBACK

Year	2007	2008	2009	2010	2011	2012	2013
Present Value	-855000	183096,2152	185338,0306	987782,1487	829250,7791	551938,19	309599,4304
$\sum PV_i$	-855000	-671903,7848	-486565,7542	501216,3945	1330467,174	1882405,364	2192004,794

Year	2014	2015	2016	2017	2018	2019
Present Value	135584,0789	-1174,951841	-54390,03497	-87701,88531	-113911,5186	498672,6129
$\sum PV_i$	2327588,873	2326413,921	2272023,886	2184322,001	2070410,482	2569083,095