Cost-effective applications of the Clean Development Mechanism in Eritrea, East Africa

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1. SYNOPSIS

Incremental capital investment cost calculations for Eritrean efficiency and renewable energy programs provides Eritrea's CDM credit supply curve for unsubsidised fair market prices.

2. ABSTRACT

Optimum mitigation of global climate change impacts requires minimising the cost of reductions in greenhouse gas emissions reductions. The two requirements for achieving cost minimisation are (1) identifying minimum cost projects, and (2) negotiating access and credit for minimum-cost projects. Energy efficiency and renewable energy investments in Eritrea, East Africa provide some of the most cost effective emissions reductions investments available. In Eritrea an emissions reduction credit or payment of $10 per ton ($1.0 = 1.1 Euro) of avoided carbon emissions can provide approximately 85% of the cost of a national rural household efficiency enhancement program. The most effective projects in the Eritrean case involve market transformation programs that can double or triple efficiency of household cooking. For such programs an approximate reduction of annual Carbon emissions of 0.3 tons per year per household are possible. CDM can also make substantial contributions to efficiency enhancements throughout the energy sector along with contributions to wind energy development. In this paper we provide descriptions and cost/benefit estimates of a spectrum of potential Eritrean CDM projects. We conclude with a discussion of equity issues and fair exchange prices for carbon emissions reduction programs.

3. INTRODUCTION

As we reach the year 2001, we find that the earth's atmosphere is reaching the limits of its capacity to absorb anthropogenic CO_2 emissions. We are now entering the phase where the global economy is starting to incur the very significant global environmental and economic costs from climate change. It is no longer a question of IF we will incur such costs, but a question of how these costs will be distributed. Economic policy analysts are now confronted with the question of how the consumption of the non-renewable resource of the earth's greenhouse gas emissions tolerance will be priced, traded, expropriated or allocated. We define "global climate capital" as the capacity of the Earth's eco-sphere to absorb greenhouse gases without excessive climate change costs. How global climate capital is used, rented, and appropriated will be a continuing political and economic negotiation process, and the analysis of costs, benefits, and prices will allow a diversity of actors to optimise their negotiating positions.

Most of the cumulative CO_2 emissions have been made by a handful of mostly developed countries. Developed areas such as North America have emitted a total of approximately 233 tons of fossil fuel carbon per capita (1998 population) for the 1870-1990 period compared to less than 6 tons of cumulative fossil carbon per capita for Africa, and 88 tons per capita average for Western Europe. People from the developed world are therefore using anywhere from fifteen to nearly forty times the share per person of the Earth's global climate capital compared to people in Africa. When land use change is considered, Africa's per-capita share increases by a factor of 3-4 but stark inequality in the use of global climate capital remains.

The development of energy supplies to meet the needs of an increasing standard of living in the developing world can follow development paths which are either more or less carbon-intensive. Given current and near-term technologies, the less carbon-intensive development paths tend to require more financial investment capital. This is because investments like efficiency and renewable energy substitute capital equipment and infrastructure investment for fuel cost savings, and this requires capital.

Yet, developing countries tend to have shortages of financial capital compared to developed countries, so that energy and other productive processes tend to have low capital intensity and high operating costs in the developing world compared to more developed countries. In the energy sector this means that production of energy services tends to be less efficient and tends to have higher fuel consumption rates than average energy services production in developed countries. On the other hand the disproportionately low incomes in developing countries generally means that the over-all consumption of energy services remains low even though the energy sector efficiencies may be low. The result is that per-capita Carbon emissions in developing countries are a fraction of those in developed countries.

The Clean Development Mechanism (CDM) attempts to reduce the financial capital investment costs of carbon emissions reductions in developed (Annex I) countries. It does this by allowing developed countries to reduce the cost of emissions reductions investment by getting credit for investments in those sectors of the developing world who are willing to make low-cost emissions reductions investments. In some sense, CDM is designed to increase the inequality in usage of the Earth's global climate capital by decreasing the cost of over-consumption by developed countries through decreased consumption in developing countries.

From the perspective of the Eritrean people, the CDM will be insufficient to balance the true costs of confronting carbon emissions and climate change impacts. Eritrea is likely to be already incurring quite substantial costs to its economy from a relatively recent (in the last 30 years) increase in droughts and inter-annual rainfall fluctuations. We estimate that adverse climate change impacts may be as high as 30% of Eritrean cereals, pulses, and oilseed production and the costs may be born disproportionately by the poorest of Eritrea's people. CDM, with its emphasis on minimising investment costs for Annex I investors, can be only one piece of an integrated global climate change mitigation policy.

In this paper we provide a case study of the CDM potential of Eritrea. We begin with a description and estimate of some of the climate change costs that may be incurred by Eritrea's population already. We proceed with an estimate of which countries are receiving the benefits of global climate change cost externalisation given the principle of the equality of human rights. We then provide a description of the Eritrean energy sector and a baseline estimate of future carbon emissions. We go on to discuss different carbon emissions reduction investments and estimate the capital intensity of each. We then calculate the fair market price of emissions reductions based on the price that is required to recover the full incremental capital cost. We conclude with a discussion of the potential emissions reduction strategies, emissions reduction amounts, and the fair market price for such emissions reductions. We end with a request for CDM partners that are interested in fair, unsubsidised emissions reduction projects.

4. CLIMATE CHANGE COSTS TO THE ERITREAN ECONOMY

The Eritrean economy may already be paying a substantial price as a result of the carbon emissions by developed countries. An analysis of regional rainfall records indicates that seasonal rainfall anomalies (for July and August rainfall) have been getting more extreme with more severe droughts in recent years. Four of the ten most extreme years of the last century have occurred in the 1990's with two more of the ten most extreme years occurring in the 1980's. Furthermore, compared to the first half of the century, the extremes have tended towards drought, especially since 1965 when global CO_2 concentrations accelerated their increase resulting in a 1.4 ppm/year increase in CO_2 from 1965 to 1999 compared to a 0.35 ppm/year increase from 1900 to 1950.

In order to estimate the economically efficient global environmental rent that large energy consumers should be paying Eritrea for climate impacts to the Eritrean economy, we estimate the average agricultural impacts of rainfall anomalies in the 1975 to 1999 period.

First we calculate the monthly rainfall anomaly. For a given station, we calculate the average rain, the standard deviation of year-to-year fluctuations in monthly rainfall, and then define the anomaly as the rainfall fluctuation (difference from average) divided by the standard deviation. This provides a dimensionless rainfall anomaly for each rainfall station. Our analysis used the World Meteorological Organisation stations between 30E and 50E longitude and 10N and 20N latitude that have at least a 50% completeness of record for 1900 to 2000. We then calculated the average anomaly for each month of each year and took the sum of the July and August anomalies as indicative of the primary growing season rainfall anomaly for the region.

Next, we took recent statistics of agricultural production from Eritrea and calculated the correlation between regional rainfall anomaly and agricultural production. We take the sum of the FAO statistics for cereals, pulses, and oilseeds and obtain the following table:

Table 1: Eritrean agricultural production (cereals, pulses and oilseeds) and regional rainfall anomaly for the 1993-1998 period

Year	Production (Mt)	Rainfall Anomaly (1900-1950 base)
1993	124380	-0.49
1994	318737	1.14
1995	225080	-0.08
1996	148900	-0.86
1997	163000	-1.10
1998	528613	1.25

Correlating rainfall anomaly with production we find that for this period a rainfall anomaly of 1.0 produces a change in production of 133,000 metric tons. From 1980 to 1999, the regional rainfall anomaly has averaged –0.6 below the 1900 to 1950 average indicating that Eritrea may be experiencing agricultural impacts from climate change that are fluctuating but tend towards drought over the long term. Using the average change in anomaly we may estimate average production impacts of –80,000 Mt/year. In addition, there are larger year-to-year rainfall fluctuations compared to the rainfall regime that existed earlier in the century. The systematic drought impacts are approximately 30% of the average production over the 1993-1998 period. This is a very significant potential impact that may quite literally remove one quintal of food from the typical rural Eritrean household each year on average. Such impacts will be greatest on the rural sectors of society who earn the least cash income.

5. ESTIMATION OF GLOBAL CO_2 EMISSIONS SHARES

The calculation of Eritrea's relative contribution to climate change mitigation and efficient compensation for such a contribution requires a calculation of who is using what share of the Earth's global climate capital.

In this calculation we use the carbon emissions data provided by Carbon Dioxide Information Analysis Center at Oak Ridge National Laboratory, USA. We calculate the total carbon emissions from the sum of fossil fuel consumption, cement manufacture, and land use changes for the world, North America, Western Europe and Africa. And because CO_2 has a residence time in the earth's atmosphere of approximately 120 years, we take the sum of the carbon emissions over the 120-year period of 1870 to 1990 as indicative of which economies are currently utilising the earth's global climate capital. The results of the calculation are summarised in the following table:

Table 2: Cumulative carbon emissions shares for different areas of the world for the 1870-1990 period

	World	North America	Western Europe	Africa
Fossil Fuel & Cement Emissions (millions tons of Carbon)	216000	71000	37000	4300
Total Emissions (millions Mt C)	331000	81000	39000	16600
Use Share	100%	25%	12%	5%
Population (1998, millions)	5900	300	420	750
Fossil Fuel & Cement Emissions (Mt C/capita)	37	230	88	5.6
Total Emissions (Mt C/capita)	56	268	92	22
Use of Global Climate Capital Share	100%	476%	164%	39%

Some figures may not match due to rounding…

As can be seen from the above table, Africans on average are using only 39% of their share of global climate capital compared to 476% for North Americans and 164% for Western Europeans. Under current conditions, the developed countries are borrowing from developing countries' share of global climate capital. To the extent that the Clean Development Mechanism can approximate a fair return for the loan the developing world's global climate capital to the developed countries, then CDM can perhaps contribute to increasing the economic efficiency of global climate change management.

6. OVERVIEW OF ERITREAN ENERGY SECTOR

The Eritrean energy sector in broad strokes is similar to other countries with very low per-capital income. In 1995, about 78% of primary energy consumption was biomass for household cooking applications in stoves and devices that have efficiencies of approximately 5-10%. The transportation sector is the next largest sector with regards to energy use. Diesel, petrol, and fuel oil account for 17% of energy consumption and other oil products (kerosene, Liquid Petroleum Gas (LPG), and Jet Fuel) account for about 4%. Electricity was about 1% of energy consumption in Eritrea and was generated and distributed with a combined efficiency of about 30%. A generation and distribution efficiency of 45% is probably feasible, with a new power plant and power distribution network making substantial progress recently.

7. BASELINE CARBON EMISSIONS SCENARIO

In the baseline Eritrea carbon emissions scenario, we must assume that without financial assistance, there will be relatively low investment levels in special programs for energy efficiency improvements. In that case, there is little if any increase in the efficiency of stoves and other appliances. And the growth in energy use is driven by growth in population, commercial energy services and national income. Population growth is expected to slow down from the present to 2050. The UNDP projects a population of 9.0 million in 2050, up from the 3.6 million in 1998. And the annual population growth slows down from the current 3% per year to less than 1% per year by 2050.

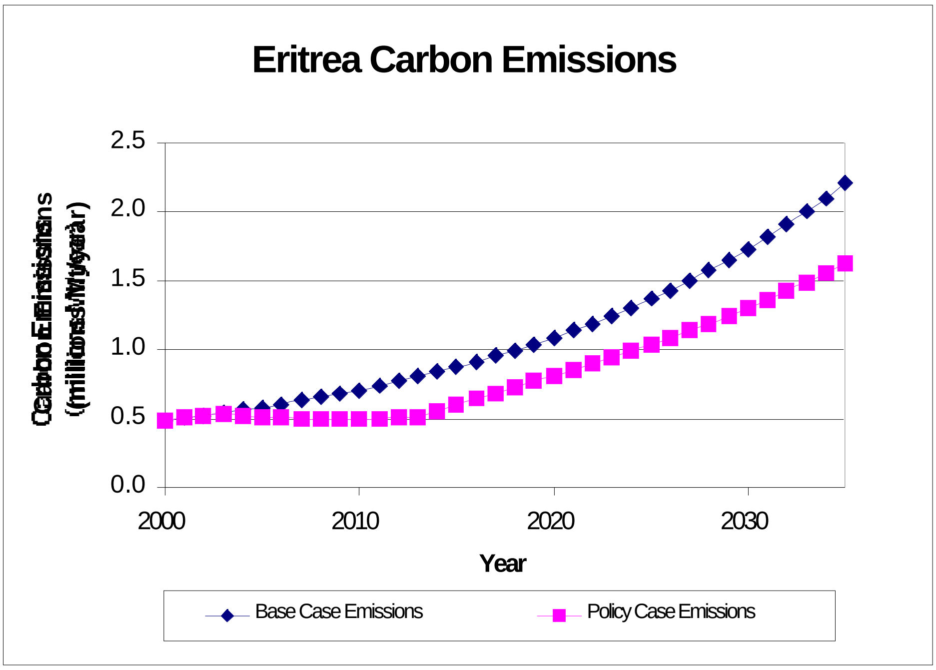
We construct a rough model for energy use projections from 1950 to 2050. In the model we make the following assumptions:

- First that population growth has been 3.0% per year from 1950 to 1996, and that from 1996 to 2050 the population growth rate decreases by 0.042% per year.
- That national income growth is 6% per year and that per-capita income was $200 in 1992.
- That the fraction of the population with electricity increased 0.3% per year from 1950 to 1996. That the fraction of people with electricity in 1996 was 20%, and that from 1996 to 2050 the fraction of people without electricity decreases 2% per year (when compared to the faction without electricity the previous year).
- That the per-capita biomass consumption is 0.6 metric tons per year, and that all households without electricity use primarily biomass, and half of the houses with electricity continue to be heavy biomass users.
- That electricity function is proportional to the fraction of people with electricity service, the population, and inversely proportional to an electric sector efficiency factor that increases 1% per year.
- That national primary biomass production is 15 million metric tons per year.
- That 30%, 25%, 20%, 15%, 7.5%, and 2.5% of national primary biomass production goes into ecological stocks that have mean lifetimes of 1, 3, 5, 10, 20 and 50 years respectively when undisturbed by household energy use.
- That households harvest their biomass fuel from different ages of stock proportional to the amount of biomass resident in that age of stock.
- That in 1950 (for an initial condition of the biomass stock calculation) the biomass stock is in equilibrium with conditions of no human harvesting.

Data inputs for the model include the estimate of 0.6 Mt/capita biomass consumption, a 1998 population of approximately 3,577,000 (from the UNDP), electricity consumption of 162.5 Gigawatt-hours in 1996.

With these assumptions we can make rough estimates of future emissions and compare alternative scenarios that may make investments in efficiency and demand-side management interventions that may be funded by the Clean Development Mechanism. In evaluating investment costs, we use a real discount rate of 6% that corresponds to a nominal discount rate of 9% with 3% inflation. This is approximately the public policy discount rate in Eritrea. A higher discount rate results in an increase in the estimate for the feasible carbon price for any particular policy or program.

Figure 1: Eritrea Carbon Emissions for base case and policy case scenarios



We calculate the emissions reductions from a variety of investments that reduce potential carbon emissions. We build a spreadsheet model that calculates base case and policy case scenarios. The calculations are performed to 2050, and the investments in various emissions reduction strategies are made within the period of 2000 to 2035. Figure 1 shows a relatively moderate estimate of the emissions reductions that can be achieved in Eritrea through emissions reduction efforts and collaboration.

8. POTENTIAL CDM PROJECTS

In Eritrea, there is a diversity of potential CDM projects. These projects range from household stove efficiency projects that decrease biomass demand and increase ecosystem biomass stocks to other appliance efficiency measures, transportation sector efficiency improvements, and wind energy investments. Figure 1 illustrates our estimates of Eritrea's carbon emissions under a business-as-usual scenario compared to the policy scenario. The policy scenario is a combination of efficiency and renewable energy promotion policies and investments. One can see that the policy scenario has the potential of limiting Eritrean carbon emissions growth through 2015 after which emissions would grow due to increasing demand for electricity and petroleum products. The largest impact program under the policy scenario is a national biomass stove efficiency program that has a potentially large impact on biomass fuels demand.

Figure 2: High efficiency traditional stoves, Eritrea

Stove Efficiency

For a total investment of about $35 per household (of approximately 5 persons) it is possible to increase the efficiency of the main bread-cooking stove from about 6-8% efficiency to an efficiency exceeding 20%. Figure 2 shows a digitised photograph of the high efficiency stove design. Through better control of air flow, creation of a lower air inlet, and double-walled insulated ceramic sides, stove efficiency more than doubles. Since at least half of an Eritrean household's cooking energy is spent cooking bread on traditionally inefficient stoves, high efficiency stoves have the potential of decreasing biomass use in Eritrea about 30%. Further modifications and innovations with efficient stoves that allow all household cooking to increase in efficiency can potentially increase average cooking efficiency by 100% and decrease biomass fuel use by _.

We estimate the effects of a national stove efficiency program by calculating the effects in a spreadsheet-based national energy accounting model. The model keeps account of biomass stocks of different age categories and therefore provides an estimate of how changes in demand change the amount of carbon stored in the Eritrean ecosystem. We assume that the program increases the biomass utilisation efficiency by 50% in 80% of households over a period of ten years from 2002 to 2012.

Figure 3: Eritrea biomass stocks under base case and policy case scenarios

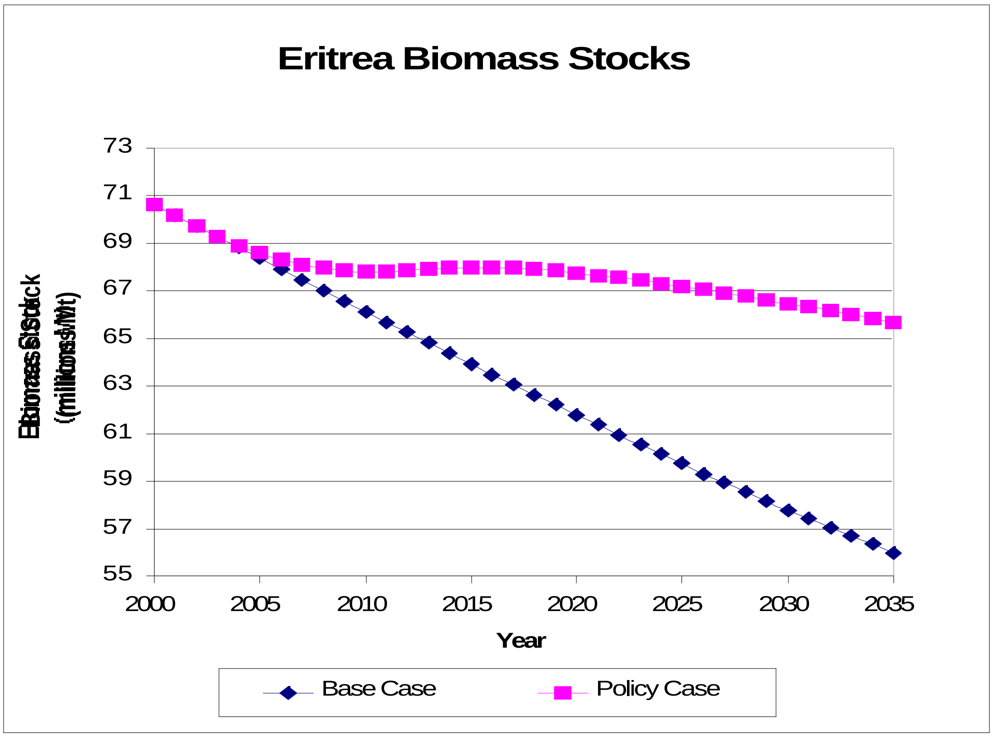


Figure 3 shows the estimated impact of such a stove efficiency program on the stock of Eritrean biomass. Consistent with previous studies and reports [Lahmeyer, 1997], our spreadsheet model estimates Eritrean biomass stock to be slightly over 70 million metric tons in 2000 with an annual unsustainable decrease in stock of about 0.6% per year. Much of the lack of sustainability comes from increasing population pressure that creates increased demand. The stove efficiency program will allow efficiency improvements to outpace population growth for an extended period and will stop and temporarily reverse the biomass stock decline from 2008 to 2020. After 2020 the forecasted biomass stock decline is much more moderate and other measures that increase efficiency further, encourage fuel switching or increase ecosystem productivity can aid in completely halting and reversing the decline in Eritrean biomass stock.

In financial terms the net capital expenditure for an aggressive biomass sector efficiency improvement program has a present value of $21 million, and the present value of carbon emissions revenues is $17 million at $10 per ton of avoided carbon emissions. To raise the entire capital for the implementation of this program requires a carbon emissions price of $12 per ton C.

Electric End-Use Efficiency

Next to biomass efficiency programs, electricity sector efficiency programs are the next most cost-effective carbon emissions reduction programs available in Eritrea. This is true for a couple of reasons:

(1) Due to lack of information and capital, there is a lack of energy efficiency investments in the economy, so that the energy efficiency investments that do occur tend to have a very high rate of return, and

(2) Most electricity is generated and distributed with only moderate efficiency from petroleum based fuels which have a high carbon content.

To calculate aggregate economic and carbon emissions impacts of electric end use efficiency, we made several assumptions:
(1) Base case end use energy efficiency improves at 1% per year from 2000 to 2035 and has an average return on efficiency investment of 100%,
(2) For a moderate energy efficiency policy, aggregate end use efficiency improves 2% per year from 2000 to 2035 and has an average aggregate return on efficiency investment of 50%,
(3) The real end use price of electricity is constant at $0.08/kWh.

Given these assumptions we calculate the present value of costs and benefits for the 2000 to 2050 period. The present value (at 6% discount rate) of the total net increased national capital expenditure in energy efficiency investments $25 million, the present value of revenues at $10/ton C is $7.5 million and the required carbon emissions price for raising the entire investment capital is $34.

Petroleum (Transportation) End-Use Efficiency

With regards to carbon emissions economics, petroleum sector efficiency improvements have benefits that are about half as cost-effective as electricity sector efficiency programs (when electricity derives its energy from petroleum fuels). This is because the amount of carbon per dollar of retail energy expenditure is less. For electricity there is about 2.8 kilograms of carbon emissions per dollar of electricity, while for petroleum products there are about 1.6 kilograms of carbon emitted per dollar of retail fuel expenditure in Eritrea. Note that for Eritrea the majority of the petroleum sector fuels are for transportation activities.

To calculate aggregate economic and carbon emissions impacts of petroleum sector end use efficiency, we made several assumptions:
(1) Base case end use energy efficiency improves at 0.5% per year from 2000 to 2035 and has an average return on efficiency investment of 100%,
(2) For a moderate energy efficiency policy, aggregate end use efficiency improves 1% per year from 2000 to 2035 and has an average aggregate return on efficiency investment of 50%,
(3) The real end use price of petroleum products is constant at $0.50/liter.

Given these assumptions we calculate the present value of costs and benefits for the 2000 to 2050 period. The present value (at 6% discount rate) of the total net increased national capital expenditure in petroleum energy efficiency investments $72 million, the present value of revenues at $10/ton C is $11 million and the required carbon emissions price for raising the entire investment capital is $66.

Wind Energy Development

Wind energy can contribute to reducing Eritrea's carbon emissions in two ways. First it can be used to substitute for electricity generated from petroleum products. Or it could be developed to substitute for biomass fuel used in household cooking.

Because biomass stoves are approximately five times less efficient than electric stoves, one kilowatt hour wind generated cooking energy use that is substituted for biomass energy use can save 0.69 kilograms of carbon emissions. For a five-year residence time of biomass in the Eritrean eco-sphere and a $1500 capital expenditure for one kW of wind generation capacity, we calculate 29 tons of avoided carbon emissions over a 20-year period. This means that if CDM was to provide the necessary capital for substituting wind for biomass cooking, it would need to provide about $69 per ton of avoided carbon emissions for the carbon emissions savings to pay for the initial capital expenditures at 6% discount rate. If the program is done after biomass stoves are made more efficient, then $114 per ton of avoided carbon emissions would have to be supplied to pay for the project.

To calculate the costs and benefits of a wind development promotion we also ran the spreadsheet model to see the effects of aggressive wind energy promotion on Eritrean carbon emissions. This calculation was run with several assumptions:

(1) The base case has 0.25%/year market share growth for wind energy from 2005 to 2035, while the policy case has 1%/year market share growth for the same period.
(2) The net investment cost for wind energy relative to thermal power plants is $1500/kW capacity and the capacity factor for wind turbines is 30%.
(3) The wind power displaces electricity generated from petroleum products.

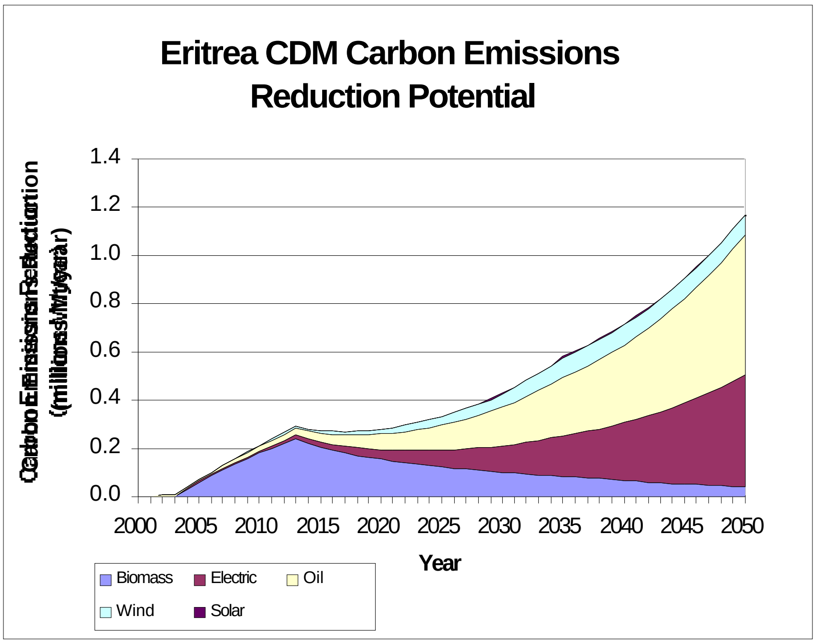
Under these assumptions, the net capital investment cost (discounted to 2000 at 6%) is $69.5 million with the net contribution from carbon emissions revenues at $10 per ton C is $2.9 million. For CDM to actually pay for the incremental costs of the wind development the price of the carbon emissions credits would have to be $238/ton. Lower costs for wind turbines would decrease this cost proportionally.

9. COST VS. PRICE FOR ERITREAN CDM PROJECTS

Figure 4 illustrates the potential carbon emissions reductions from various potential Eritrean CDM programs. The figure shows that biomass efficiency programs provide the greatest near-term emissions reductions, but these reductions diminish as the Eritrean biomass ecosystem stock re-equilibrates with the reduced demand. Over the longer term, emissions from electricity production and petroleum product consumption will produce the most emissions. As such, energy sector efficiency programs provide the most cost-effective means of reducing emissions because current markets demand extremely high returns from such investments, and significant gains can be made through policies that increase capital investment in energy efficiency, and reduce risk in energy efficiency investments. Wind energy provides an additional means of reducing Eritrean carbon emissions, but for this emissions reduction method to be feasible through CDM programs one or several things need to happen:

(1) wind turbine costs need to decrease,
(2) additional sources of wind energy development capital need to be developed in addition to CDM and/or,
(3) the price of carbon emissions reduction credits needs to increase from $10/ton to the range of $100 to $250/ton.

Figure 4: Eritrea CDM carbon emissions reduction potential for biomass efficiency, electricity sector efficiency, oil sector efficiency, wind development, and solar development programs



It is likely that a combination of these three factors will make wind energy a more feasible CDM project in the future.

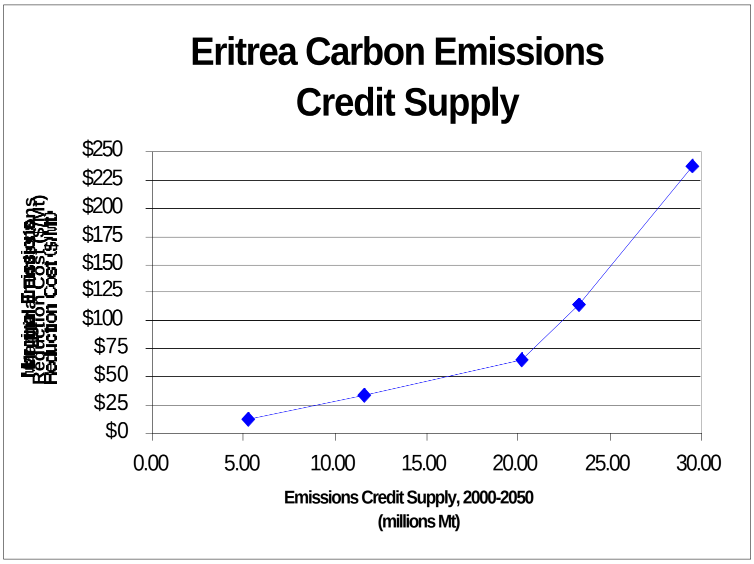
We summarise the results of our cost/benefit calculations for Eritrean CDM projects in the following table:

Table 3: Costs, benefits and unsubsidised emissions credit price for Eritrean carbon emissions reduction programs

CDM Program	Investment (million $)	CDM Contribution @ $10/ton (million $)	Avoided Emissions 2000-50 (million Mt C)	Feasible Carbon Price ($/Mt)
Biomass Efficiency	20.9	17.2	5.2	12.14
Electric Efficiency	25.1	7.5	6.3	33.57
Petroleum Efficiency	71.8	10.9	8.6	65.83
Wind Development	69.5	2.9	2.1	237.74

We can also display the above the results combined with the results of wind development for biomass fuel switching to produce a supply curve for Eritrean CDM credits. This supply curve is shown in figure 5, which shows that approximately 5 million metric tons of credits are available for slightly above $10/Mt and the supply is doubled as we reach $30/Mt. Supply doubles yet again at slightly more than $70/Mt and after that price must increase rather dramatically to further increase supply since more capital intensive methods like wind power development are needed to decrease emissions further.

Figure 5: The supply curve for Eritrea carbon emissions credits



10. CONCLUSION

In this paper we calculate the allocation and costs of global climate capital and incremental carbon reductions. We show that for Africa on average, more than 60% of Africa's share of global climate capital is being borrowed by developed countries without any interest payments. Eritrea as one of the least developed countries in Africa probably has an even greater share of its global climate capital leant to developed countries. In addition, Eritrea may be incurring as much as a 30% annual tax on its annual rain-fed agricultural production because of climate changes induced primarily by the activities of developed countries.

In spite of already bearing an unequal share of global environmental preservation costs, Eritrea may be able to make further cost-effective contributions to global environmental preservation. We develop a model of the Eritrean energy sector and calculate the net present value of carbon emissions reduction investments discounted at a real interest rate of 6%. We use these cost estimates to calculate the supply curve for carbon emissions reduction credits for the period 2000 to 2050 that can be provided by the Eritrean economy. The supply curve begins with about 5 million tons of emissions credits (about one ton C per capita) that are available at $12 per ton. The supply increases to 11.5 million Mt C (about 2-3 tons per capita) at $34 per metric tons of carbon. And the supply doubles yet again to about 20 million metric tons of carbon (about 4 tons per capita) at a price of about $70 per Mt C.

Being a country with very low per-capita income, we believe that Eritrea provides some of the lowest cost emissions reductions possible. There may exist cost quotes from other countries that are significantly lower, but these very low CDM emissions credit costs are probably leveraged by shifts in domestic capital that subsidise the CDM investments. We would like to argue in favour of a CDM that actually pays the true cost of carbon emissions reductions. This is preferable to highly leveraged CDM investments that minimise costs for developed country investors by leveraging limited developing country resources.

If the base case scenario for emissions in a developing country is truly a base case, then that scenario will represent the economically most efficient allocation of domestic capital. If a CDM project does not pay 100% of the incremental investment costs of carbon emissions reductions, then the balance will have to be provided through other sources, such as shifts in domestic developing country capital investments. These shifts in domestic capital investments will de-capitalise some sector of the developing country's economy in order to subsidise the investment expenses of the CDM project. This subsidy exports the returns on domestic capital for the sake of energy supply cost reduction in the developed country and transfers capital and wealth from poor (developing country) to rich (developed country). Such capital investment subsidies violate the development goals of CDM.

Eritrea wishes to contribute to the solution of global climate change problems by offering projects that reduce carbon emissions in an efficient and cost effective manner. But as one of the poorest countries of the world, Eritrea does not wish to use national domestic capital to subsidise continued excessive developed-world carbon emissions levels. To this end, Eritrea seeks international partners who are truly willing to trade carbon emissions reductions for investment capital at fair, unsubsidised prices. Eritrea believes that if it is allowed to compete in a fair market that does not demand investment subsidies from developing countries, Eritrea can provide some of the most efficient and effective emissions reductions projects on the planet.

11. REFERENCES

Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, P.O. Box 2008, M.S. 6335, Oak Ridge, TN 37831, USA.

Lahmeyer International, "Strengthening the Department of Energy, Eritrea", Final Report, April 1997 prepared under contract with the United Nations Office for Project Services.

UNDP," World Population 1998", Department of Economic and Social Affairs, Population Division, United Nations publication, (ST/ESA/SER.A/176), 1999, http://www.undp.org/popin/wdtrends/p98/fp98.htm