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Encouraging CDM energy projects to aid poverty alleviation

Attachment 4

Assessment of GHG Benefits from small-scale energy projects

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Acronyms

AIJ	Activities Implemented Jointly
BAU	Business As Usual
CAPA	Clean Development Mechanism for Poverty Alleviation Project
CCCF	Climate Change Challenge Fund of the FCO
CDCF	Community Development Carbon Fund of the World Bank
CF-Assist	Carbon Fund Assist for capacity building for the CDM from the World Bank
CDM	Clean Development Mechanism (defined in Article 12 of the Kyoto Protocol)
CER	Certified Emission Reductions (generated from CDM projects)
CO_2	Carbon dioxide
COP	Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC)
COP-MOP	Meeting of Conference of the Parties to the United Nations Framework Convention on Climate Change serving as the Meeting of the Parties to the Kyoto Protocol
CP	Commitment Period
DFID	Department for International Development
EB	Executive Board for the CDM
ERU	Emission reductions units
FCO	Foreign and Commonwealth Office
FDI	Foreign Direct Investment
GHG	Greenhouse gas
GWh	GigaWatt hour
ICS	Improved Cook Stoves
IET	International Emissions Trading
IPCC	Intergovernmental Panel on Climate Change
JI	Joint Implementation (outlined in Article 6 of the Kyoto Protocol)
KP	Kyoto Protocol
MCA	Multi-Criteria Analysis
MHP	Micro hydro power plants
MVP	Monitoring And Verification Protocol
M&V	Monitoring And Verification
ODA	Official Development Assistance
PCF	World Bank Prototype Carbon Fund
SHS	Solar Home Systems
S-L	Sustainable Livelihoods
UNFCCC	United Nations' Framework Convention on Climate Change
UNEP	United Nations Environment Programme

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1 Introduction

This is Attachment 4 to the main report to DFID on encouraging CDM energy projects to aid poverty alleviation. In this part of the study we have focussed on the greenhouse gas benefits from small-scale energy projects both in communities and small industries in Ghana, Kenya and Tanzania.

Under the Kyoto Protocol (KP) to the United Nations Framework Convention on Climate Change (UNFCCC) the final agreements known as the Marrakech Accords were agreed at the seventh Conference of the Parties (COP7) in 2001. Within the Accords many of the details for the implementation of the Kyoto Protocol were worked out in detail. In particular some of the modalities for the CDM were developed including the project cycle for the CDM. It was also decided that small scale projects should be given preferential treatment and encouragement through fast tracking with simplified procedures.

Small scale projects are defined in the following terms.

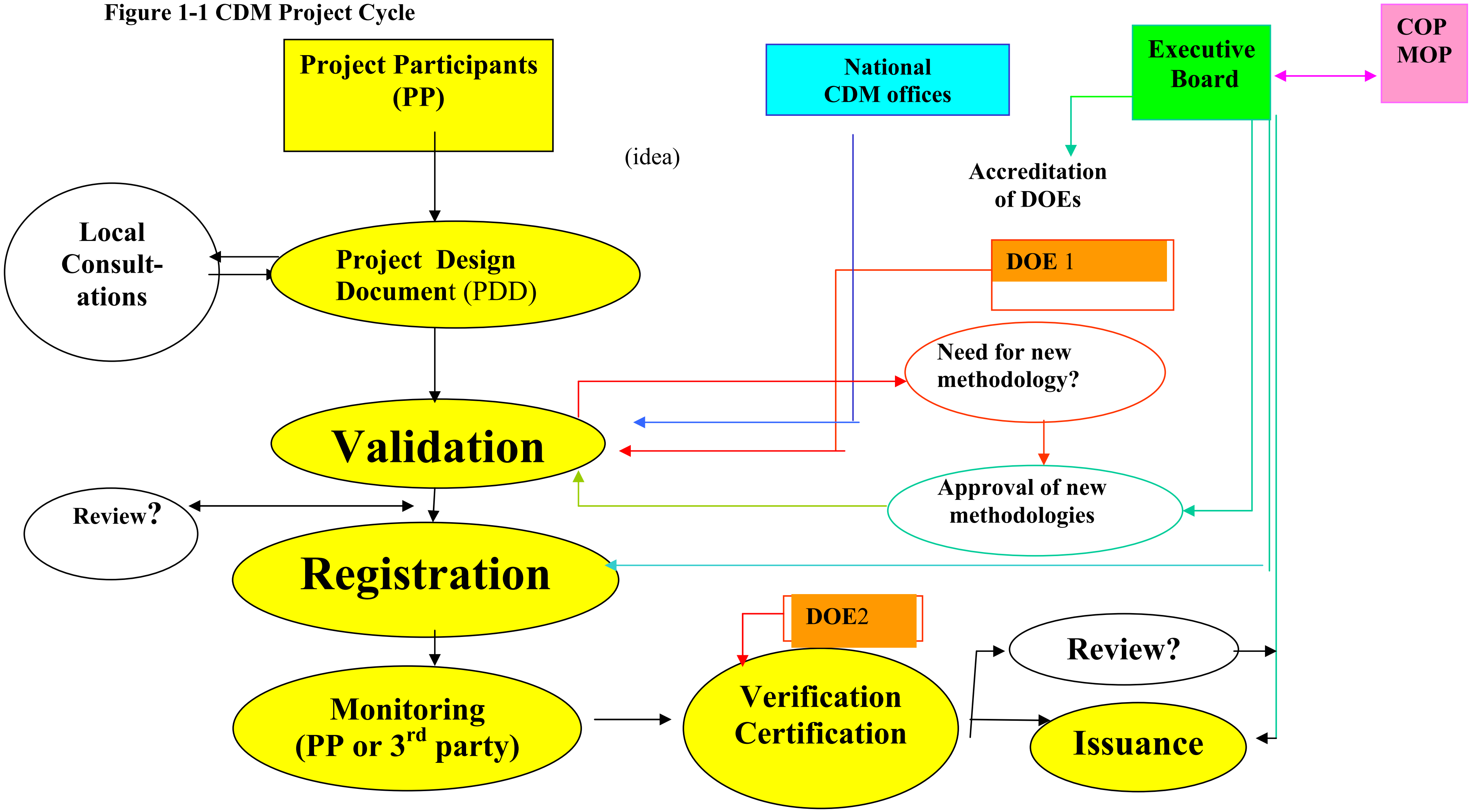
- Renewable energy projects with maximum output capacity equivalent of up to 15MW
- Energy efficiency improvements which reduce energy consumption on supply or demand side by up to 15GWh/y
- Other project activities that both reduce emissions and directly emit less than 15kt of CO_2e annually

All CDM projects must go through a process known as the project cycle in order to generate certified emission reductions. The CDM project cycle consists of the following stages.

- Project design stage: where the project participants must prepare a project design document (PDD) which includes the baseline methodology the monitoring plan and approval for the project from the host country
- Project validation and registration stage: where an designated operational entity (DOE) checks the PDD and if it is in order validates the project and sends it to the Executive Board for final registration.
- Project Implementation and monitoring: After registration the project can be implemented and the monitoring plan put into operation.
- Project verification and certification: Once the emission reductions have been generated the participants can invite a second DOE to verify the reductions and these are then sent to the executive board for certification and issuance.

The details of these stages and the conditions surrounding them are summarised in the diagram in Figure 1-1. Developments in the CDM are elaborated further in Attachment 1.

Figure 1-1 CDM Project Cycle



An expert group to the Executive Board on the CDM was set up to generate simplified baselines and other modalities for small scale projects. This group reported in time for COP8 in 2002 where their guidance was adopted by the meeting. The group have provided a new fast tracked simplified PDD for the small scale projects and a set of simplified modalities for the baselines (UNFCCC2002). However to date there has been little direction on bundling of the small scale projects. Bundling or gathering many small projects together into a programme of projects is considered a necessity for small scale projects as the transaction costs for individual PDDs and monitoring and verification costs would be too high to make them viable.

These developments have occurred since the onset of this study and are incorporated into the discussion. One purpose of this study has been to examine methodologies for estimating emission reductions with a view to generating proposals for simplified approaches which can still maintain environmental integrity. The results will be available for input to the Executive board and are also compared to the current recommendations from the Expert group on small scale projects for the Executive Board for the CDM. Under the capacity building aspects of the project it is also intended that these baselines can act as a template for the country partners for future CDM projects.

The issues considered are

- project boundaries,
- the baseline,
- additionality of the project,
- simplified monitoring
- uncertainties.

All of these issues are relevant to the Project Design Document (PDD) which is currently required before a CDM project can be validated and registered. Leakage is not included in the analysis as the latest UNFCCC guidance on small scale projects specifically directs that no treatment of leakage is required.

1.1 Structure of Attachment 4

In the following sections we discuss the analysis which has been carried out on the projects in each of the study countries and then bring these together and discuss the implications of the results. Section 2 deals with the projects and their descriptions while section 3 describes the methodology used.

We discuss the results of the analysis in Section 4. These are then further analysed in section 5 to give comparisons across projects and countries with their resulting implications for standardising baselines, data uncertainties and monitoring. Uncertainties including additionality uncertainty are discussed.

In section 6 we compare the analysis results with the new simplified guidance for small scale projects available from the EB for the CDM. And make recommendations on improvements. The report concludes in Section 7 with an examination of the implication of the results for bundling projects and suggests some options and highlights problems.

2 Projects

2.1 Project selection and data

The study focussed on energy sector development projects in the following countries:

- Kenya
- Ghana
- Tanzania

A process was initiated for gathering information on successful development-orientated projects which also contributed towards greenhouse gas (GHG) emissions reduction in the energy sector of the case study countries. From an original large set, a number were chosen for more detailed analysis. The selected projects covered the following types:

- Biogas digester;
- Improved Cooking Stoves (ICS);
- Micro- and Pico- Hydro-Power (MHP);
- Off-grid Solar Photovoltaic Systems, known as Solar Homes Systems (SHS) and for a hospital research facility;
- Capacitors for power savings;
- Biomass fuelled cogeneration plant;
- Higher efficiency cement kilns;
- Sustainable wood source;
- Efficient Charcoal kilns.

The initial project lists are much longer than the final selection and an initial selection is attached as Annex 4.1 for information. The final selection was based on a number of criteria which were as follows:

- Project type e.g. energy efficiency;
- Sector e.g. energy, industrial, agriculture;
- Size individual and programme if applicable;
- Technology and fuel e.g. biomass boiler with sawmill waste;
- Service provided e.g. cooking, lighting, heat etc;
- Amount of service delivered e.g. lighting for 5 hours using 4 CFL bulbs and no of households, or kWh;
- Grid/off grid;
- Owners/funders/participation level;
- Status, operational? If not when?
- Data availability? Surveys required?
- Who is receiving the service from the project?
- What are the benefits from the project?
- What is being substituted by the project? I.e. details of what is currently supplying the service.

The final determinants of the projects selected were the availability of the data and the fact that the projects had to be operational though some partners had difficulty with this aspect. The lists were therefore amended considerably with time. The final selection of projects studied in Ghana, Kenya and Tanzania has been described in Attachment 3 in section 2. We therefore only list them here in Table 2-1.

Table 2-1: List of projects studied across the partner countries

Kenya	Tanzania	Ghana
MHP, Tungu Kaburi	MHP Uwemba	
Thima Pico hydro		
Sony sugar co Diesel to bagasse cogen	*Sugar cogen grid to bagasse Mtibwa*	*Biomass Plantation for sustainable wood source Nabari*
Bamburi cement energy efficient kilns	*Kitulanga Charcoal Kilns*	*Charcoal Production, Western Region More efficient kilns*
TEA industry MHP projects		*Energy Efficiency in Small Scale Industries – Capacitor Installations*
	Solar Power for hospital research laboratory Utete	*SHS at Kpasa*
	ICS *IREDECT programme*	*Biogas project at Appolonia*

Those in blue indicate where it is possible to have cross country comparisons.

Data requirements were then drawn up and sent to national experts to collect the relevant data. These data requirements were tailored to the project type and an example of technical data requirements for projects is attached as Annex 4.2. There were very real problems in collecting internally consistent data about the projects and it is obvious that some data does not exist.

Two field trips were undertaken in Ghana and Kenya to build capacity on data collection and on the CDM. Active participation in data collection for the social and technical data for selected projects with country partners was important. The goals and direction for the project was clarified and ensure that all partners had a clear understanding of the CDM and the project. Meetings were also conducted with government and industry representatives to raise awareness on the CDM and level of engagement in the project particularly assessment of sustainability benefits.

3 Analytical Approach

The approach taken in this study to the estimation of emission reductions of the greenhouse gases has been to explore the uncertainties in the estimation. This has involved the scenario analysis approach to constructing baselines for the projects under study (Begg et al 2002). There are two main reasons for doing this.

1. It enables us to confront the issue of low quality data by exploring the effect of uncertain information on the final result
2. It enables judgements to be made on simplifications in the baselines while maintaining environmental integrity

In the process of accounting for emission reductions we consider many of the issues dealt with in a PDD. In order to be clear, we first of all define what we mean by project boundaries, additionality, baselines and leakage using the definitions from the Marrakech Accords.

Definitions

Before discussing the projects in detail we define below the main issues which are relevant to the discussion from the Marrakech Accords (UNFCCC 2001)

"The ***project boundary*** shall encompass all anthropogenic ***emissions*** by sources of greenhouse gases under the ***control*** of the project participants that are ***significant*** and reasonably ***attributable*** to the CDM project activity."

"A CDM project activity is ***additional*** if anthropogenic ***emissions*** of greenhouse gases by sources ***are reduced below those that would have occurred in the absence of the registered CDM project activity***."

"The ***baseline*** for a CDM project activity is the scenario that reasonably represents the anthropogenic emissions by sources of greenhouse gases that ***would occur in the absence of the proposed project activity***."

"Leakage is defined as the net change of anthropogenic emissions by sources of greenhouse gases which occurs ***outside the project boundary***, and that is measurable and attributable to the CDM project activity."

Normally the emission reductions are calculated by calculating the project emissions for a given service, then calculating the baseline emissions for the same service and subtracting the project emissions from the baseline emissions to provide the emission reductions for that service level within the project boundary.

From the definition of a baseline given above it can be seen that it is feasible to have more than one baseline representing 'what would have happened in the absence of the project'. In fact there is a range of approaches to baseline construction which forms a continuum from a project specific set of scenarios concerning possible future emission paths for the project to benchmark approaches. Benchmarks may form part of a scenario approach but the main difference is in how the baselines are used. These have been discussed recently in Begg et al (2002) and Van der Gaast et al (2003). Our approach (Parkinson and Begg 2001, Begg and Parkinson 2001) has been the project specific scenario analysis approach which allows the exploration of uncertainties about the future emissions paths for these projects. There is usually no single correct path but plausible alternatives going off into the future.

In the CDM an effective way of managing the uncertainties associated with the counterfactual nature of baselines is to limit the time over which the project is to be credited as the further off into the future we go the less reliable the baseline is. The Marrakech Accords recognise this and propose either a 10 year limited crediting lifetime or three times 7 year crediting periods with baseline revision at each renewal. In this study we have assumed a 21 year crediting lifetime and explored the continuing additionality of projects in that time.

3.1 General Methodology

In assessing the projects in terms of emissions reduction and costs, we follow the example described in detail in Parkinson et al (2001). They used the CORINAIR/EMEP (1996) methodology for the calculation of emissions of GHGs, which is compatible with the IPCC guidelines for national inventories (IPCC/UNEP/OECD/IEA, 1996). For costs, they used the incremental costing method of the GEF (Ahuja, 1993).

Project level assessments of the case study projects have been carried out using a spreadsheet model of each study project. The spreadsheets consist of a Microsoft Excel file with several layers: the first layer contains a summary of major input parameters and output results; the second has details of the project on a year-by-year basis; the third has details of the baseline case on a year-by-year basis; other layers may explore different baseline scenarios or project scenarios.

Outputs from the spreadsheet models are values for each of the four critical accounting variables:

- emissions reduction over the lifetime of the project (tonnes of CO_2 equivalent);
- the lifetime-averaged specific emissions reduction (tCO_2/MWh);
- the incremental economic cost (US$);
- the specific incremental cost (US$/$tCO_2$).

3.2 Equivalence of Service

In order to allow comparison between different projects, the 'unit emissions reduction' can be calculated per unit of activity. Conventionally (e.g. Begg et al, 1999), this has been the emissions reduction per unit output of the project [in tCO_2 equivalent/MWh]. However, the use of such a measure is questionable for many of the projects. This is due to the fact that many development-orientated projects significantly increase the energy service available, e.g. by providing higher quality lighting, when compared with the baseline. The difference in service in klmh provided by the project is roughly 500 times the service provided by kerosene due to the filament or Compact Fluorescent lights being used. In that case alternative comparisons are used. Martens et al (2001) proposed standardised baselines for SHS systems on the basis of the Watts peak of the PV panel in a regression equation.

Conventionally, use of a 'per unit energy output' measure assumes that there is 'equivalence of energy service' between the project and the baseline, but when this is not the case, the value cannot provide a reliable standard for project comparison. This can be seen in many of the results presented below[1]. Hence, for many development-oriented projects we advocate using an alternative measure for unit emissions reduction: $kgCO_2$/capita/y. While such a measure has its limitations, its superiority for many of the project types in this study is clearly illustrated below. Problems can arise when using this measure when the number of Households or the number of people in the household varies considerably within a community as was found in Ghana.

3.3 General Assumptions

Before presenting the baseline discussion and analysis results, it is necessary to state the general assumptions applied to the analysis.

The main environmental assumptions are:

- biogas combustion produces no net emissions of CO_2, ie it is CO_2 neutral[2];
- leaks of biogas from the digesters are negligible;
- aerobic digestion of the dung would have occurred with negligible methane emissions;
- combustion of agricultural waste, e.g. bagasse, is CO_2 neutral;
- fuelwood is not from sustainably managed forests, it is *not* CO_2 neutral;
- changes in energy demand, except where measured, are negligible during the lifetime of the projects.

The main economic assumptions are:

- all fuel prices are assumed to remain constant for the lifetime of the project;

[1] To illustrate this, we can look at the unit emissions reduction achieved by replacing an open fire burning wood (from unsustainable source), by a non-GHG emitting source. This gives a value of about 2.6 tCO_2/MWh: possibly the highest reduction that can be achieved. However, for an SHS replacing kerosene lamps, values as high as 8tCO_2/MWh are apparent! Clearly, this latter value reflects the considerable increase in energy service provided by the SHS, rather than the high emissions of the kerosene lamp.

[2] If we assume that the crops/ grass that cattle eat are re-grown, then the uptake of CO_2 by these plants during growth will be approximately equal to the CO_2 produced by combustion of the methane (biogas) created by the anaerobic digestion of the dung from the cattle.

- changes in the fuel quality of both the project and the baseline are negligible during the lifetime;
- all baseline costs before the project start date are sunk;
- a discount rate of 4% (social discount rate) and crediting lifetime of 21y are used.

Obviously, it is important to bear these assumptions in mind when considering the results, particularly as they have implications for uncertainty. For example, variations in fuel prices, which can be large, will lead to a much higher level of uncertainty in the incremental costs and unit incremental costs than is given here.

3.4 Country Contexts

The country context for each of the study countries has been compiled so that the empirical information on the country is available for the construction of the baselines for the projects. The country context also allows an insight into the development priorities of the host and how the projects contribute to alleviating these host concerns. The study countries are Kenya, Ghana and Tanzania.

The main country aspects of interest which are summarised for each country in Annex 4.3 of this report include:

- general aspects;
- poverty situation;
- socio-economic profile;
- environment;
- energy production and use;
- policies and development objectives.

4 Analytical results for the estimation of emission reductions

The projects that have been analysed have been listed and described in section 2. In this section we discuss the baselines and the results which have been generated for each of the projects in the three study countries. The calculations have been carried out using the assumptions and methodology referenced above given the detailed country contexts in section 3.4.

4.1 Ghana

Five projects carried out in Ghana and the results from the emission reduction calculations are discussed below.

4.1.1 Appolonia

The biogas plant was not very successful because it is only used for a lighting service most of the time as the cooking service originally planned was not popular with local people who feared germs and odours from the gas. Biogas is used for cooking for short periods when wood is too wet. When there are problems with the plant then diesel is used. Diesel use in the actual project was high. What we have done in the calculations is to look at the project reductions with different scenarios for the biogas production. This is shown in Table 4-1.

Baselines

1. Present situation continues: kerosene used for lighting for project lifetime (20y). If the funding for the programme had not been available, it is possible, given the low level of technological development in Ghana, that the situation could have remained unchanged. There is uncertainty in the number of people in households (8-30) and in the amount of kerosene used in each household per month before and after the project. This scenario explores this uncertainty with a high kerosene use figure of 12 l/HH/month. The per capita figures assume an average of 10 people/HH.

2. In this case the assumptions remain substantially the same as for scenario 1 but a low kerosene use scenario is explored using 9 l/HH/mth. This implies that 40% of the kerosene use is not replaced by the project.

Project

3. The other main uncertainty in this project was the actual use of the biogas plant. Though theoretically 80% biogas 20% diesel (project case 2) was projected, this figure does vary considerably in practice. Obviously the reductions calculated are on the basis of this biogas use, and monitoring would reduce any risk of overestimation. The impact of using 20% biogas 80% diesel (project case 1) on the total emissions is given in baseline 3 for the high kerosene use scenario baseline 1.

	Emissions Reduction	Unit Emissions Reduction		Incremental Costs	Unit Incremental Costs
	$ktCO_{2e}$	$kgCO_2$/capita/y	tCO_2/ MWh	M US$	US$/$tCO_2$
80%biogas 20% diesel Baseline 1 High kerosene use	0.18	32	-	0.0002	1
80%biogas 20% diesel / Baseline 2 low kerosene use	0.12	21	-	0.004	35
20% biogas/80% diesel / Baseline 1	0.01	2	-	0.011	1200

Table 4-1 Results for Appolonia biogas project

Another aspect of this analysis is consideration of the avoided methane emissions. These have not been accounted for here as methane is produced under anaerobic digestion conditions. Normally the dung and human excreta would be left under aerobic digestion conditions with only very low methane emissions. More work is required to check this aspect. If anaerobic conditions are available as in a farmyard manure heap then emissions of methane could be the order of 5.5kg methane /tonne manure (IPCC 1994).

4.1.1.1 Conclusions

- This is a small project and is concerned only with a lighting service consequently the emission reductions are very low. The costs per tonne are very variable. Exploration of the uncertainty in the data for kerosene use shows that for variation from 9 to 12 l/HH /month the reductions show a variation of 33% between the first two baselines. In addition it is obviously crucial that to attain the reductions the biogas plant is kept running at the predicted rate. If, as in baseline 3, the diesel use increases from 20% to 80%, the reductions decrease by about 95%.

- For monitoring it will therefore be essential that for this type of project there is a reasonable baseline survey done on kerosene use and that some spot checks are carried out to ensure that diesel use does not escalate during project operation.

- The uncertainty range over the baseline and project conditions leads to a total uncertainty value on the reductions of 0.095 kt CO_2 ± 89% showing the necessity for minimising errors on these key factors.

- The incremental costs of this project, which are not the same as the normal costs/tonne calculation, seem to be favourable for this project on a stand alone basis if the biogas use is high and the kerosene baseline use is high.

4.1.2 Kpasa Solar Home Systems (SHS)

The project installation was started in 1998 and finished in July 2000 with a guarantee period of one year. It provides power, about 60kWh/y from each 50Wp Solar PV panels, for 410 Households, providing electricity for lighting and thus replacing kerosene lamps. In practice a range of different sizes of panels are provided for different applications.

Assumptions

- Calculated load factor is high but consistent with insolation level and number of lamps.
- The average capacity of the panels was 50Wp
- 210 SHS were distributed in the first year and 210 panels in the second year. It is projected that each will last 20 years so that in the final crediting year there are 210 systems left.
- The lifetime of the panels is assumed to be 20 years.

Baselines

1. In this scenario the existing situation of kerosene lamps for lighting continues into the future. Available ranges of figures for kerosene use vary and so a low kerosene use scenario at 2 lamps per household is taken to explore this uncertainty. This represents 7l kerosene/month. All the kerosene use in the baseline is assumed to be replaced by the project. The incremental costs associated with the project for the householders are subsidised through the Spanish 50% export credit and a concessional loan. These costs are calculated against the costs of kerosene in the baseline.
2. In this scenario the existing situation of kerosene lamps for lighting is expected to continue into the future but a high kerosene use path (12l/mth) is used to explore the uncertainty in the data. The kerosene replaced by the project is 40%. In this case the unsubsidised project costs are used for comparison.
3. In this scenario the project does not remain additional for the full 21 year crediting lifetime and after the baseline revision at 14 years it is assumed that the project would have been carried out anyway due to changes in economic circumstances or government policy. The low kerosene use path is used for comparison.

	Emissions Reduction	**Unit Emissions Reduction**		**Incremental Costs**	**Unit Incremental Costs**
	$ktCO_{2e}$	$kgCO_2$/capita/y	tCO_2/ MWh	M US$	US$/$tCO_2$
Baseline 1 Low kerosene use	1.9	23	-	0.02	12 (subsidised)
Baseline 2 High kerosene use	3.4	42	-	0.48	140 (un-subsidized)
Baseline 3 Project non additional after 14 years and has low kerosene use	1.2	17	-	-	-

Table 4-2 Results for Kpasa SHS project in Ghana

4.1.2.1 Conclusions

- The project is mainly lighting service replacement so that the emission reductions are relatively small. The number of households is fairly high at 410 so that the reductions are much higher than the Biogas project above. In the baselines 1 and 2 we have explored again the implications of the data uncertainty in the use of kerosene in the baseline. The data uncertainty leads to an overall relative uncertainty in the emission reductions of 2.65 ±28%, which is in line with the results for the biogas case.
- Baseline 3 gives an opportunity to see the effect of baseline revisions should a project fail to be additional in the future. When the project is initiated it will not be known whether the baseline revision will be allowed after 14 years or not The uncertainty in reductions associated with the additionality variation from 14 to 21 years is 1.55 ± 23%.
- The incremental costs of the project calculated using a social discount rate shows the impact of the subsidies on the affordability of the project is very high and crucial to its success.
- The overall result for the emissions reductions combining all the uncertainties is 2.3 kt CO_2 ± 48%.
- The unit emission reductions in baseline 3 are less than baseline 1 as 14 years of reduction is averaged over 21 years lifetime.

4.1.3 Greencoal project

The project involved the setting-up of a charcoal production factory at the Swiss Lumber Company Ltd sawmill at Manso Amenfie in the Western Region of Ghana.

The factory uses residues remaining from timber processing. The SLC decided to utilize its sawmill residues for clean charcoal production for the domestic and export market. For this purpose, carbonisation technology developed by the Carbo Group was employed. The project became fully operational in 2002.

Emission reductions from this project arise from two sources.

1. The reductions from using a new modern kiln compared to an earth mound
2. The reductions from the use of the sawmill waste as a carbon neutral source rather than an unsustainably managed forest.

Emission increases from the project may arise from export. A third factor is therefore considered.

3. The emissions from the transport of the charcoal to the Netherlands if it is mainly exported.

The baselines constructed explore these issues.

Project Boundaries

The project boundaries include the project, the wood source and the market for the charcoal.

Baselines

1. Efficient Kilns

The emission reductions arise from the change in emissions of volatile organic compounds (VOCs) from the charcoal kiln compared to the old earth mound. There is a range of volatile compounds that can be emitted at different stages in the charcoal making process. Work to characterise these emissions and compare the results across a range of different charcoal kilns has been carried out by Pennisse et al (2001) and by Smith et al (1999). The data from Pennisse et al (2001) show a range of values for the same type of kilns eg Kenyan earth mounds used in the baseline. From the ranges provided, high and low emissions scenarios were prepared. These were compared to the Brazilian rectangular kiln with tar recovery which we felt was closest to the CARBO CG 2000 used in this project. Direct Data from CARBO on their emission characteristics could not be obtained.

The greenhouse gases of interest emitted by the kilns included CO_2, CH_4, and N2O. N_2O is of particular interest because of its very high global warming potential. The summaries of the scenarios used is given in the Table

Kiln	%Yield	Emission Factor CO_2 g/kg of charcoal produced	Emission Factor CH_4 g/kg of charcoal produced	Emission Factor N_2Og/kg of charcoal produced
High emissions scenario Kenyan earth mound	21.6	3027	61.7	0.084
Low emissions scenario Kenyan earth mound	34.2	1058	32.2	0.068
Brazilian rectangular kiln	36.4	543	36.5	0.011

Table 4-3 Emission Factors for charcoal kilns

There was only one set of data available for the Brazilian Kiln

Baseline 1 used an inefficient earth mound kiln with a high pollutant emissions scenario as described in the Table above with a sustainable wood source.

Baseline 2 produces charcoal with an inefficient earth mound kiln but with a low pollutant scenario as described in the table above.

Source of the wood

The source of the wood in the baseline would normally be from an unsustainably managed forest. In the project, waste wood from the sawmill is used. This wood is normally burned or left in piles to decay in the forest. Thus we have a more sustainable carbon neutral source from the waste wood.

Baseline 3 is a scenario where an efficient charcoal is used but with an unsustainable wood source

Baseline 4 compares an inefficient kiln with an unsustainable wood source which would be considered to be the combination best representing the existing situation. This baseline uses a high emissions scenario

Baseline 5 is as for baseline 4 but with a low emissions scenario.

	Emissions Reduction	**Unit Emissions Reduction**		**Incremental Costs**	**Unit Incremental Costs**
	$ktCO_{2e}$	$kgCO_2$/capita/y	tCO_2/ MWh	M US$	US$/$tCO_2$
Baseline 1 Sust wood Inef kiln High scenario	9			0.92	106
Baseline 2 Sust wood Inef kiln low scenario	-1			0.92	
Baseline 3 Unsust wood Efficient kiln	8			0.62	75
Baseline 4 Unsust wood Inefficient High scen	50			0.62	12
Baseline 5 Unsust wood Inefficient Low scen.	15			0.62	42

Table 4-4 Results for Greencoal project

Transport emissions

In this analysis the effect of exporting the charcoal is explored for the project. It was calculated that additional emissions from the HFO from shipping could range from 0.8 to 2.9ktCO2 over the 21 years of the project depending on whether the calculation is based on using estimated weight or volume. This amounts to roughly offsetting 3-10% of the reductions expected but as a percentage of the reductions calculated for the low scenario baseline is quite high from 7-20%. In practice this would have to be taken into account.

4.1.3.1 Conclusions

- Baseline 1 and 2 explore the effect of the increased efficiency of the project and the variation in data for the emissions associated with the operation of an inefficient charcoal kiln given the data available from Pennisse et al. In baseline 2 the negative emissions means that the earth mound is performing better than the new kiln for a sustainable wood source where the CO_2 emissions are not counted. This is contrary to expectations but consistent with the measured data. The uncertainty in the emission reductions is therefore high depending on how the kilns are built and operated. From these data the emission reductions, discounting the CO_2 as it is deemed to be carbon neutral in these baselines, are 4 ± 125%. *This uncertainty is very high*. Further data on the operation of the kiln in terms of its emissions as a kiln type are essential so that some of this uncertainty can be decreased. An extension of the Pennisse study would be useful here. It should not fall to the operator to try to make such measurements of the gases emitted.
- With an unsustainable wood source then the comparison between baselines 4 and 5 again explores the effect of the range of data for the high and low scenarios for an inefficient kiln in the baseline due to the increased efficiency of the project. The results now include the CO_2 emissions from the kiln so that the range of results is different. Both now produce reductions which are 32.5 ± 54%.
- For an unsustainable wood source the effect of wood source is explored in baseline 3 which gives reductions of 8ktCO_2 and comparing with the average baselines 1&2 means that the wood source is a more important source of reductions.
- Comparing baselines 1&2 with 4&5 confirms the importance of the wood source and highlights the uncertainty on the inefficient kiln performance
- The incremental costs of the project are very difficult to determine, as there are no good data for the baseline situation. The figures given are based on nominal labour costs. For some reason the O&M costs are potentially high even at 1%. The costs assume that the wood is bought at market but this is not really the case.
- Where there is transport to a developed country market the emissions can be significant from this source and have to be taken into account in calculating the final reductions.

4.1.4 Nabari Traditional energy sustainable wood project.

The Traditional Energy Unit encouraged the local communities to establish woodlots to rehabilitate degraded woodlands and provide alternative sources of woodfuels for the communities. 7 ha out of the proposed total of 60 ha of woodlots have been established under the project. The project provided seedlings through the Forestry Service Division whilst the communities provided labour to prepare the land and maintain the seedlings Soya beans were planted alongside as inter crops.

Project boundaries
The project boundaries were taken to include the wood source for cooking, in this case the sustainable wood plantation, and the local dwellings with their 3 stone fires.

Baselines and assumptions

The local people in the Nabari village have been planting trees for their new sustainably managed wood source and have planted 7 ha in 2 years. This rate was taken as a high planting scenario and used to extrapolate over the crediting lifetime.

Another lower rate scenario at 2.5 ha/y was also constructed.

It was also assumed that there would be no harvests from the sustainably managed woodlot for the first 5 years as the trees grow to the point of harvesting.

Baseline 1: In this case the unsustainable wood source would have continued to be used over the lifetime but with increasing time and labour commitment as the wood becomes more and more difficult to obtain.

Baseline 2: This explores what would have happened if the project had been delayed by 10 years and is used to explore the effect of uncertainty in the additionality of the project.

Baseline 3: This baseline explores the uncertainty in the rate of tree planting. In this case we decrease from 3.5 to 2 ha per year.

	Emissions Reduction	**Unit Emissions Reduction**		**Incremental Costs**	**Unit Incremental Costs**
	$ktCO_{2e}$	$kgCO_2$/capita/y	tCO_2/ MWh	M US$	US$/$tCO_2$
Baseline 1 unsustain-able wood Tree planting at 3.5ha/y	2.3	0.85	1.71		
Baseline 2 Unsustainable wood for 10 y and then the project	2.1	0.76	1.53		
Baseline 3 Unsust wood but lower rate of tree planting 2ha/y	1.4		1.50		

Table 4-5 Results for Nabari Sustainable Wood project

4.1.4.1 Conclusions

- The reductions from the project varied according to the tree planting scenario from 1.4 to 2.3 tCO2 over the lifetime of the crediting project giving an overall expected reduction of 1.85tCO2 ±24%.
- Thus the uncertainty in the rate of tree planting over the lifetime of the project does have a large effect on the reductions generated by the project and this is an obvious key parameter to be monitored during the project lifetime.
- The other main assumption that the forest is sustainably managed must also be monitored.
- The additionality of the project must be clear if the longer lifetime of the project is chosen as this also has a major effect on the expected reductions.
- The scenarios for the tree planting showed that in such projects the wood available to supply household needs takes some time to be established and it is not until the last two or so years of such projects that all households are supplied.

- The reductions for Baseline 2 are not half of baseline 1 as might be expected. This is due to the time delay in the initial stages in being able to harvest the wood only after 5 years.

4.1.5 Capacitors AREED projects

The electricity tariff in Ghana is structured in such a way that the maximum demand charge is based of kilovolt amp (kVA). Customers therefore pay a penalty so that when customers' power factor is less than 0.90 a penalty is charged. The installation of capacitors in industries corrects the power factor to the required level of 0.9 (being the least) so that industries no longer have to pay a surcharge and save energy. The capacitor installation also saves the utility the losses that would otherwise have been incurred in transporting power.

The Power factor correction capacitors installation Project that was studied was undertaken by Dekons Engineering and AB management. They installed power factor correction capacitor banks in industries to reduce their maximum demand (kilovolt - amp) and improve their power factor.

Customers with very poor power factors, that is, below 0.70 were selected, economic viability of the capacitor installation was analysed and the necessary agreement made with the customer for outright purchase or payment over a period of not more than 1year.

Project Boundaries

The project boundary is taken as the factory at which the capacitor is installed and the power system to which it is connected for its electricity supply.

Baselines and assumptions

Power factor correction reduces losses on a system by decreasing the currents in transformers and conductors that feed a reactive load. However there are debates currently raging as to whether there will be any GHG emission savings as the capacitors do not reduce the real power required by the load, only the reactive power. However correcting the power factor can allow a greater utilisation of the supply distribution system, i.e. a 500KVA transformer can supply 500 kW at a power factor of 1, but 400kW at a power factor of 0.8. This is the reason why utilities want to minimise the cost of investment in plant and put incentives in place to encourage power factor correction. Power factor correction certainly is to be encouraged, probably as part of other energy efficiency measures being put in place, but is probably negligible in actual GHG savings.

In Ghana there was no record made of the kWh savings so a baseline could not be produced.

4.2 Tanzania

In Tanzania 5 projects were explored but it proved to be impossible to collect the data from 2 of the projects. Below we discuss the results from the three remaining projects.

4.2.1 Uwemba MHP Project

The Microhydro power (MHP) project (843kW) was constructed in 1984 and has operated from 1991 in Njombe district in Uwemba village. It replaces a diesel generator for Njombe town and Uwemba village and provides electricity for domestic use and small industries including a tea factory, mills and domestic water pumping. It is owned by Tanesco. There is an increase in number of local and town households served. It is affordable by middle income domestic users at national rates though some local house structures are not suitable for wiring.

Project Boundary

The boundary of the project is the MHP plant and the dwellings, factories and other amenities served by the plant.

Baselines

Baseline 1: In this scenario we propose a historic baseline where the existing situation would persist into the future with no change. The diesel generator does in fact still operate with only part of its output being replaced by the project.

Baseline 2: The existing diesel generator continues for 10 years and is then replaced by another diesel generator. This is essentially equivalent to baseline 1 in terms of reductions but not in terms of costs.

Baseline 3: The existing situation would have continued for 10 years and then the project would have been undertaken. In this scenario the additionality of the project is explored. The argument is that it is likely that initiatives such as this would be mainstream activities in 10 years time.

Project Alt: In this case the uncertainty in the data for the output of the plant is explored. The data for the output of the project is explored by calculating the expected output from the flow and head data also provided for the project. This gives an alternative lower output for the project and this is used in the calculations for Baselines 1 to 3 again and revised figures are obtained.

	Emissions Reduction	Unit Emissions Reduction		Incremental Costs	Unit Incremental Costs
	$ktCO_{2e}$	$kgCO_2$/capita/y	tCO_2/ MWh	M US$	US$/$tCO_2$
Baseline 1 Existing situation continues	49		0.77	1.3	26
Baseline 2 Old diesel replaced by new diesel	49		0.77	0.6	13
Baseline 3 Project carried out in 10 years	24		0.34	0.8	32
Baseline 1 alt project using head and flow figures	34		0.77	3.1	91
Baseline 2 alt	34		0.77	2.6	75
Baseline 3 alt	17		0.34	1.9	102

Table 4-6 Results for Uwemba MHP project

4.2.1.1 Conclusions

- The uncertainty in the output data for the project gives a range of 34 to 49 kt CO_2 for the emission reductions over the crediting lifetime. This gives a reduction of 41.5ktCO_2 ± 18%. This indicates the importance of good monitoring in the project output.
- The uncertainty in the additionality of the project for the whole 20 years would be minimised by the baseline revisions built in to the CDM system. The analysis shows that the variation is significant and a decision is required from the start on the likelihood of alternative action taking place within the crediting time.
- The overall uncertainty in the reductions including the additionality uncertainty is 33ktCO_2 ±48%.
- The incremental costs compared to the baseline are still fairly high for this project though the revenue streams have not been included. Some form of bundling may be required.

4.2.2 Improved Cookstoves Project (ICS)

The project provides for production and dissemination of improved cookstoves with lower wood fuel requirement at household level in urban and rural areas. It replaces traditional 3 stone wood stoves in mainly rural areas and inefficient charcoal stoves in urban areas. Overall it is equivalent to 144MW with 120,000 stoves.

Project boundaries

The project boundaries include the use of the stoves over all the dwellings in the ICS programme. The source of the wood or charcoal for cooking is also included in the sense that they are assumed to be unsustainably sourced.

Baselines and assumptions

In this project it is not clear what proportion of the stoves were metal charcoal burning stoves compared to the traditional 3 stone wood stove. The baselines explore this uncertainty.

A scenario is constructed on the number of stoves used in households bearing in mind the replacement after 3 years life.

Baseline 1: Alternative programmes either do not get sufficient funding or do not work. Traditional wood and charcoal stoves continue to be used. The project replaces 75% charcoal and 25% wood.

Baseline 2: Alternative programmes either do not get sufficient funding or do not work. Traditional wood and charcoal stoves continue to be used. The project replaces 25% charcoal and 75% wood.

Baseline 3: Traditional stoves for 5y, then phase-in of ICS programme. Due to Government policy/ other NGO activity on fuelwood scarcity, a more optimistic scenario is that efficiency improvements will be made to stoves without the ICS programme.

A further possible baseline is a phase-in of fuelwood from managed forests, ie a CO_2 neutral source. This has not been examined here.

Whilst LP gas is a desirable fuel for cooking, its expense means that it is unlikely that a significant number of the households targeted by the ICS programme would have been able to use it during the project lifetime. Electricity is too expensive for cooking.

	Emissions Reduction (2sig figures)	Unit Emissions Reduction		Incremental Costs	Unit Incremental Costs
	$ktCO_2$	$kgCO_2$/capita/y	tCO_2/ MWh	M US$	US$/$tCO_2$
Baseline 1 75% charcoal and 25% wood	5800	340	2.3	-86	-15
Baseline 2 25% charcoal and 75% wood	6700	390	2.7	-37	-6
Baseline 3 Project additional for 5y	2000	270	0.8	-47	-24

Table 4-7 Results from ICS project analysis in Tanzania

4.2.2.1 Conclusions

- The improved cook stoves still release significant amounts of GHGs but a CO_2 neutral source for the fuelwood would cut this considerably. Nevertheless, the programme yields significant emissions reduction.

- The uncertainty in total emissions reduction and unit emissions reduction is ±54%. This level is high due mainly to the exploration of additionality. Five years is really a minimum time before a project could not have been predicted to be additional anyway and this uncertainty represents a maximum value. In the CDM the crediting period would have 7 year revisions so that this full uncertainty would not be applicable.

- The uncertainty relating to the data available in terms of the numbers of charcoal or wood stoves is much lower at 6450 ktCO2 ± 7%. Compared to other uncertainties, this does not make a large difference to the result and is therefore not an issue in data collection. However this is a minimum uncertainty and other data uncertainties such as the actual lifespan of stoves, the way they are used etc are not explored here but are still important.

- In terms of costs, the programme can be seen to lead to a considerable saving. This is due to the savings in consumption of fuelwood, which dwarfs the costs associated with running the programme for training the potters, or the extra cost of the improved stoves compared with the traditional ones. It should be noted, however, that much of the fuelwood in rural areas is collected rather than bought[3], hence the economic savings of this project are more in terms of time than currency.

4.2.3 Utete Solar Hospital Research Project

This consists of the provisions of 12, 75Wp Solar panels for a malaria research unit at Utete district hospital in Rufiji coastal region. It was installed in 1999 and replaced the use of the diesel generator still used in rest of hospital. It provides a lighting service, increased 24hr service for computers, communication, refrigeration and an expanded health service to neighbouring communities.

Project Boundary

The project boundary for the calculation of the GHG reductions includes the solar panels and the research labs served by the power supply.

Baselines and assumptions

The uncertainty in this project arises from the data for the output generated by the panels as it implies a relatively low solar insolation level compared to official maps of solar insolation available. An alternative project scenario was therefore generated to investigate the effect of the uncertainty. The uncertainty in the additionality of the project is also explored.

Baseline 1: In this baseline the existing diesel generator continues to operate for 3 years but is then replaced with a new diesel generator which operates for the rest of the crediting lifetime.

Baseline 1a: In this case we generate a baseline similar to baseline 1 and calculate the emission reductions as usual on the basis of equivalence of service with the project. However the data gathered for the project corresponds to a low insolation level for Tanzania (1451kWh/m^2/y). From official insolation maps the level in Tanzania should be in the region of 1900kWh/m2/y. This baseline uses this higher output level to calculate the reductions in emissions.

Baseline 2: This baseline explores what would have happened if the project had been done anyway after 10 years and is therefore additional for half the crediting lifetime chosen. It is assumed that the diesel generated would continue to operate during this time. The service is taken as the low output level given by the data.

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[3] In the results presented, we assumed that fuelwood that was collected rather than bought had the same currency value.

	Emissions Reduction	Unit Emissions Reduction		Incremental Costs	Unit Incremental Costs
	$ktCO_2$	$kgCO_2$/capita/y	tCO_2 MWh	M US$	US$/$tCO_2$
Baseline 1 Low service output Historic baseline diesel	0.029		0.89	1119	38
Baseline 2 As for 1 with high service output	0.038		1.16	-142	-4
Baseline 3 Additional for 10 y	0.015		0.44	820	56

Table 4-8 Results for Utete Solar project

4.2.3.1 Conclusions

- The uncertainty on the output from the project makes a very large difference to the final results as can been seen from Table 4-8 above.
- The alternative output based on known insolation levels means that the project not only realises higher emission reductions than the initial calculation but that it achieves them at cost savings. The costs calculated are incremental costs of the project compared to the baseline and not just project costs so that this is an important conclusion.
- The uncertainty in the reductions from variations in the possible output from the project is 0.033 $ktCO_2$±13%
- Uncertainty in the additionality of the project also has a major effect on the reductions over the lifetime of the project as can be seen from baseline 2. A decision on the appropriate crediting lifetime is important to maximise the CERs if there is a risk of non additionality in the future.

4.2.4 Mtwibwa Sugar Cogeneration

At Mtibwa (2.5MW) and TPC sugar factories (6MW for 22GWh/y), the new plant uses bagasse. It replaces grid electricity for factory needs.

4.2.5 Kitulango forest efficient charcoal kilns

This project involves replacement of traditional earth mound inefficient kiln to reduce wood demand. The new half-orange kiln is more efficient (1/3 more) and has been built in Kitulangalo forest reserve.

In the two projects described above there is no available data for the analysis despite continued assurances of delivery from the managers concerned. As a result we have analysed only three of the five Tanzanian projects.

4.3 Kenya

In Kenya we have five projects which were selected to cover a range of sectors and project types. In the following sections we discuss each in turn.

4.3.1 Tungu MHP project

This project is an 18 kW mechanical turbine producing 14 kWe, targeting 300 HH direct beneficiaries and about 4000 individuals indirectly at Chuka, Meru District.. The community who designed it from the start owns it. In Kenya current legislation prevents the delivery of a lighting service and so the main purpose is to power a new enterprise centre with a hairdresser, welding shop, battery charging facility, grain milling. It replaces services from a diesel generator for milling and wood and charcoal for tobacco curing. The number of households who have membership in the scheme is 300 but it is available to all.

Project Boundaries

The boundaries of the projects relate to the MHP plant itself and the services being provided by the project to the village of Tungu.

Baselines and assumptions

In this project it was not clear how much of the project output substituted for grain milling and the associated diesel consumption and how much of the output substituted for wood burning for tobacco curing. The baselines were therefore constructed to explore this uncertainty in the baseline activities. Additionality uncertainty was not explored in this case, as it is unlikely to have taken place without ITDG intervention.

Baseline 1: In this baseline the amount of grain milling using diesel generators in the baseline is assumed to be equivalent to 75% of the project output while the amount of wood used for tobacco curing is equivalent to 25%.

Baseline 2: In this baseline the amount of grain milling using diesel is assumed to be 25% while wood burning accounts for 75% of the project output.

	Emissions Reduction	**Unit Emissions Reduction**		**Incremental Costs**	**Unit Incremental Costs**
	$ktCO_2$	$kgCO_2$/capita/y	tCO_2/ MWh	M US$	US$/$tCO_2$
Baseline 1 75% diesel 25% wood	0.34		1.37		
Baseline 2 25% diesel 75% wood	0.57		2.32		

Table 4-9 Results for Tungu MHP in Kenya

4.3.1.1 Conclusions

1. The emission reductions calculated from this project are 0.46 ± 24%. The uncertainty in proportion of fuels substituted in the baseline is therefore an important parameter that needs to be properly measured in a full CDM project.
2. The project does not deliver large emission reductions and would need to be bundled. One reason for this is that the load factor for the project is very low at 8% if confined to these uses analysed here though water pumping is planned.

4.3.2 Sony sugar Cogeneration plant with bagasse

This project is located in Awendo – Sare, South Nyanza and is owned by the Sony company but it was carried out with community participation. It is proposed that a 15 MW cogeneration plant is built (2003-7) replacing grid electricity in the pre project situation using biomass (bagasse). Though this was not an operational project it will take place within an existing sugar factory structure.

Project boundaries

The boundaries include the cogeneration plant and the houses receiving the lighting service and the grid system.

Baselines and assumptions

The existing sugar factory uses electricity from the grid for the factory and for lighting in workers houses. Two scenarios were constructed for the development of the grid over the next 20 years.

Baseline 1: In the first scenario the development of the grid was assumed to come via more coal and oil fired (diesel) generation in the future. An emission factor for the grid, developed from 1995 grid figures, was calculated as increasing linearly into the future. This was used as a high scenario projection.

Baseline 2: In this scenario there is more hydro and renewables (about 50%) in the grid mix of the future. The corresponding average constant 'low' emission factor is used in the calculation of reductions.

Baseline 3: In this scenario the grid use continues for 10 years and then the project takes place. This scenario examines the additionality of the project in the commercial environment.

	Emissions Reduction	**Unit Emissions Reduction**		**Incremental Costs**	**Unit Incremental Costs**
	$ktCO_2$	$kgCO_2$/capita/y	tCO_2/ MWh	M US$	US$/$tCO_2$
Baseline 1 High grid mix emission factor	127		0.40	0.3	2
Baseline 2 Low grid mix emission factor	111		0.35	0.3	3
Baseline 3 Low emission factor for 10 years and then the project	55		0.17	0.2	3

Table 4-10 Results for Sony Cogeneration project

4.3.2.1 Conclusions

- The emission reductions from the project are in the range 91 ktCO_2±. 40% if the project may be built after 10years anyway.
- The uncertainty in the reductions due to the development of the emission factor for the grid, without additionality exploration, is 119ktCO_2± 7% over the lifetime and therefore does not have a large impact on the results. However this datum should be available in practice.
- The project carbon cost per tonne is good but the transaction costs are not included in the calculation.

4.3.3 Kathamba and Thima pico Hydro power project

These are 2 Pico hydro power schemes rated at 1.2 kW and 2.2kW respectively supplying 226 HH with power using a micro grid near Kerogoya town in Kirinyaga district. It provides electricity for lighting replacing kerosene lamps and is community owned.

Project Boundaries

The project boundary includes the hydro plants and their respective communities.

Baselines and assumptions

An assumption is made that each household uses an 8W CFL for 5 hours per day.
Emissions from battery charging have been calculated to be negligible.
It is also assumed that there is no residual kerosene use.

Baseline 1: In this scenario the existing kerosene use in the baseline is assumed to be constant throughout the crediting lifetime. The kerosene use is taken as 10l/month for this scenario which is the high use scenario.

Baseline 2: This is similar to baseline 1 but in this case we have a low kerosene use scenario at 7 l Kerosene/month.

Baseline 3: The low scenario for kerosene use for lighting continues for 10 years and then the project is undertaken. This again explores additionality and the effect of the choice of the short fixed and long revised crediting lifetimes.

	Emissions Reduction	Unit Emissions Reduction		Incremental Costs	Unit Incremental Costs
	$ktCO_2$	$kgCO_2$/capita/y	tCO_2/ MWh	M US$	US$/$tCO_2$
Baseline 1 High grid mix emission factor	1.10	57	11.66	-0.12	
Baseline 2 Low grid mix emission factor	0.77	40	8.16	-0.08	
Baseline 3 Low emission factor for 10 years and then the project	0.38	20	4.08	-0.05	

Table 4-11 Results for Kathamba and Thima pico hydro plants

4.3.3.1 Conclusions

- The emission reductions from this very small lighting project are low and assuming a 21 year crediting lifetime are 0.93$ktCO_2$±18%
- The uncertainty in the kerosene use is fairly high and means that this is a key variable for which data must be gathered in the baseline case. In the calculation there has been an assumption of no residual kerosene use.
- Compared to kerosene the pico hydro plant for lighting is cheaper and saves money.
- The choice of crediting lifetime for the project depends on the risk of non-additionality of the project in the future. Here we see that the reductions are directly proportional to the crediting lifetime so that there is an incentive to have the longer lifetime where possible.

4.3.4 AHP tea MHP

This is a 1.4MW Mini Hydro serving the 7 Factories in Kericho District built in 1999 - 2002. It will produce emission reductions due to replacement of grid and diesel electricity for machinery in the tea factories. It is not currently operational.

Project boundaries

The project boundary includes the mini hydro plant, the tea plant machinery and the grid system supplying electricity as well as the standby diesel generator.

Baselines and assumptions

The development of the grid system scenarios is already discussed under the Sony cogeneration bagasse plant. The diesel standby is used for 30% of the electricity supply. The same fraction of non-hydro sources is assumed to be supplied by diesel before and after the project.

Baseline 1: In this baseline the grid electricity emission factor over the crediting lifetime is assumed to increase. This is the high emission factor scenario for the grid. The diesel generator is assumed to be used to replace the grid 30% of the time.

Baseline 2: In this baseline the grid electricity scenario is the low scenario with 50% renewables constant for the grid development over time. Again the diesel standby is 30 % of the replaced electricity.

Baseline 3: The low emissions factor scenario for the electricity from the grid is taken along for the first 10 years and then the hydro plant comes on line.

	Emissions Reduction	Unit Emissions Reduction		Incremental Costs	Unit Incremental Costs
	$ktCO_2$	$kgCO_2$/capita/y	tCO_2/ MWh	M US$	US$/$tCO_2$
Baseline 1 High grid mix emission factor 30% diesel standby	54		0.55	-3.4	
Baseline 2 Low grid mix emission factor 30% diesel standby	50.4		0.51	-3.4	
Baseline 3 Low emission factor and diesel standby for 10 years and then the project	25.1		0.26	-2.0	

Table 4-12 Results for the AHP tea factories' MHP plant

4.3.4.1 Conclusions

- The emissions from the standby diesel generation for the factory mean that the calculation of the emission reductions is not sensitive to the variation in possible developments in the grid emission factors. The reductions are 52.2 $ktCO_2$ ±3%.
- The additionality results are similar to the results from the projects analysed above.
- The project produces cost savings and therefore no cost per tonne carbon is calculated.

- These results are very similar to those from the Uwemba project.

4.3.4.2 East Africa Portland and Bamburi Cement Works

This project is an energy efficiency project for cement production where a more efficient horizontal dry kiln replaces 4 vertical wet kilns at Mombasa and the Athi river. The project was carried out in 1998 - 2001.

Project boundaries

This project is an industrial project conducted within the factory site replacing 4 vertical kilns with an efficient dry kiln. The boundary includes the factory and the electricity grid supplying the factory with electricity. The reductions are calculated for the energy saving from the project as it does not affect the clinker/cement ratio.

Baselines and assumptions

The emission reductions arise from two sources. One is the energy saving produced by the project from the increase in efficiency and the other is the reduction in CO_2 from the carbonate added in the process. Sathaye et al (2001) have analysed similar installations in Brazil and China to produce standardised baselines. They point out that the CO_2 associated with the cement produced depends on the total amount of clinker produced which can be reduced by altering the clinker per tonne cement ratio. In this project there was no information on the clinker per tonne of cement associated with the baseline though project information is available. We therefore concentrated on the energy savings generated by the project and related those savings to the grid mix used for the AHP and the Sony projects. However, despite a great deal of effort to obtain data on baseline and project energy consumption and cement production, it was unfortunately not possible to generate a figure for emission reductions from the project. More work would be required on this.

5 Implications of results

The results that have been presented in section 4 above have been presented for the individual projects. In this next stage we consider the projects within the countries and also compare across countries for suitable projects. *In each case we have left out the results from the continued additionality of the project and compare the results only on the other data uncertainties explored in the baselines.* Additionality uncertainty is discussed in a separate section below.

5.1 Ghana

	Total Emissions Reduction	**Unit Emissions Reduction**		**Incremental Costs**	**Unit Incremental Costs**
	$ktCO_2$	$kgCO_2$/ capita/y	tCO_2/ MWh	M US$	US$/$tCO_2$
Appolonia Biogas	0.15±20% (for 9-12lkerosene/mth) 0.01-0.18 (for 20-80%compared to 80/20% biogas)	32-21 2-32		0.0002-0.004 0.011-0.0002	1-35 1-1200
Sustainable wood Nabari	1.85±24% with range of tree planting rates		1.5-1.71	-	-
Kpasa Solar homes	2.65±28% (7-12lkerosene/mth)	23-42		0.02 subsidised 0.48 un-subsidised	12 140
Greencoal project	Unsustain. wood High and low inefficient kiln 32.5±54% Reduction due to wood source mainly & efficient kiln Transport 0.8-2.9kt			0.92	106

Table 5-1 Summary table for Ghana projects

5.1.1 Discussion and recommendations

- The data uncertainties investigated in the projects contributed about 30% to the uncertainty of the emission reductions but can in the main be reduced by monitoring/surveys before the project (kerosene use) or monitoring during the project (tree planting rates or biogas production).

- However some uncertainties will need more work to resolve. Particularly in the case of the charcoal kilns, there is a wide variation in performance of the same type of kiln and we would suggest that further studies are required to obtain meaningful values for standardised approaches.

- The reductions were highest in the case of the sustainable wood greencoal project with charcoal kilns. This was due to the large size of the project. Though the Nabari sustainable wood fuel project relates to a cooking service, where much more energy is consumed compared to the lighting service, this reduction was not significantly higher than the Kpasa solar homes project. This is probably due to the large number of homes affected by the project in Kpasa. This is in agreement with previous studies (Begg et al 1998).

- Most carbon reduction costs were positive and high except for Kpasa where there was a subsidy.

5.2 Tanzania

Project	**Total Emissions Reduction**	**Unit Emissions Reduction**		**Incremental Costs**	**Unit Incremental Costs**
	$ktCO_2$	$kgCO_2$/ capita/y	tCO_2/ MWh	M US$	US$/$tCO_2$
Uwemba MHP project 893kW	41.5±18% variation due to project output uncertainty		0.77	0.6-3.1	13-102
ICS	6450±7% variation due to uncertainty in numbers of wood/char-coal stoves	365	2.5	-37 to -86	-15 to -6
Utete solar panels	0.033±13% due to project output variation on insolation		0.89-1.16	-142 to +1119	-4 to 38

Table 5-2 Summary table for Tanzanian projects

5.2.1 Discussion

- For Uwemba and Utete, the project output proved to be inconsistent with other data and was explored in the analysis. This project output uncertainty contributed between 13 and 18% variation. These variations are lower than those found for Ghana projects and would be removed by the project monitoring of the output in both cases.

- The projects in Tanzania tend to be larger than in Ghana with the highest reductions coming from the ICS programme through the sheer size of the programme and the fact that it addresses cooking as a service which requires higher energy inputs.

- The incremental costs of the projects vary considerably with project performance and in the ICS project, and Utete for the higher project output case, are cost saving.

5.3 Kenya

The results for the Kenya projects are set out in the summary table below.

Project	Total Emissions Reduction	Unit Emissions Reduction		Incremental Costs	Unit Incremental Costs
	$ktCO_2$	$kgCO_2$/ capita/y	tCO_2/ MWh	M US$	US$/$tCO_2$
Tungu MHP	0.46±28% variation in diesel and wood use		1.37-2.32		
Sony sugar cogeneration with bagasse	119±7%		0.35-0.4	0.3	2-3
AHP tea MHP 1.4MW	14.5±3% variation due to grid mix minimised by 30% standby diesel		0.15	-3.4	
Kathamba pico hydro	0.93±18% variation from kerosene use		8.16-11.66	-0.08 to –0.12	
Cement factory					

Table 5-3 Summary table for projects in Kenya

5.3.1 Discussion

- Much of the uncertainty in the calculations of emission reductions is arising from the baseline situation. Surveys for kerosene use before the project will be needed. Variations in the grid mix for Kenya had little effect due to the high Hydro component.

- The Tungu project though ostensibly larger than the pico hydro at Kathamba has less emissions reductions as the load factor is very low. Thus there is unused potential for further reductions in this project. In addition the consumption of diesel in a relatively efficient generator and woodburning compared to inefficient kerosene consumption also contributes to the higher reductions at the pico sites.

- The AHP project is cost saving while the Sony cogeneration plant incremental costs are low and could mean that this project is viable too.

5.4 Comparison on project size

A summary of the projects listed in order of size of plant giving both the baseline condition and the final reductions is presented in Table 5-4.

Table 5-4 Summary in order of size over all countries

Country	**Project**	**Baseline**	**Size**	**Reduction over 20y in ktCO$_2$**
Tanzania	ICS	Trad stoves	144MW	6450
Kenya	Cogen	Grid electricity	15MW	119
Kenya	MHP	Grid and diesel	1.4MW	52.2
Tanzania	MHP	Diesel generator	843kW	41
Ghana	Trad wood	Unsustainable wood	38kW	1.85
Ghana	SHS	Kerosene	21kW	2.7
Kenya	MHP	Diesel and firewood	18kW	0.46
Ghana	Biogas	Kerosene	12.5kW	0.15
Kenya	Pico	Kerosene	3.4 kW	0.93
Tanzania	solar	Diesel	0.9kW	0.033
Ghana	Eff charcoal kiln	Inefficient kiln	720t/y charcoal	32.5

It can be clearly seen from the table that there is no direct correlation with project size and reductions and that other factors play a major part in the quantity of reductions achieved by a project. Nevertheless, the larger the programme of small-scale projects or the larger the individual project then the greater the expected emission reductions would be.

Other key factors for reductions are the baseline fuel use and the type of service provided. These are investigated more closely in the following section.

5.5 Comparison across projects and countries

In this study only MHP projects can be easily compared across the countries. In the case of solar projects the nature of the projects is quite different with one being a large panel set in a hospital while the other concerned individual solar homes. Results from the previous study are therefore included for comparison. The improved cook stoves are also compared with the results from the previous study (Begg et al 1998) as there is no available cross country comparison in the current study.

Table 5-5 Summary of across country comparison of projects

Country	project	baseline	Reduction $ktCO_2$	tCO_2/MWh
SOLAR				
Tanzania	Utete hospital solar 0.9kWp	Diesel generator	0.033	1.1
Ghana	Kpasa shs (410HH) 21kWp	kerosene	2.65	
Zimbabwe (1998 study)	SHS (9800HH) 0.4MWp	kerosene	45	
Kenya (1998 study)	SHS (20000HH) 0.28MWp	kerosene	13 over10y panel life	
HYDRO				
Tanzania	Uwemba mhp (843kW)	diesel	41	0.77
Kenya	Tungu mhp (18kW)	Diesel and firewood	0.46	1.87
	Kathamba pico (3.4kW)	kerosene	0.93	
	AHP tea MHP (1.4MW)	Grid and diesel	52	0.15
Sri Lanka (1998 study)	MHP 27kW	kerosene	0.9	
Sri Lanka (1998 study)	MHP 1.7kW	kerosene	0.13	
ICS				
Tanzania	120000stoves wood and charcoal 144MW	Inefficient stoves	6450	
Kenya (1998 study)	Wood, 1500MW	Inefficient stoves	41300 (15y)	1.4
Sri Lanka (1998 study)	450000 stoves 240MW	Inefficient stoves	3280 (15y)	0.84

5.5.1 Solar PV

The results across the countries studied including those from the previous study are consistent with the size of the project for the case of the solar homes with the baseline being kerosene use as would be expected. We have only one solar project where the baseline is diesel and in that case it is not consistent and has a lower emission reduction than the kerosene case. It is logical that the diesel generator is more efficient than kerosene lamps hence the lower reductions. It sends a signal that the baseline component is crucial in selecting a standardised baseline approach.

5.5.2 MHP

Unlike the SHS with kerosene baseline, the MHP project reductions are not linearly correlated to the size of the project. For the kerosene baseline projects, the variation in reductions does not follow the project generator size. These differences between Kathamba and the two Sri Lankan projects can be explained by variations in load factor between the projects and variations in kerosene consumption across the projects.

Where the projects have a diesel generator baseline or mixed diesel baseline then the size of the project again does not correlate with reductions. It may be expected that the reductions would depend on the load factor. However the reality is more complex with diesel being on standby for the AHP project with a load factor of 30% and grid being the main baseline emission source. For the Uwemba MHP which is theoretically about half the size, the baseline is a diesel generator with 22% load factor. The AHP project delivers only slightly more reductions than the Uwemba project because it has a mixed baseline with the grid emission factor for Kenya being quite low because of the high proportion of Hydro in the grid. The Tungu baseline is a mixture of wood and diesel giving an uncertainty of 28% in the estimation of reductions. As discussed earlier, the reductions for Tungu are lower than might be expected because of the efficiency of the diesel generator in the baseline and the wood compared to kerosene lamps. Thus the projects studied, despite having the same technology, have very different baseline situations that will need to be taken into account in any standardisation process.

5.5.3 ICS

Again the reductions are not linearly correlated to the size of the project though the trend is clearly that larger projects have deeper reductions.

In all cases wood use was lowered by the project so that the baselines here are the same. We would suggest that the differences arise because of the difference in the type of wood and the amount of wood used in the baseline.

Again the standardisation of the baseline must take this into account.

5.6 Conclusions for standardisation and bundling

- The size of the project can only indicate a general trend for increased reductions with increased size of the project.
- The reductions are also dependent on what is substituted in the baseline. This in turn depends on the service being provided.

- What is substituted in the baseline can vary considerably for some project types. For example for Micro or Pico Hydro power and for Solar power the baseline can vary from kerosene to diesel generators and grid electricity. For ICS the baseline tends to be consistent as inefficient wood stoves.
- It will be important in a standardised procedure to take account of these factors and provide differentiated baselines according to what is substituted.
- Current advice does not take account of this range of complexity.
- This has implications for bundling projects where care will need to be taken that in a mixed set of baseline conditions representatives of each baseline condition are taken for monitoring and verification.

5.7 Additionality uncertainty

In the baseline scenarios described above, the effect of some variations in crediting lifetime has been explored on the basis that for some projects there is a likelihood that they would have been done anyway at some point within a 21 year crediting lifetime. However the effect of the risk of a project becoming non additional within a given crediting period can be explored. From work carried out under the EU Probase project (Begg et al 2003), it has been shown that the effect on emission reductions associated with the risk of non-additionality of a project can be expressed as an uncertainty. Thus a correction factor for the risk of non additionality can be suggested and used as a weighting factor for a baseline.

In the case of the EU study, a 25% weighting factor on a standardised baseline (ie 75% credited) was suggested as an average factor over a range of possible years (1-5y) of non additionality for large projects for a 10 year fixed lifetime. In this study we have considered only the 21 year crediting lifetime. This crediting lifetime has a 7 year revision so that the effect of the non additionality risk is much lower. This is due to the fact that in the first 3-5 years predictions can be reasonably accurate and the main risk is only in years 6 and 7. Two years of reductions may therefore be erroneously credited with up to a maximum 30% relative uncertainty in the 7 year periods. Particularly for large projects, this could work out at an average factor of about 10%, which is not a large loss in integrity in absolute terms.

In the case of small-scale projects, such a correction could be another disincentive to carry out these projects. We would therefore suggest that as a correction factor should not be used as the risk of non-additionality is generally low in developing country circumstances.

5.7.1 UNFCCC guidance

Under the recent guidance from the EB for the CDM for small-scale projects (UNFCCC 2002), the additionality issue has been dealt with by consideration of the barriers to the implementation of the project. These barriers are listed in Appendix A to the guidance. In addition in the Annex B on baseline methodologies evidence that there are incremental costs associated with the project compared to the baseline technology can also be provided for a renewable energy project. Where the project is an energy efficiency project then in addition to the barriers method, project participants can show that the payback period is longer than X years in the case of retrofit. For new supply side transmission and distribution measures, it should be shown that technical transmission and distribution losses are reduced by more than Y% from the baseline technologies or processes. In the case of other energy efficiency measures, for retrofit the guidance is as above, but for new measures the project activity should improve efficiency by more than Y%.

6 Comparison with EB recommended standard methods

For the projects a comparison can be made with existing guidance for small-scale under the Executive Board for the CDM. In the following section we take the projects according to the categories outlined in the EB guidance for Type (i) and then Types (ii) and (iii) followed by a comparison of the monitoring guidance with the analytical results for each project. The project types and categories are given in the table below.

Table 6-1 Project Types and categories for Small Scale Projects from EB Guidance

Project type	***Project Category***
Type (i) Renewable energy projects	*A. Electricity generation by User/Household* *B. Mechanical energy for the User/Enterprise* *C. Thermal energy for the User* *D. Electricity generation for a system*
Type (ii) Energy efficiency improvement projects	*E. E Supply-side energy efficiency improvements- Transmission and distribution* *F. F Supply side energy efficiency improvement – generation* *G. Demand side energy efficiency programmes for specific technologies* *H. Energy efficiency and Fuel Switching measures for industrial activities* *I. Energy efficiency and Fuel Switching measures for buildings*
Type (iii) Other project activities	*J. Agriculture* *K. Switching fossil fuels* *L. Emission reductions in the transport sector* *M. Methane recovery*
Types(i) to (iii)	*N. Other small scale projects (new or revised)*

6.1 Comparison of Guidance for Renewable energy projects (Type1) for category A projects (Electricity generation by the user/household) with Analysis

This category is defined as 'renewable technologies that supply an individual household or user with a small amount of electricity. The generation capacity should be less than 15MW or less than 15GWh'.

The projects which come under this category are
Kpasa Ghana
Appolonia Ghana
Utete solar project, Tanzania
AHP MHP
Sony cogeneration

We take each in turn and compare our results with the recommended standardised approach. The results are summarised in Table 6-2.

Table 6-2: Comparison of EB baseline recommendations for Type (i) projects and Analysis

Project	Baseline conditions	UNFCCC recommendations for Baseline	Calculated reductions for UNFCCC baseline ktCO2	Calculated total reductions from analysis ktCO2	Comment
Appolonia Biogas	Kerosene for lighting 9-12l/mth/HH	Where the electric output is metered the baseline is the kWh produced times the emission coefficient for diesel power based on a 50% load factor No mention of CH4 reduction	0.09kt metering electricity output in this case does not guarantee that the biogas is the fuel burned		The standardised equation takes no account of the uncertainty in the biogas proportion and could overestimate if this is not monitored and the residual diesel use accounted for. Otherwise there is little difference in result.
		Where the electric output is not metered and liquid fuels are displaced the baseline is the fuel consumption of technology in use or would have been used times the emission coefficient for the fuel displaced.	As for analysis	0.15±33% (kerosene data uncertainty) 0.09±89% (biogas% uncertainty)	No difference in approach for baseline Project emissions must include all sources so residual kerosene and diesel use should be covered
Kpasa SHS	Kerosene for lighting 7-12l/mth/HH	Where the electric output is not metered and displaces liquid fuels the baseline is the fuel consumption of technology in use or would have been used times the emission coefficient for the fuel displaced	As for analysis	2.65±28% (kerosene data uncertainty)	No difference in approach

		Alternative from Table B1 for SHS is 75kg/y+4*Wp for 410 HH over 21y	2.37 ktCO2		Result from SHS equation is in range calculated from kerosene use
Utete Solar 12*75Wp	Diesel generator for hospital	Electrical output is metered at 2.15MWh/y The baseline is the kWh produced times the emission coefficient for diesel power based on a 50% load factor from Table B4 using the SHS equation from Table B1 as above	0.059kt CO2 0.077kt CO2	0.033	Tendency to overestimate with this B4 equation[1] EF used compared to other standard values used in this analysis but is more related to characteristics of diesel generators according to the references used. Again an overestimate using B1 equation
AHP MHP for tea production This Project could come under this category Type (i) A (electricity generation) or B (mechanica	Grid electricity and 30% diesel standby 98286MWh	Under A (electricity generation) or B (mechanical energy for the user) the project baseline is as follows Where the electric output is metered the baseline is the kWh produced times the emission coefficient for diesel power based on a 50% load factor It assumes a diesel only baseline and 4-6 hrs/day service and no grid Under Type (i) C Baseline is not relevant as it specifies fuel consumption or firewood though	78.6kt CO2 The electricity produced is metered but the baseline is not diesel as assumed Not relevant	52.2±3%	Uncertainty on which category this project belongs to as is mixture if grid and diesel generator. None are completely appropriate The only category which discusses grid electricity is Type (i) D for projects supplying into the grid UNFCCC categories available need to be widened

l energy) or C Thermal energy for the user Or Type D electricity generation for a system)		it does discuss replacing a fossil fuel system. Under type (i) D the baseline is the weighted average of the current generating mix or The operating and build margin baseline Using the MHP equation from Table B1	Similar to the analysis 56ktCO_2		MHP equation gives similar results
Sony cogener-ation with Bagasse 1.4MW	Replace-ment of a grid lighting service and grid for factory	This is similar to the problem for the AHP plant above. The electricity generated by the plant is used to replace a grid lighting service and the factory grid use Under type (i) A (electricity generation) or type (i) B (mechanical energy for the user) the project baseline is as follows -Where the electric output is metered the baseline is the kWh produced times the emission coefficient for diesel power based on a 25% load factor (Table B4) It assumes a diesel only baseline Under Type (i) C This baseline is not relevant as it	253kt CO_2 The output EF used is 0.8 This is similar to our analysis	119kt CO_2 The output EF used for the Kenyan electricity system is 0.41kgCO_2/kWh	This type of project is best covered by the type (i) D baseline in the guidance and some modification is required.

		specifies fuel consumption or firewood though it does discuss replacing a fossil fuel system. Under type (i) D the baseline is the weighted average of the current generating mix or The operating and build margin baseline Output Emission factors times the output of the plant	though the category is not appropriate Analysis result as for study		
Uwemba MHP Tanzania	Diesel generator Load factor 22% For lighting	Generation for a system Baseline for Type (i)D Annual kWh*EF for modern diesel of relevant capacity operating at optimal load discuss with Rona in Table B4	EF is 0.8 50.5kt	Calc 34-49ktCO2 Depending on project output	In this case the reductions are calculated on almost the same basis and the results differ only in the slightly higher EF recommended in Table B4
Tungu MHP Kenya 18kW	Diesel generator for grain milling and firewood for	Diesel for grain milling Electricity generation for mechanical energy Type (i) B Where baseline would have been diesel generation then baseline is the mechanical energy produced (MJ) times 3.6 to convert to kWh times the	Measured total output is 12MWh Assumed 75% milling as for baseline 1 (9MWh), EF	For baseline 1 75% milling the total reductions due to milling were calculated as 0.16ktCO2	The main problem is that there is no explicit guidance where there is a mixed baseline such as this. Information may not be available for the relative

	tobacco curing	emissions factors based on Table B4 for 50% load factor and the relevant capacity in this case 1.3 Firewood for curing Type (i) C thermal energy for the user Firewood consumption times emission coefficient for firewood	1.3 0.23ktCO2 This is as for analysis		proportions of the activities and an approach to this is also needed. The method uses a high emissions factor for the generator due to the small size of the generator so that standard values as used in this analysis may underestimate the reductions

[1] The simplified guidance from the EB (Annex B to UNFCCC (2002) FCCC/CP/2002/7/Add.3 Simplified modalities and procedures for small scale projects) contains recommended methodologies under the project types listed in Table 4-6. Under type IA a list of equations is given in Table B1 which apply to SHS and hydropower among others based on an ECN study. Under type ID Table B4 contains a list of emission factors for diesel generators for three load factors for a range of generator sizes.

6.2 Comparison of Guidance for Energy efficiency improvement (TypeII) and other project activities (Type (iii)) with Analysis

The projects which are considered under this part of the existing guidance are

Sustainable woodfuel Nabari, Ghana
Improved Cook stoves in Tanzania
Greencoal improved charcoal kiln in Ghana
Efficient Cement Kilns in Kenya
Each of the projects is summarised in the following table.

Table 6-3 Comparison of EB small scale projects baseline recommendations and Analysis for other project types.

Project	Baseline conditions	UNFCCC recommendations for Baseline	Calculated reductions for UNFCCC baseline $ktCO_2$	Calculated total reductions from analysis $ktCO_2$	Comment
Greencoal Ghana	Inefficient kilns And sustain-able wood source	Type (ii) (H) demand side energy efficiency and fuel switching for industrial projects. The UNFCC baseline is specified by the energy use of the retrofit measures or what would have been built The emissions are calculated by the product of each energy form in the emissions baseline times the emission coefficient. Type (ii) (G) is an alternative but does not take account of the change in sustainable wood source	In this case the fuel is wood but the emissions from the kilns are a complex mixture of pollutants and variable in output so that the data on efficient and inefficient kilns is essential for the comparison. In principle the analysis carried out followed this but required much more data which should be included in the guidance	Depending on sustainable or unsustainable wood source in the baseline the reductions are 4±125% Or 32.5±54%	New guidance is required for this type of project. An indication is given in this analysis. The wood source has to be in the project boundaries
Woodfuel	Sustain-	There is no suitable category for		The analysis	A new category is required

Ghana	able wood source	this project type . The current Types (ii) (H) or (I) are specified for industrial facilities or buildings while the switching fossil fuels does not apply (Type (iii) (K)		was based on the substitution of unsustainably sourced wood with sustainably sourced wood 1.85±24% due to uncertainty in rate of tree planting. This would have to be monitored	for this project type. The calculation is based on the amount of fuel used (which would have to be monitored by surveys) and the emission factor for wood.
Cement Kenya	Improved efficiency kilns	This project could be described under Type (ii) (H) energy efficiency and fuel switching for industrial technologies The baseline is based only on the electricity use of existing equipment if a retrofit as is the case here corrected for transmission and distribution losses for the grid. The emissions factor is that specified under type (i) D. operating and build margin method or the weighted average of the current generation mix or dispatch data. For cement in addition to energy savings from efficiency improvements some projects may			A specific category for small cement works could be added which can allow for process emission reductions if required. Some guidance on equivalence of service is also required.

		reduce the process emissions from the clinker production			
Project	**Baseline conditions**	**UNFCCC recommendations for Baseline**	**Calculated reductions for UNFCCC baseline ktCO$_2$**	**Calculated total reductions from analysis ktCO$_2$**	**Comment**
ICS Tanzania	Improved efficiency cook stoves	This project is a programme of small energy efficient stoves and comes under Type (ii) (G) This is the only type to take account of programmes of small projects. This type discusses only energy displaced as fossil fuel or as electricity while in this project it is wood There is no provision for equivalence of service. It is assumed that the same service is provided more efficiently.	In principle the method should follow the advice on fossil fuel which is the fuel use multiplied by the emission coefficient for the fuel for the baseline emissions and compared to the fuel use for the project.	The method used in this study follows this principle for wood. The analysis result was 6450ktCO$_2$±7% with uncertainty in wood or charcoal stove relative numbers It should be noted that the lifetime of the stove is usually 3 years so that the calculation of the reductions has to calculated for each stove for 3 years or the lifespan of the stove only	ICS is not mentioned or catered for in this guidance but it would require little modification of the existing guidance to include wood as a fuel. The number of stoves and lifespan are required data However the restriction of 15GWh could be problematic as it is difficult to be precise about the number of hours for which the stoves operate. In this case the full 180000 of the programme could not be counted. It would have to be in the region of 90000 assuming stoves are used for 4 hours a day 365 days a year. This restriction seems unnecessary as the project

				and summed over the number of stoves rolled out in the programme.	cannot be considered as a large project due to the small-scale nature of the individual stoves.

6.3 Implications for Standardised approaches to baselines for small scale projects

This study has examined a range of project types in different countries which has shown that project type does not give a simple guide to the relevant baseline for a project. There can be many different baseline circumstances for a given project type and some widening of the existing guidance is recommended to increase flexibility of application.
This comparison with the existing guidance from the UNFCCC Executive Board is detailed in the Table 6-2 and Table 6-2, in sections 6.1 and 6.2 above. The specific comments for each of the projects studied are given in the table in detail but some general summary points can also be made as follows:

- There is some flexibility in the existing guidance in terms of the need to consider mixed baselines but the guidance does not explicitly suggest that the different aspects to the reductions have to be considered under the relevant category and assembled to give a total for the project. This is particularly clear and relevant for the Tungu MHP project.
- The principle that in general, there should be equivalence of service between the project and the baseline is shown by the need to use the project activity level when calculating the reductions. This seems to be reasonably consistent across most of the categories though it is not explicitly dealt with. However, in some cases such as in energy efficiency, no specific direction is given and this needs to be added e.g. for equivalent tonnes of charcoal produced in project and baseline.
- Many of the projects do not fit the available categories but these are recognised to be a starting point and new methodologies are being submitted for approval to the EB. In this study we have found that the main exceptions to the categories available are cement kilns, charcoal kilns, sustainable wood, and power capacitors.
- Though for some projects there were appropriate categories we found that for most of the projects some modification is required in the recommended guidance. An example is Tungu which has a mechanical component and a thermal component. In this case two categories are required. However the guidance for the mechanical energy produced an underestimate of the emissions while for the Uwemba MHP an overestimate was produced. For the Sony cogeneration and the AHP MHP where the baseline was grid electricity the Type (i) A and (i) B appropriate to these projects did not provide for such a baseline but could easily be expanded to cater for this.
- For ICS a modification of Type (ii) (G) is required to include firewood. There is currently no appropriate guidance. There is also the problem of the size of the programme involving these small projects as a whole programme of this size could not be counted as <15GWh reduction. Nor could it be considered a large scale project because of the nature of the household level of the equipment this would seem an unreasonable restriction.

- The SHS project at Kpasa was able to be properly processed using the baseline guidance either on kerosene or using the solar power equation. On the other hand for the solar project at Utete the reductions were overestimated by both the UNFCCC recommended diesel and the solar equations.
- Some closer examination of the environmental integrity of the equations and emission factors suggested is required especially with regard to Table B4 and B1(see footnote above) If these equations are to be applied widely then we suggest that they should be double checked or weighted as they do not give conservative estimates.

6.4 Implications for Monitoring

A comparison is made in the following section between the guidance from the EB on monitoring for the specified project type and the actual requirements for the project derived from detailed analysis. The results are summarised in the following Table 6-4.

In the table, we list the implied monitoring requirements from our study and compare them to the monitoring guidance provided by the EB. For the Utete solar project, the AHP, Sony and Uwemba projects, the advice based on metering electricity consumption was appropriate. However for the other projects there were some problems. These are summarised below.

- The biogas project requires two main issues to be addressed. One is the kerosene use before and after the project. This needs to be sampled (which was not covered in current guidance on monitoring though mentioned in the baseline advice). The other is the biogas component of the fuel for the generator. This is crucial for the final reductions and their environmental integrity. Spot checks will be required on the biogas composition. This has to be explicitly included for this project type where there is a possibility of more than one fuel for the generator.
- The monitoring advice for the Kpasa SHS and Biogas project is based on metering electricity in the baseline and does not mention the kerosene use before and after the project. The existing guidance on monitoring is therefore insufficient if the standard equation is not applicable.
- In the projects where the baseline is kerosene use it may be possible to minimise monitoring by taking a conservative value for the baseline kerosene use based on an initial country survey which could then be applied to all projects in the country. In this study a value of 10l/mth could be taken for Ghana. For Kenya the average was 8l/mth but more data would be required to confirm this. This would avoid the need to modify the standard equations by weighting.
- For the Tungu MHP project the guidance was also insufficient for the thermal parts of the baseline and new guidance along the lines suggested is required.
- No relevant guidance was available for the charcoal greencoal project, the sustainable wood project, the cement kilns project or the Improved cook stoves project. For the ICS the lifetime of the stove before replacement and the number of stoves is required. Monitoring recommendations are given from the analysis in this study in the table below.
- The uncertainty analysis has helped to pinpoint key variables which need to be measured to maintain integrity.

Table 6-4: Comparison of UNFCCC recommendations for calculation of reductions and for monitoring

Project	Baseline conditions	UNFCCC recommend-ations for monitoring and calculation of reductions	Uncertainty Analysis Recommendations	Comment
Appolonia Biogas	Kerosene for lighting 9-12l/mth	Metering the electricity system or sample where the baseline is based on the electricity produced. Reductions are subtraction of project from the baseline for the project output so assumes equivalence of service	Kerosene consumption surveys before and *after the project on random sample basis.* Checks to see that biogas/diesel ratio maintained are needed. *This could not be done purely on the metered electricity output* Reductions cannot be based on equivalence of service between project and the baseline for lighting with kerosene. Simple subtraction is OK but projects cannot be compared easily.	The UNFCCC monitoring approach cannot be used for this project as the baseline has no electricity produced. It needs to be expanded to include fuel use before and after the project. It neglects the problem with the biogas/diesel mixture with the need to ensure that the biogas input is maintained Monitoring of the biogas component would be required in addition.
Kpasa SHS Ghana	Kerosene use (7-12l/HH/mth)	Annual check that all systems or sample needed to ensure still operating where baseline is from Table B1. Reductions are simple subtraction of project from the baseline	Kerosene consumption surveys before and *after the project on random sample basis* Reductions cannot be based on equivalence of service between project and the	The UNFCCC monitoring approach checks that SHS systems are still working when using standard equation If kerosene based there is no guidance on monitoring before and after project.

			baseline for lighting with kerosene. Simple subtraction is OK but projects cannot be compared easily	
Project	**Baseline conditions**	**UNFCCC recommend-ations for monitoring and calculation of reductions**	**Uncertainty Analysis Recommendations**	**Comment**
Utete Solar Power	Diesel generator for hospital	Metering the electricity system or sample where the baseline is based on the electricity produced. This is equivalence of service	As for UNFCCC	This is the correct monitoring advice for this project
AHP MHP in Kenya	Grid electricity and 30% diesel standby	Metering the electricity system or sample where the baseline is based on the electricity produced. This is equivalence of service	For Kenya there is no large effect of projected changes in the electricity supply system so that the result is not sensitive to future projections of the grid emission factor in Kenya. The 30% diesel standby also buffers the sensitivity of the reduction to these changes.	The monitoring advice from Type A /B C is relevant
Sony Cogenerati on with Bagasse	Grid electricity	Metering the electricity system or sample where the baseline is based on the electricity produced. This is equivalence of service	As for AHP plant above. There is no diesel standby but Kenya emission factors for grid only vary by 7%	The monitoring advice from Type A /B C is relevant
Uwemba	Diesel generator for lighting service	Metering the electricity produced by the renewable		This monitoring advice is relevant

		technology. This is equivalence of service		
Project	**Baseline conditions**	**UNFCCC recommend-ations for monitoring and calculation of reductions**	**Uncertainty Analysis Recommendations**	**Comment**
Tungu MHP	Diesel for milling and firewood for tobacco curing	Metering system output by all or sample of systems Metering the thermal energy or sample thereof for tobacco curing		The first part on milling is relevant to the project the amount of wood use before and after the project is needed for the thermal energy part and the amount of tobacco cured. New additional advice is required here
Greencoal project Ghana	Improved efficient kilns and sustainable wood source	For retrofit the recommendations are for documenting the specifications of the equipment replaced, metering the energy use of the equipment installed and calculating the energy savings. In this case this would not be quite correct as there are two aspects. One is the shift to sustainable wood and the other is the change in	We would suggest that experimental data on the emissions from typical kilns is generated to give more data for use in the baseline and new technologies must have their emissions characteristics specified. In addition the amount of wood use needs to be closely monitored for this project and its source if it is to be considered sustainable	The UNFCCC advice does not apply to this project. New advice as suggested is required with some guidance on equivalence of service in terms of tonnage of charcoal.

		pollutant emission concentrations with the new technology		
Nabari woodfuel project	Sustainable wood source	No available project type	In this case the amount of wood used in the project would need to be established by surveys Checks to ensure sustainable practices are maintained	New advice as described
Cement Kenya	Improved efficiency of kilns	For retrofit the recommendations are for documenting the specifications of the equipment replaced, metering the energy use of the equipment installed and calculating the energy savings. Clinker data is also required	In this case the energy bills for the company should be available before and after the project. clinker data is also required if there are process reductions	Again there is no direction on equivalence of service between the project and the baseline eg in terms of tonnage of cement A standardised methodology has been also been developed by Sathaye et al (2001) for these projects and this could be tested for incorporation
ICS Tanzania	Improved Cook stoves	There is no existing category and wood as a fuel is not mentioned in Type (ii) (G)	Wood use for cooking before and after project	Surveys of the wood use before and after the project on a spot sampling basis are required. The number of stoves sold and the lifetime of the stoves

7 Bundling

For small scale projects, the transaction costs incurred by the projects present a significant barrier to the implementation of these small scale projects under the CDM. These costs are associated with the ease by which the baselines and monitoring plan can be generated, validated, monitored and verified by an operational entity. They are recognised to be very high compared to the project costs and the expected revenue from the sale of CERs. (Michaelova and Stronzic 2002, Green et al 2003).

The Executive Board for the CDM has recognised this problem and a simplified Project design document (PDD) for small scale projects along with simplified baseline modalities discussed above were approved at COP 9. In addition only one operational entity is required for validation and verification compared to two for large projects.

To try to minimise the transaction costs associated with the CDM project cycle, small scale projects may be aggregated as a programme or portfolio of projects for all stages of the project cycle to spread the costs over a number of projects. This is called bundling.

However in addition to the transaction costs associated with the project cycle there are other costs to be considered. For example most of these small scale projects require capacity building for the local participants and participation arrangements to ensure local input to the design of the project and local term engagement with the project. This is vital to ensure the delivery of the GHG reductions and sustainability benefits in the long term. These other costs include

- the costs of additional capacity building requirements for small scale projects,
- the simple institutional process and structures required in each country for small scale projects with minimisation of investor risk,

Only the first accrues solely to the investor. The institutional process for approval within the host country will have a knock on effect for investors but costs will also accrue to the host country. If a simple institutional process is not in place then there will be a risk of failure of the CDM process for small scale projects in the host country. Mechanisms to offset the risk to investors such as that by the government of Costa Rica would also have host country costs but would make it more attractive to investors.

In practical terms there is also a need to consider the different bundling options available which will work in practice to produce the required minimisation in costs though at the same time it is important to design the approach to ensure the maximisation of local sustainability benefit delivery.

A recent study by Green et al (2003) evaluated the CDM transaction costs and revenues for some CDM type projects in Ghana and concluded that bundling was essential for enabling small scale projects to be implemented under the CDM. They suggested that a bundling organisation financed by commercial enterprises would be needed but that the risks were still too great as the CER production from each project is not in the control of the bundling organisation and thus project failures could be high. If the bundle is made up of many projects involving a range of different parties then this can become unmanageable. They suggest that these risks can be managed if the projects share some synergy and other criteria are met. The criteria given are

- high CER regimes of at least 20000tCO_2/y through aggregation
- CERs should form at least 10% of the net revenue for the project
- established institutional frameworks for the CDM in the host country
- common elements for baseline standardisation.

In the following sections we discuss the issue of size of project in relation to the projects in this study and the issue of common elements for baseline standardisation. Institutional arrangements are dealt with in Attachment 5.

7.1 Suitability of current projects in terms of size

Michaelova and Stronzic (2002) categorised projects according to size in terms of total reductions and correlated this with expected costs and cost of reductions per tonne carbon dioxide. Their categories were

- Large (wind solar thermal) giving reductions of 20000-200000tCO_2/y
- Small (boiler conversions, DSM, small hydro) giving reductions between 2000-20000tCO_2/y
- Mini (energy efficiency in housing , SME, mini hydro) 200-2000tCO_2/y
- Micro (PV) <200 tCO_2/y

They suggested from this the rough guide that projects of 20000t CO_2/y were needed before the cost of the reductions would make the project attractive to investors.

Taking the Table of projects listed by size from Section 2 of this Attachment 4 we can label the projects using the colour scheme indicated.

Table 7-1 List of projects and sizes

Country	Project	Baseline	Size	Reduction over 20y in $ktCO_2$
Tanzania	ICS Programme	Trad stoves	144MW 30-60GWh/y reduction project would need to be halved in size to meet 15GWh restriction	6450
Kenya	Cogen	Grid electricity	15MW	119
Kenya	MHP	Grid and diesel	1.4MW	52.2
Tanzania	MHP	Diesel generator	843kW	41
Ghana	Trad wood	Unsustainable wood	38kW	1.85
Ghana	SHS	Kerosene	21kW	2.7
Kenya	MHP	Diesel and firewood	18kW	0.45
Ghana	Biogas	Kerosene	12.5kW	0.15
Kenya	Pico	Kerosene	3.4 kW	0.93
Tanzania	solar	Diesel	0.9kW	0.033
Ghana	Eff charcoal kiln	Inefficient kiln	5GWh/y	32.5
Kenya	Cement	Inefficient kilns		
Ghana	Capacitors	Inefficient power factor		

It can be seen that the ICS project in Tanzania is already a bundled project. It is the only one likely to have transaction costs spread over the projects sufficiently to make the project viable in terms of transaction costs for the CDM. In fact it may be over the limit for small projects which as pointed out earlier would be counterproductive. The advice on de-bundling from the EB would mean that only part of the project could be eligible for CERs.

The Ghana SHS is also bundled in a sense, but like all the other projects is too small, and would have to be bundled further in some way.

7.2 Implications for Bundling from the Analysis

The results from our analysis have an impact on how projects can be bundled to effectively maximise the time savings associated with the simplified procedures for fast tracking projects. From the discussion above a target of at least 20000tCO_2/y for the reductions from a set of projects has been identified (Michaelova and Stronzic 2002) so that the number of projects included in the bundled project should be able to be identified. This should also ensure that the CERs represent a significant percentage of the net revenue.

In the following sections we explore the possible bundling options with respect to the projects in the study firstly from the baseline point of view and then from the monitoring aspects.

7.2.1 Bundling options and Baseline standardisation from the analysis

In the set of projects examined in this study, it is clear that similar project types do not necessarily have similar baselines. For example for the MHP projects the range of mixed baselines was high and ranged from kerosene to grid electricity. This does not apply to ICS or to SHS projects where wood fuel or kerosene is usually replaced.

Simplified baseline modalities can be applied where the baseline situation is similar or there are only a small number of standardised baselines needed to describe the bulk of the projects. Thus the focus has to be on what is being replaced in the baseline as well as what service the project is providing. For the MHP projects in Kenya, the service provided and baseline are listed in the table below.

Table 7-2 MHP projects in Kenya with varying baselines

Project	Service	Baseline	Comment
Tungu	Electricity for local enterprise centre Heat for Tobacco curing	Diesel generator Wood fuel	Mixed baseline
Kathamba Pico Hydro	lighting	kerosene	Simple baseline
AHP tea MHP	electricity for factory and lighting	Grid electricity	Simple baseline

From Table 7-1 it can be seen that in the same country we can have a whole range of different baseline conditions for the same project type. However simplified baselines can be applied for these types of projects, and even with this diversity, bundling over a larger sample would be possible provided the baseline situation is known for each and that they fall into limited categories such as those in the table above.

Similarly if a series of projects are of different types, the diversity of the baseline situation is all that matters in terms of minimising the complexity. Table 7-2 illustrates this for different projects.

Table 7-3 Mixed type projects with similar baselines

Project	**Service**	**Baseline**	**Comment**
Pico Hydro e.g. Kathamba	lighting	kerosene	Simple baseline
Biogas project such as that in Appolonia Ghana	lighting	kerosene	Simple baseline
SHS projects such as Kpasa in Ghana	lighting	kerosene	Simple baseline

It is interesting to consider how projects may be bundled to maximise the benefits for GHG reductions and for sustainability. With this in mind, one could envisage projects complementing each other to maximise the range of sustainability benefits as in Table 7-4.

Table 7-4 Projects with complementary benefits

Project	**Service**	**Baseline**	**Comment**
Community projects			
SHS	lighting	kerosene	Simple baseline
MHP	Electricity for enterprises	diesel	Simple baseline
ICS project	Cooking	wood	Simple baseline
Sustainable wood project	Carbon neutral source for cooking	Unsustainable wood	Simple baseline

Green et al (2003) also propose some options for bundling where

- there could be a range of project types/sectors bundled together
- over a range of countries
- a bundling organisation is set up and funded by commercial enterprises

However from their conclusions too much diversity in the first two factors would tend to increase the risk of failure due to lack of control with no clear standardisation of the baselines.

From this analysis we would agree that a range of countries would be too difficult in practice but the kind of synergies discussed above would be possible combinations for bundling and using standardised baselines. Our proposals are listed below.

- same project type with limited number of standardised baselines
- different project types providing a similar service and with similar baseline conditions
- different project types which are complementary to the needs of the target community or company but with a limited number of standardised baselines

7.2.2 Bundling options and Monitoring requirements

The other key factor for minimising costs in the project cycle is in the monitoring requirements that affect the costs of monitoring and verification. From this analysis we suggest that the bundling options described above do have feasible monitoring implications. Taking each in turn we examine the requirements.

Table 7-5 MHP same project type /different baselines

Project	Service	Baseline	Monitoring
MHP project such as Tungu	Electricity for local enterprise centre Heat for Tobacco curing	Diesel generator in neighbouring village Wood fuel	Metering for plant Surveys of wood fuel use before and after project Survey of deployment numbers
Pico Hydro e.g. Kathamba	lighting	kerosene	If Equation from Table B1 (UNFCCC) then only surveys to see deployment and operational. (Standardised equation is not reliable) or deployment numbers and kerosene surveys before and after project
MHP such as AHP tea	electricity for factory and lighting	Grid electricity	Metering for plant Surveys or records of deployment numbers

For projects with similar baseline conditions

Table 7-6 Mixed type projects with similar baselines

Project	Service	Baseline	Monitoring
Pico Hydro e.g. Kathamba	lighting	kerosene	If Equation from Table B1 (UNFCCC) then only surveys to see deployment and operational. (Standardised equation is not reliable) or kerosene surveys before and after project and deployment numbers
Biogas project such as that in Appolonia Ghana	lighting	kerosene	Biogas use spot checks Deployed numbers Kerosene use before and after surveys or use of standard equation
SHS projects such as Kpasa in Ghana	lighting	kerosene	Deployed numbers Spot check are operational Kerosene use surveys as above or use standard equation

For projects where there are synergistic benefits both for the GHG reductions and for the sustainability benefits then the monitoring can be standardised on a few variables as follows.

Table 7-7 Projects with complementary services

Project	Service	Baseline	Monitoring
Community projects			
SHS	lighting	kerosene	Use weighted equation or kerosene use surveys before and after Deployment numbers Spot checks are operational
MHP	Electricity for enterprises	diesel	Electricity metering Deployed numbers
ICS project	Cooking	wood	Deployed numbers. Lifespan, Spot checks to ensure are operational. Surveys for wood use before and after
Sustainable wood project	Carbon neutral source for cooking	Unsustainable wood	Hectares planted Sustainable practices maintained Survey of wood use This can applied across country for all projects

7.2.3 Recommendations

- The bundling of projects could be carried out under a variety of formats to minimise the costs of the baseline construction.
    - The simplest is to have a large programme of the same type of project e.g. ICS or SHS. Other formats include
    - Projects of different types but the same baseline conditions (the ICS and SHS are a special case of this as they do usually replace wood/charcoal or kerosene use respectively)
    - Projects of the same type but with a limited number of different baseline conditions
    - Projects which can complement each other in terms of GHG reductions and sustainability benefits with limited number of different baseline conditions.

- The monitoring information can be derived from limited spot sampling to keep down costs and from general surveys within the country.
- These country surveys to measure for example, wood and kerosene use, can then be applied to all subsequent projects to be bundled in that country.
- The reductions can be calculated either using the standard baseline equations in UNFCCC Tables B1 and B4 with some checks to prevent overestimates or through the baselines suggested from the analysis.
- The reductions should be calculated for one representative project for each baseline type and then multiplied by the numbers deployed and operational, maintaining equivalence of service and lifetime of technology (e.g. 3 years for ICS) where possible.

Bundling of projects also requires consideration of the institutional structures in the country and the capacity building requirements for these projects. These are discussed in Attachment 5 to the main report.

8 References

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Annex 4.1 Initial Project List

Kenya	Tanzania	Ghana
MHP, Tungu Kaburi	*MHP Uwemba*	
		Solar Water Heaters, Urban & Rural Communities**
Sony sugar co Diesel to bagasse cogen	*Sugar cogen grid to bagasse Mtibwa*	
		Solar pump Water treatment, rural communities
Bamburi cement energy efficient kilns	*Improved efficiency of charcoal Kilns for rural communities*	*Biomass Plantation for Charcoal Production, Ashanti Region More efficient kilns*
Thima Pico hydro		
		Solar PV Refrigeration**
African Highland Produce MHP and cogen	*Solar dryers Agricultural communities*	*Solar Dryers***
Solar power for schools instead of kerosene	*SHS for off grid*	*Solar Home Systems for Rural Communities*
ICS	*ICS TATEDO programme*	*ICS Energy Efficiency cookstoves & lighting, urban & rural*
Improved brickmaking wood to diesel		
		Solar Water Pumps, rural communities** for drinking water
	Energy Efficiency in industry National programme	*Energy Efficiency in commercial & Industries, Nationwide*

Projects in blue would provide cross country comparisons

Annex 4.2 Technical Data Requirements

CAPA project:

Project Types: Pico, Mini- and Micro-Hydro, Solar , and energy efficiency projects eg charcoal kilns

Technical and Financial Data Requirements

About this form/questionnaire:

Please find below a brief explanation on the structure of the forms, and important guidelines about how to fill the form.

For each project, there are two cases on which we need data:

- **Baseline case**: this is a description of the most likely situation in the absence of the project. If without the project 'nothing new' would have happened, then you must describe the existing situation before the project started. However, it is also possible that in the absence of the project, the existing situation would not have remained unchanged. In that case, you need to describe the expected changes in the absence of the project (for example if a micro hydro scheme replaces a very old diesel generator which is almost falling apart, then this generator would have had to be replaced in the near future anyway, e.g. by a newer diesel generator or by 'nothing' if there was no money to replace the old generator)
- **Project case**: details about the project

This form has 3 sections which need to be filled, both for the baseline case and for the project case;

1. **A general description of the situation**
2. **Technical data**
3. **Financial data**

NB: section 2 will be used to calculate the emissions reduction of the project (i.e. GHG emissions of the baseline minus GHG emissions of the project)
section 3 will be used to calculate the incremental cost of the project (i.e. the total cost of the project minus the total cost of the baseline)

<u>When you fill in the form, please bear in mind:</u>
The more information you can provide, the better. However, it is also important to make a note of the reliability of the data. So:

- Please give **measured** operating data as much as possible. If data from the feasibility study is available in the project case, please specify this *as well*. Please label all data: measured [**M**], estimated [**E**], from feasibility study [**F**]
- For all data please **specify units** if these are not the same as requested in the form
- If possible, please estimate uncertainties in the values given, eg ±20%.

Not all questions will necessarily apply to all project types

If you have any technical drawings or reports on the project please attach.

1. General Information

1.1 Baseline Case:

1.What was the energy source that supplied energy needs before present project? Eg kerosene lamp

2.Did it give an equivalent energy service? If not, how did it differ?

3. Age of the existing measure/s

4. How long had this situation been in place, and how long might it have continued without the project ?

5. What are the other local sources of energy?

6. Which ones could have been developed if the project had not been built (technical and financial details of these will be require in sections 2 and 3)?

7. What were the limiting factors?

8. please give details of ownership of the pre-project situation

8. How is the fuel transported.

9. How far is it transported?

10. Other information:

1.2 Project Case:

1. Type of project

2. Location

3. Ownership

4. Date built

5 Why the technology was chosen?

6 How much foreign involvement was there – technical, material, financial, etc?

7. Is there an existing base for the technology in the country?

8. What is the source of the equipment - local or imported?

9. Does the project simply replace an old energy source or does it create new energy end-used by making power available (or both)?

10. Is demand for the power that this plant is supplying likely to rise? How is this likely to be met?

11. If energy is supplied to commercial plant, have the other outputs, eg tea, been increased as a result of the project?

12. How is the fuel transported.

13. How far is it transported?

14. Other information:

2. Technical Data

2.1 Baseline Case (pre-project situation)

If pre-project situation was a ***project****:*

1. Capacity (design) [kW]

2. Remaining lifetime [y]

3. Annual output/ usage [kWh/y or state units used] (for previous five years, if possible)

4. Efficiency [%]

5. What was the fuel used?

6. Where does the fuel come from? Place and distance in Km

7. For Wood: Is the wood harvested from a forest practising sustainable forest management?

8. Annual fuel consumption [kg/y or MJ/y] (for previous five years, if possible)

9. Calorific value of fuel [MJ/kg]

10. Load factor

11. For Charcoal Kilns
Output from the project in kg charcoal per year

12. What was the condition of plant when replaced? Did it need replacing or was it still providing an acceptable level of service?

13. Function (domestic, enterprise, or grid connection)

14. Where is the market for the goods?

15. How are they transported to market?

16. Please indicate what would have happened in the absence of the project eg continue status quo, alternative project technology eg diesel generator?

If the pre project situation was a programme please give average values and the range of variation

*If pre-project situation is **individual appliances** , please give the following information in addition*

1. Number and type of appliances

2. Efficiency [%]

3. Annual fuel consumption [kg/y or MJ/y]

4. Calorific value of fuel [MJ/kg]

5. Lifetime of appliances [y]

2.2 Project Case

1. Capacity (design) [kW]

2. Annual Output/ Usage [kWh/y] for each year of operation since commissioning (or total output since commissioning)

3. Efficiency [%]

4. Load factor [%]

5. Expected lifetime of equipment [y]

6. Distance to grid [km]

7. Has the project been operating satisfactorily during its lifetime? Please give details of outages, both maintenance and forced.

8. What external factors affect the operation of the project? (eg rainfall)

9. Function (domestic, enterprise, or grid connection)

10 What is the fuel used?

11. Where does the fuel come from? Place and distance in Km

12. For Wood: Is the wood harvested from a forest practising sustainable forest management?

13. Annual fuel consumption [kg/y or MJ/y] (for previous five years, if possible)

14. Calorific value of fuel [MJ/kg]

For Charcoal Kilns

15. Output from the project in kg charcoal per year

For a programme of projects please give answers to 1-15 for the programme and 16

16. Domestic and enterprises served by scheme (number of households, type of enterprises, load pattern breakdown from different sectors, if possible) [kWh]

Project type specific data:

micro/ mini-hydro

Head [m]

Flow rate [l/s]

solar pv

Total area of panels [m^2]

3. Financial Data

3.1 Baseline Case (pre-project situation)

[in local currency]

1. Annual operation and maintenance costs (including spares) [currency/y]

2. Fuel costs [currency/kg or currency/MJ]

3. Transport costs, if relevant

3.2 Project Case

[in local currency]

1. Capital cost (including breakdown by funding organisation) If labour was provided by locals as an alternative to finance, please give details.

Hardware costs
Engineering and construction costs
Planning costs
Other costs
Total

2. Annual operation and maintenance costs (including spares) [currency/y]

3. Annual Fuel costs [currency/kg or currency/MJ]

4. Annual Income from electricity sales [currency per kWh] plus any other outputs (mechanical/heat/etc.)

5. Annual Transport costs/y

6. Transaction costs:

- feasibility study ,
- preparation of proposal,
- training costs,
- loan administration,
- other costs

7. How was the project implemented ?

8. who was involved?

9. How was the project financed?

Finance	Donor country	Host country	Owner	Other
Grant				
Equity				
Loan				
Loan admin.costs				
Total				

10. Loan Structure

what was the interest rate and time limit for repayment?

What is the current market rate for loans in this sector?

Can the government be held responsible if the loan is not paid back?

What is the current inflation rate in the country?

For a programme of projects please give the data as for a project but give average values for the programme and the range of variation

Thank You

Annex 4.3 Country Contexts

These are attached as a separate document.