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United States Agency for International Development
Greenhouse Gas Pollution Prevention Project
Climate Change Supplement
(GEP-CCS)

Fostering Climate Change Initiatives for Sustainable Development

Task 1C
Development of Computational Tool Kits

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May 14, 2001

CLIN 1: Fostering Climate Change Initiatives for Sustainable Development

Development of Computational Toolkits

Background

The Greenhouse Gas Pollution Prevention Project - Climate Change Supplement (GEP-CCS) is engaged in the building of capacity of project developers and the Climate Change Centers (CCC) at Development Alternatives. One of the major tasks that The Louis Berger Group, Inc. GEP team (LBG/GEP) is engaged is development of clean energy projects that have possibilities of carbon offsets that can be captured for their perceived value. The CCCs would play the role of facilitating such projects during and beyond the GEP-CCS LOP. In order to build the capacity of the CCCs, (predominantly DA) LBG/GEP designed Computational Toolkits that help in developing and structuring the Climate Change Mitigation Projects (CCMP)[1]. LBG/GEP sought help from professional consulting firm, Econergy International Corporation (EIC), which has developed considerable expertise in the clean energy projects for financing of the inherent carbon offsets. Along with EIC and DA LBG/GEP has been able to develop a five-component toolkit, which includes:

- Baseline Development Toolkit;
- Carbon Finance Toolkit;
- Monitoring & Verification Toolkit;
- Marketing & Funding Toolkit; and
- Sustainable Development Toolkit

These toolkits are interlinked and generally operate in the sequence indicated above, except for the SD tool, which works in parallel. The CCC would need to gather sufficient experience in project development and structuring, as these tools are by no means a substitute for an experienced consultant. This deliverable briefly describes the component toolkits. Each toolkit is explained by means of a note and a presentation that would help the user understand their usage.

Clean Energy Projects

Energy generation and use is by far the most emission intensive activity. It is estimated that in India, 60% of the GHG emissions emanate from energy generation and use. Thus, it would be important to direct effort towards projects in this area so as to be most effective. In view of this, LBG/GEP has concentrated upon developing tools to analyze the clean energy projects. There is no clear definition of a clean energy project. However, it loosely includes renewable energy technologies like wind, biomass, solar PV and

[1] CCMP is an accepted term worldwide predominantly for the Clean Energy Projects that have GHG emissions reduction opportunities.

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thermal etc., energy efficiency improvement projects like waste heat recovery, combined cycle heat and power, cogeneration, fossil fuel technologies like clean coal usage, switching to cleaner fuels etc. In other words, any project that does better in terms of emission over the technologies that have proliferated widely. In addition to these industrial and infrastructural projects, a major set of projects pertain to those that help mitigate GHG emissions from urban activities, notably, the landfill methane capture and use projects, vehicle emission reduction programs etc.

The toolkits treat the projects in four main categories:

i. Projects that displace grid -connected electricity;
ii. Projects that displace off-grid electricity;
iii. Projects that replace thermal energy generation; and
iv. Methane recovery projects

Computational Toolkits

The toolkits would help the CCC to test the project concept and develop the project through the project cycle. The SD toolkit would test whether the CCMP meets the goals of sustainability. Thereafter, the Baseline tool would enable development of scenarios of baseline. The M&V toolkit would help in assessing the cost of operationalizing the protocol and make the Offsets valuable and measurable. The carbon finance toolkit would help in estimating the offsets and value thereof. The Marketing & Funding toolkit would package the project and identify the appropriate funding agency for the project. Thus, the toolkit as a whole would guide the CCC and developer in making the project bankable with the carbon funds. The toolkits are discussed briefly below.

Baseline Toolkit

The starting point for the project development is to decide the datum against which the proposed project is being measured. It would be essential for the project developer to fix this based on the current understanding of the international developments. The baseline tool describes various methods of deciding the baseline for measurement of project performance.

Carbon Finance Toolkit

After the baseline is measured, the Carbon Finance tool aids the developer in developing and analyzing his/her project. The conventional project considerations are the starting points. The tool delves on the identification and analysis of risks of various types faced by the project and the promoters and also discusses various strategies of mitigation or provision for these.

Monitoring & Verification Toolkit

The identification of baseline helps in designing and structuring the project. However, the project performance is of paramount importance in order to make the carbon finance flow to the developer and the Carbon Offsets to have credibility. This cannot be achieved unless the project developers have conceptualized the Monitoring & Verification Protocol and identified the necessary capital investment to implement the same. The M&V Protocol not only describes the method of monitoring and verifying the project's performance against the set baseline but it also measures the current baseline at periodic intervals and revalidates or modifies it. The M&V tool is developed to help the CCC in advising the developer.

Marketing & Funding Toolkit

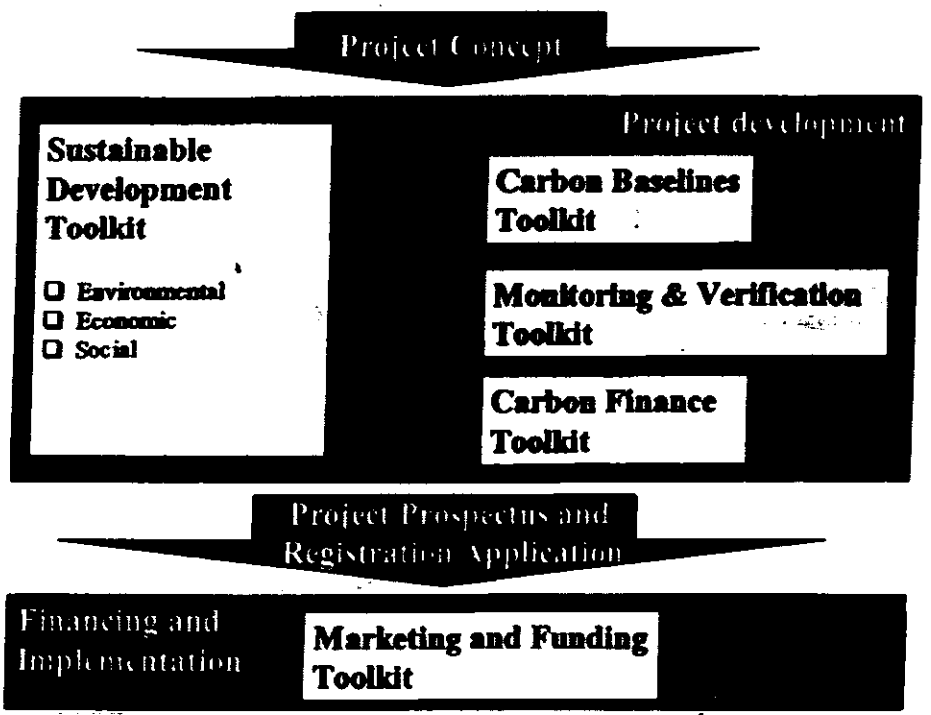
Having developed the project under the acceptable norms, it is very important to prepare the project proposal by including the desired modules and present to the funding agencies. Also, it is very essential to identify as many funding agencies so as to select the most appropriate to the developers. The Marketing and Funding tool helps in preparing the project documents in the pattern desired by a majority of funding agencies. It also provides the contacts of currently available carbon offsets funding agencies. This toolkit would need periodic revisions by the CCCs.

Sustainable Development Toolkit

One of the goals of the GHG emissions reduction projects is to measure the adverse impact of climate change on social development and devise ways of minimizing and mitigating the same. Thus, the CCMP must have sustainable development as the prime goal. The Sustainable Development tool brings out these facets of a CCMP and suggests methods of measuring the performance of the CCMP on the sustainable development criteria.

Interlinkage of tools

As mentioned earlier the toolkits are linked with each other. The input from the Baseline Development tool helps in calculating algorithms of the Carbon Finance toolkit, which in turn helps in the Marketing & Funding tool. The M&V toolkit helps in creating verifiable Carbon Offsets of good quality. The Sustainable Development tool helps in satisfying the host country government to convince about the project's capability to meet the sustainability goals of the nation. When used as a group, these toolkits allow a project developer to transform a project concept (with the potential to reduce GHG emissions) into a viable GHG reduction project whose emissions reductions are commoditized and ready for sale on the open market. The diagram below explains briefly how these toolkits are linked.



Disclaimer

This toolkit and the constituent tools are not intended to substitute for engaging a qualified professional who is experienced in the development of climate change mitigation projects baselines development, financial analysis, marketing and designing and implementation of monitoring and verification protocols. The quality of emission reductions, as perceived by the marketplace, and therefore the market value of the reductions, may be severely downgraded in the absence of the involvement of a professional who has a proven track record of providing these specialized services. The tools are developed with a view to provide a general guidance and introduction to the user in developing the clean energy, GHG mitigation projects. The Louis Berger Group, Inc., GEP Team strongly recommends the user to access a professional expert in order to validate their project concept and design in order to improve the chances of success in achieving funding for their projects. As such LBG expressly states that it shall not be held responsible for any disputes that may arise in case of projects developed by using these toolkits.

Computational Tool Kit: Baseline Development

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DISCLAIMER

This toolkit is not intended to substitute for engaging a qualified professional who is experienced in the development of the carbon emissions baseline of a climate change mitigation project. Establishment of a credible baseline is critical for all CCMPs. Achieving a credible baseline is extremely complicated for certain CCMPs. The quality of emissions reductions, as perceived by the marketplace, and therefore the market value of the reductions, may be severely downgraded in the absence of the involvement of a carbon baseline professional who has a proven track record of providing these specialized services.

Executive Summary

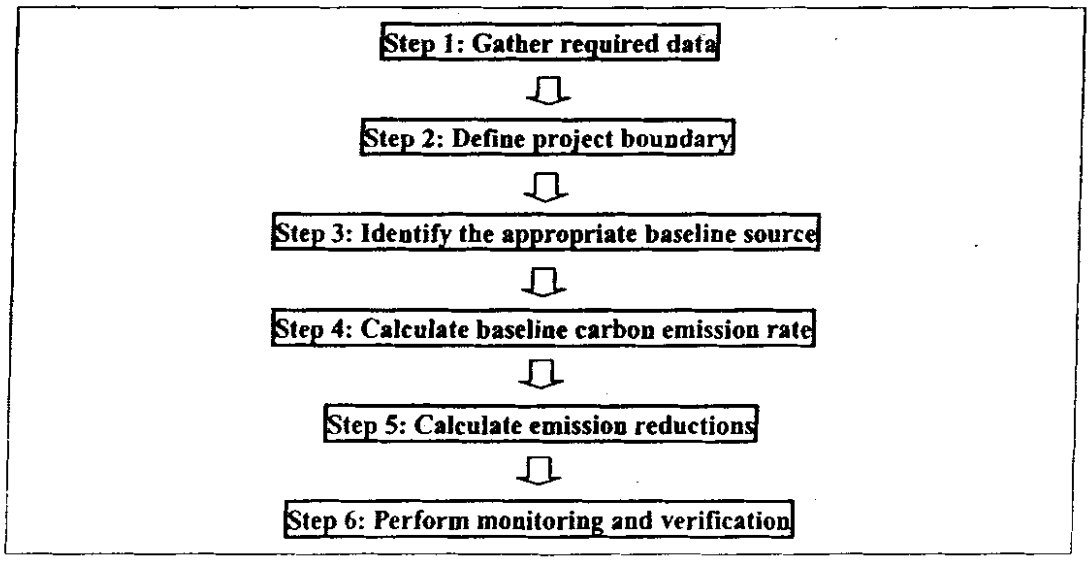
The objective of this toolkit is to provide a basic understanding of the process of quantifying the greenhouse gas emission reductions resulting from a climate change mitigation project (CCMP). The quantity of emission reductions determines the carbon credits that can be sold to interested buyers. As such, the process described here is the basis for the topics covered in the other toolkits.

Checklist

[illegible]

The baseline represents the emissions that would occur in the absence of the CCMP. The value of the emission reductions is the difference between the emissions with the CCMP in place and the baseline emissions. This toolkit presents the steps required to develop a credible baseline and quantify emission reductions, which are illustrated in Figure 1.

Figure 1: Critical Path Diagram for Baseline Development



Step 1. Gathering the required data typically involves collecting information about 1) the emissions source that will be displaced; 2) the performance of the CCMP in terms of energy produced (for generation projects) or reduction in energy consumption (for efficiency projects); and 3) the CCMP's emissions, if any. The quality of the data gathered is critical, as it directly affects the credibility of the emission reduction calculations.

Step 2. The project boundary identifies the systems and emissions sources that are affected by a CCMP. Typically, this boundary includes the CCMP itself and the project site, plus the sources whose emissions will be displaced by the CCMP. This step is important in assuring that all of a project's impacts are considered.

Step 3. The baseline emissions source is the specific source that will be displaced by the CCMP. Identifying this source can be a complex task in projects displacing grid-produced electricity, because it is necessary to determine which generating plants are marginal (those that will have their operation curtailed first). The marginal source changes over the course of a day and a year. For off-grid projects, identifying the baseline source is much simpler.

Step 4. Calculating the baseline carbon emission rate involves determining the quantity of carbon emissions that the baseline source produces per unit of electrical or thermal energy generated. The carbon emission rate depends on the carbon content of the type of fuel burned by the baseline source and the efficiency of the source in converting fuel into energy. When more than one emissions source makes up the baseline, a weighted average emission rate is determined, taking into account the emission rate of each source.

Step 5. The emission reductions from the CCMP can then be calculated by multiplying the baseline carbon emission rate calculated in the previous step by the electrical or thermal energy generation that is displaced by the project, then subtracting any emissions that are generated by the CCMP itself. In most cases, the generation displaced is equal to the net generation of the CCMP (for alternative energy generation projects) or the reduction in energy consumption resulting from the CCMP (for energy efficiency projects). The emissions generated by the CCMP depend on the type of project implemented. Mechanisms that can produce such emissions are indirect fossil fuel use, non-CO_2 greenhouse gas (GHG) emissions, and land use change.

Step 6. In performing the baseline calculations, we estimate the future carbon emission reductions that will result from the CCMP. The projections used may or may not prove to be accurate, however. To later determine the true quantity of emission reductions, monitoring and verification must be performed, as discussed further in the M&V Toolkit.

These procedures are presented in detail for CCMPs involving alternative energy production or energy efficiency, but the principles discussed can be applied to any CCMP, such as a transportation or reforestation project.

1. Introduction

Intended applications of toolkit

This toolkit describes the essential elements and steps for baseline calculation procedures to be applied to climate change mitigation projects (CCMPs) in India in the energy generation and energy efficiency sectors. This toolkit is intended only as a road map by which the Climate Change Centers (CCC) and the CCMP developer can gain a strong conceptual understanding of the baseline characterization that must be established for the project.

The procedures in this toolkit apply to two broad project types:

1. Alternative energy production, in which a less carbon-intensive source (renewables, natural gas, etc.) is used to generate electric or thermal energy
2. Energy efficiency, in which electric or thermal energy consumption is reduced

Both project types can displace carbon emissions from four different sources:

1. Grid-generated electricity
2. Electricity generated off the grid
3. Thermal energy generation
4. Methane sources

Other non-energy project types, such as transportation or land-use CCMPs, are described in a general way here. Specific treatment of such project types is not provided, but the basic principles provided here establish the groundwork for performing baseline analysis of such projects. Further, it is anticipated that case materials based on projects under development in India may be prepared as part of the testing of this toolkit.

Linkages with the other toolkits

This Baseline Toolkit is closely linked with the Monitoring and Verification (M&V) Toolkit and it provides necessary input to the Sustainable Development, Carbon Finance, and Marketing and Funding Toolkits. The Baseline Toolkit develops the procedures for determining the baseline carbon emission rate and quantifying the emission reductions resulting from the CCMP. The M&V Toolkit identifies the parameters that must be monitored to update the baseline calculations and determine the actual CCMP performance, which will allow the quantification of actual emission reductions. The M&V Toolkit presents the procedures for this quantification, which are those included in the Baseline Toolkit. In developing the baseline, there is risk that the baseline does not accurately predict the actual emission reductions that will occur. M&V addresses this risk, assuring that the buyer of carbon credits gets what they pay for.

The Baseline Toolkit provides necessary input to the other three toolkits. The emission reductions calculated in this toolkit are one yardstick with which to assess the project's environmental sustainability, as discussed in the Sustainable Development Toolkit. They

also determine the quantity of carbon credits that can be traded, which is a necessary prerequisite to the Carbon Finance and Marketing and Funding Toolkits.

2. Conceptual Background

Definition and importance of a baseline

CCMPs implemented in India will produce reductions in greenhouse gas emissions. A distinguishing feature of such projects is that the commodity they produce, emission reductions, are unobservable, as they are the difference between the emissions with the CCMP in place and the emissions that would occur in the absence of the CCMP. To quantify a project's emissions reductions, it is necessary to construct the hypothetical baseline, the emissions that would occur in a business-as-usual scenario.

Internationally accepted standards demand that selected CCMPs have a credible, quantifiable and verifiable baseline of emissions, from which reductions can be measured and verified. The establishment of the baseline is the key step in determining the extent to which a CCMP satisfies the requirement of additionality under the market based mechanisms relating to carbon-reduction trading regime.

In the absence of a standard baseline set by regulatory authorities, for example a technology standard, baselines must determined on a project-specific basis that is reasonable and verifiable. The first step for identifying a project-specific baseline is to determine the "system boundaries" within which the GHG emissions are calculated. The systems boundary, for example, might be all electricity generated in a regional grid system into which a renewable energy project feeds, as opposed to the entire national grid. Individual CCMPs inherently displace the emissions of different sources, depending on the type of project and its location in the country. As a result, the system boundary must be carefully chosen to ensure that the baseline accurately characterizes the emission reductions from the CCMP.

For energy sector projects considered here, net emission reductions for CCMPs are calculated on the basis of the carbon content of the fossil fuel replaced. Thus, the principal elements that determine the amount of reductions include:

1. The baseline carbon emission rate
2. The project's energy production rate (for generation projects) or reduction in energy consumption (for efficiency projects)
3. The project emissions (if any)

These elements must be quantified and measured in order to accurately calculate a CCMP's emission reductions.

Training required for baseline development

For energy sector projects, baseline preparation must typically be performed by individuals with formal training in engineering or the physical sciences. Project baseline assessment requires an understanding of the combustion process, for example, and

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evaluation of the carbon content of electricity from the grid and the operation of the electric system in the region where the project is located. Economists with training or experience in the field of energy economics, and specifically utility and power system economics, should be able to perform the analysis required.

Technical analysts contributing to the baseline determination must perform calculation-intensive tasks. Proficiency with electronic spreadsheets and a high level of comfort in processing numerical data are required. Completion of a workshop providing training for CCMP baseline development is highly recommended.

Static and dynamic baselines

In general, the more conservative a baseline is, the more valuable are the associated emission reductions measured against it. Because of rapid load growth in developing countries, the trend tends to be that grid generating capacity expansion is accommodated by adding substantial thermal capacity in addition to any new hydro capacity that is available. Over time, the new thermal capacity tends to incorporate more efficient technology. Thus, over time, the carbon intensity of the marginal generating assets tends to diminish.

A static baseline, under such an expansion scenario, would overstate the emission reductions produced by a CCMP because it would be based on the relatively more carbon intensive grid that prevails at the outset of the CCMP period of performance. The more conservative baseline, from a Carbon Offset (Offset) buyer's perspective, is the dynamic baseline that captures the drop in grid carbon intensity over time and, thus, projects fewer Offsets over the period of performance.

The gradually falling baseline can reflect advances in technology, general knowledge and management, as well as overall economic development, which are likely to lead to an overall improvement in energy sector performance. The improved performance of the "business as usual" scenarios going into the future is captured in a stepped or decreasing baseline.

For projects with longer project lives, dynamic baselines are therefore generally more credible and robust than static baselines. Projects with life cycles or associated Offset sales contracts of less than five years may be reasonable candidates for use of a fixed, static baseline. Projects with longer life-cycles or Offset sales contract terms, and associated Offset calculation periods, could have gradually falling or stepped baselines that reflect, for example, changes (reductions) in the carbon intensity of electricity generation as a whole in India.

Regardless of what type of baseline is adopted, one of the most important characteristics is that it be predictable. Unexpected changes in the baseline, just like unexpected changes in interest rates or other economic variables, create undue risk and uncertainty in the project and deter buyers of Offsets and other investors motivated by climate change objectives.

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Benchmarking

Benchmarking of certain kinds of technology can serve as a simplified baseline for any subsequent projects in that sector, including CCMPs. For example, the associated reductions of energy projects can be measured against a best or least-cost technology benchmark such as combined-cycle natural gas power generation systems. Any subsequent projects that exceed the emissions of that benchmark on a per unit based (i.e. tonnes of CO_2 per MWh), would have to mitigate their emissions, and other projects that performed better than the benchmark would receive credits for their activity which they could then sell or trade.

3. Implementing the Baseline Development Process

This section begins with a self-evaluation checklist for project developers. Next, the section discusses several general principles of baseline development. Finally, the section provides detailed procedures for the development of a baseline. The specific procedures depend on the type of project, so the procedures are detailed for selected project types. The application of these procedures to non-energy CCMPs is also discussed in this section.

Checklist

[illegible]

Principles of baseline development

In order to proceed with the quantification of the baseline scenario for CCMPs, we need to specify the basic principles, or decision rules, by which the baseline scenario will be defined. Once we have stated these principles, we can define the analysis required to identify the baseline generation sources. Then we can determine the corresponding baseline carbon emission rate against which the CCMPs should be compared to determine net emission reductions. Finally, we will need to consider the updating of these estimates in the future, as an input to the monitoring and verification (M&V) plan.

Project boundary delineation

The delineation of project boundaries is an important step in the development of a credible project baseline. The project boundary identifies the systems and emissions sources that are affected by a CCMP. Typically, this boundary includes the CCMP itself and the project site, plus the sources whose emissions will be displaced by the CCMP.

Indirect emission impacts can result from project construction, transportation of materials and fuel (at least in the baseline), and other upstream or downstream activities. The CCMP's effects should be carefully evaluated to identify any such emissions sources so that they may be included in the project boundary.

Criteria for data quality

Data quality is crucial to the construction of a defensible and robust emissions baseline. This is especially true in the context of creating a baseline that incorporates anticipated changes in emissions levels, or, in the case of benchmarks for specific sectors, credible arrangements for updating the benchmarks. It is generally easier to obtain credible data for fuel switching projects, where the data sources are typically the project developer itself or its client – which may easily be protected by a confidentiality agreement covering sensitive information – as well as independently verifiable measurements of the carbon content of fuels. However, it is generally much more difficult to obtain quality data on electricity production since the required information (total generation, fuel consumption, dispatch ordering for individual plants, etc.) is often controlled by state-owned utilities concerned about divulging such information or private companies that consider the data commercially sensitive. Access to such current data on a regular basis may be beyond the capabilities of any given project developer, requiring cooperation with government and sector organizations.

Data quality directly affects the credibility of the baseline emissions analysis and thus, the quality of the Offsets produced by a CCMP. The data that form the basis for the definition of CCMP baseline emissions must be acquired from a credible source. For an electricity-generating CCMP that displaces grid electricity, these data must ultimately be attributable to the organization having ownership of the baseline equipment (such as the electric utility) or the organization having regulatory oversight authority over the baseline equipment (such as the electricity regulatory commissions).

For example, for a CCMP that affects the efficiency of on-site energy-generating equipment, such as a wood waste-fired cogeneration project, baseline data must be derived from a site survey during which the baseline energy equipment is audited and any necessary measurements are made. Similarly, end-use energy efficiency CCMP requires baseline data that are acquired during a site survey that includes an audit of the baseline equipment that will be affected by the CCMP. Such an audit involves making specific measurements that are required to quantify the energy savings attributable to the efficiency CCMP. Emissions baselines for end-use efficiency projects often also require analysis of off-site equipment, such as the case in which the energy efficiency project reduces the amount of grid-supplied electricity consumed by the host facility. In this case, the emissions intensity of the electricity generating equipment supplying the grid must be quantified in order to establish the Offsets attributable to the energy efficiency project.

Baseline development procedures

This section presents the calculation procedures used to quantify emission reductions from selected alternative energy generation and energy efficiency CCMPs.[1] These

[1] Published calculation procedures often include the effect of incomplete carbon oxidation in the combustion of fossil fuels. In the procedures presented here, this effect is not included, because it has a minimal impact on the analysis (typically 1% or less).

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calculations will depend on the source from which emission reductions are displaced. As such, three procedures are presented, each for a different CCMP type:

- Baseline Procedure 1: CCMPs that displace grid-generated electricity
- Baseline Procedure 2: CCMPs that displace off-grid electricity
- Baseline Procedure 3: CCMPs that displace thermal energy generation

A fourth procedure is presented specifically for CCMPs that generate electricity or thermal energy by burning methane recovered from, for example, a coal mine, landfill or agribusiness facility. These methane recovery projects reduce greenhouse gas emissions in two ways. First, they reduce carbon dioxide emissions by displacing electricity or thermal generation from some baseline source. These carbon emission reductions are quantified using Baseline Procedure 1, 2, or 3, as appropriate. Secondly, methane recovery projects reduce the emissions of methane (a greenhouse gas) by burning the methane in a generator. These methane emission reductions are quantified using Baseline Procedure 4.

- Baseline Procedure 4: Methane recovery CCMPs

Finally, the application of these procedures to non-energy CCMPs is also discussed.

Baseline Procedure 1: CCMPs that displace grid-generated electricity

This procedure applies to CCMPs that reduce the amount of electricity generated by the electric grid, either by the CCMP producing electricity (alternative energy production CCMPs) or by the CCMP reducing electricity consumption (efficiency CCMPs). For example, a wind power project would supply energy to the grid and offset electricity generated by another source. On a smaller scale, a solar photovoltaic system powering homes or pumping systems could displace grid-supplied power.

Step 1: Gather required data
This section lists the data required to calculate the emission reductions from a CCMP that displaces grid-generated electricity. See Steps 2 to 5 for further description of these data. From each generating source in the electric grid affected by the CCMP project, the following information is required (both current and projected future data). This is required for existing plants as well as those expected to be added in the future.

- Installed capacity (MW)
- Annual electricity generation (MWh/yr)
- Type of fuel used for each plant
- Plant heat rate (GJ/MWh) or plant net thermal efficiency (%) or plant annual fuel consumption (GJ/yr)
- Dispatching order, if available

The following information on the electric grid is useful if available (both current and projected future data)

- Load duration curve
- Typical daily load profile
- Projected demand growth rate (%)
- Schedule of plant additions and retirements

For the CCMP, the following information is necessary (both current and projected future data)

- Installed capacity (MW) (*generation projects only*)
- Annual electricity generation (MWh/yr) (*generation projects only*)
- Reduction in annual electricity consumption (MWh/yr) (*efficiency projects only*)
- Type of fuel used (*thermal plants only*)
- Plant heat rate (GJ/MWh) or plant net thermal efficiency (%) or plant annual fuel consumption (GJ/yr) (*thermal plants only*)
- Emissions generated by CCMP (t C/year)

Step 2: Define project boundary
For a project that displaces grid-generated electricity, the project boundary will encompass the project site, the existing electricity generation and transmission system to which the project will be interconnected, and the future generation and transmission facilities that may be added to the existing grid.

Currently, state electricity boards (SEBs) operate electric grids in various states that function essentially independently of one another. However, these states are grouped in five main regions spread geographically, within which the power sharing takes place. Thus, the projects' boundary would currently be considered as the specific region in which the CCMP is being developed. As and when the national grid is completed, and power transfer takes freely nationwide, the project's boundary would expand to include the existing and future electricity generation and transmission system for the entire national grid.

Because of this potential future change, special attention should be paid to the composition of the electric grid. To construct an accurate baseline, it will be critical to identify the specific generating plants that are affected by the project.

In India, most state electric systems are composed almost exclusively of thermal plants, but several states (Kerala, Himachal Pradesh, Meghalaya, Jammu & Kashmir, Orissa, and Karnataka) do have significant hydro capacity. As a result of the different resource bases of the different regional grids, the marginal source(s) displaced by a particular CCMP, and thus the emission reductions of the CCMP, could be very different depending on its location.

Step 3: Identify the appropriate baseline source
To quantify emission reductions from CCMPs that displace grid-generated electricity, it is first necessary to identify the baseline generation source(s), or the source(s) that will be

For CCMPs, it is clear that the appropriate benchmark for the baseline is the weighted-average marginal emission rate (method #2 above). The reason for this is simply the logic that governs dispatching in a generation system containing sources with low variable costs, such as hydro or renewables. Since these resources are almost cost-free in terms of variable cost, they should always be dispatched as much as possible. Thermal sources are dispatched only as necessary.

Thus, the marginal emissions source is the individual generating asset (emissions source) in the baseline case that would be the first to have its operation curtailed if a less expensive source (e.g., CCMP capacity) were available.[3] This is usually a thermal generating asset. This means that thermal sources are a significant component of the baseline case that CCMPs will replace in the short term. Although the total generation mix in some areas of India will still contain significant base-load hydro sources, the operation of these sources would be the same whether or not the CCMP is built. The inclusion of the emissions (zero) of these base-load hydro sources in the baseline carbon emission rate, such as by using the average emission rate benchmark, would be highly misleading.

Step 3 can be divided into two sub-steps: determining if non-thermal sources ever operate at the margin and determining which of the individual thermal sources are marginal.

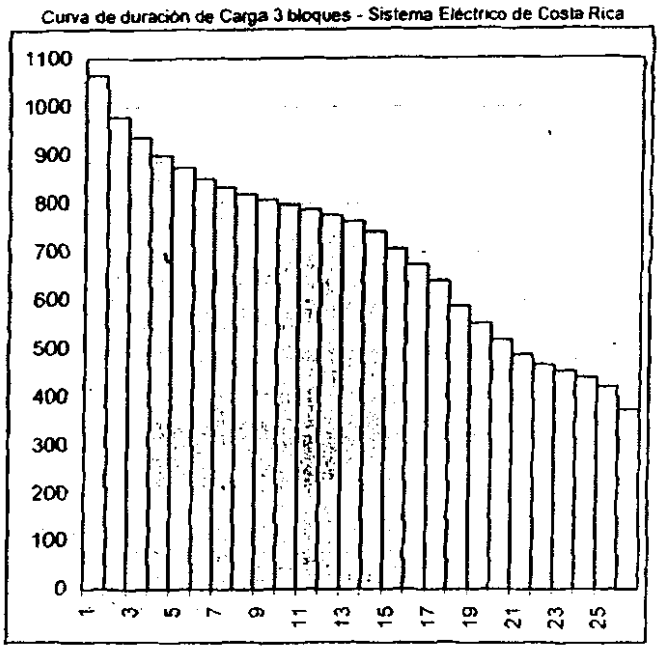
Step 3, Part A: Determine if non-thermal sources are marginal
If an electric grid contains substantial non-thermal (hydro, renewable, or nuclear) capacity, there may be times of the year when non-thermal sources are able to meet the system demand without any thermal plant operation. During these times, no emission reduction results from the CCMP's output. In these cases, it is critical to determine when thermal sources are at the margin, i.e., the time when incremental production from the CCMP (with lower variable costs than thermal power) would be able to offset thermal generation.

For mostly thermal power generation systems, in which the dispatching is mostly a function of system demand at a given time, one can use the system's load duration curve (LDC).[4] An example LDC is shown in Figure 2.

[3] In the utility system, the marginal generating plants are defined as those plants that are dispatched or utilized to meet peak loads only. During those times when end use consumption exceeds the generation capacity available from base-load plants at the utility, which are more or less in continual operation and therefore have plant capacity factors greater than 70 percent, intermediate and sometimes peaking plants are utilized to supplement total power supply to the grid. Marginal plants typically have plant capacity factors less than 20 percent. An exception to this rule may occur if, at times of low demand, there is sufficient output from "must-run" generation sources to more than meet the demand. Thus, no other plants would need to be dispatched to meet this demand.

[4] A utility's load duration curve is the cumulative frequency distribution of the utility's hourly demand levels, sorted by decreasing size according to the fraction of the year during which a given level is exceeded.

Figure 2: Example Load Duration Curve – Costa Rica Power System

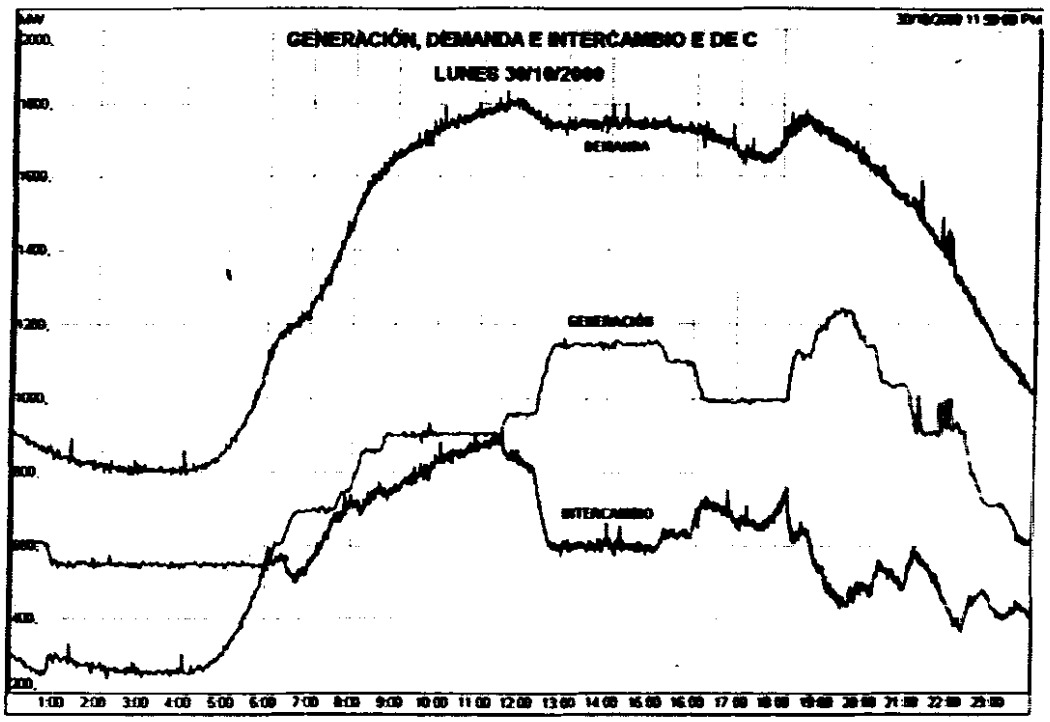


The LDC shows the fraction of the year that a given demand level is exceeded. The vertical axis is demand (MW) exceeded in a given hour and the horizontal axis is the cumulative hours during the year. One can superimpose the available generating capacity on the LDC by first applying hydro and intermittent, "must-run" sources such as wind to the load in each period.[5] Then, additional loads are met using remaining (thermal) sources, in order of ascending variable cost, until the total demand is met even in the peak period. For each period, the most expensive source that is needed is the marginal source. To account for hydro output variations, one can divide the analysis into separate wet and dry seasons; however, it can be difficult to obtain sufficient time-differentiated data to complete this analysis.

If an LDC is not available, one can use a daily load profile. As with the LDC, one can superimpose the available generating capacity on the daily load profile to determine which sources are marginal through the course of the day. An example load profile is shown in Figure 3.

[5] A must-run generation source is one that cannot be dispatched, such that its output is wasted if it cannot be used to meet some simultaneous demand. Examples include wind power and run-of-the-river hydropower.

Figure 3: Example Daily Load Profile – Mexico Power system



As discussed above, some SEB grids are dominated by thermal plants, and others by hydro capacity. Thus, the marginal source(s) displaced by CCMPs in India depend heavily on the location of the CCMP.

Step 3, Part B: Determine which of the thermal sources are marginal
After determining whether non-thermal sources operate at the margin, the next step is to determine which thermal sources are marginal. This is especially critical if the system contains base-load thermal plants. As with hydro sources, the operation of base-load thermal plants would be the same whether or not the CCMP is built. Thus, base-load thermal plants should not be included in calculating the weighted-average emission rate, because the CCMP would never displace generation from these sources.

The simplest way to determine which specific thermal generating plants represent marginal sources during some periods of the year is to compare the capacity factor[6] of existing plants. Typically, thermal plants that are dispatched to serve the base load have a capacity factor above 70%. To identify the marginal plants, look for plants with a lower capacity factor. Thermal plants with 40-50% capacity factors are probably dispatched as intermediate load, and these plants might be at the margin during some

[6] The capacity factor is the ratio of the average production to the peak capacity, which can be expressed as:
Total annual production (MWh/yr) / [peak capacity (MW) * 8760 hr/yr]

periods. Peak load plants can have a capacity factor as low as 10-20%, which indicates that these plants are at the margin whenever they are operating.

Note that hydro plants often have capacity factors around 50%, due to variations in rainfall and the need to store water for times of high demand or low production. However, it is unusual that hydro plants are truly at the margin, because as a low variable-cost resource they should be dispatched as much as possible, saving more expensive (in variable cost) thermal plants for dispatching at the margin.

Both Part A and Part B may need to be performed taking into account future changes to the electric grid. Future plant additions and retirements or future load growth may affect which sources are marginal in years to come. If information on such changes is available, the identification of the marginal sources could be repeated for each future year.

Step 4: Calculate baseline carbon emission rate

After determining which generating plants represent the baseline sources to be displaced by the CCMP, the next step is to calculate the carbon emission rate of these sources. As discussed above, the relevant baseline carbon emission rate is the weighted average of marginal emission rates for the generation plants on the margin. The baseline emissions depend on the installed generation capacity and fuel mix. To the extent that electricity is generated by fossil fuel-fired thermal power plants in the base case, the resulting carbon emissions must be accounted for on the basis of the relevant share of energy generated by each source and its carbon emission rate. Although installed capacity is an important parameter in describing the generation system and analyzing its economics, the emissions will be proportional to the total energy generated (MWh) by each source, rather than its generation capacity (MW).

Ideally, the baseline carbon emission rate should be determined on an hourly basis (8760 hours/year), to account for daily variations in loads and seasonal variations in hydroelectric and renewable output. These variations cause variations in dispatching, fuel mix and emissions. System operation can be simulated on an hourly basis using a production-cost model, in which the total demand is increased or decreased incrementally to simulate the marginal change in generation for each hour. If a production-cost model and hourly data are not available, or if the changes in generation sources are simple enough, then baseline carbon emission rate can be estimated on an annual basis.

Using an annual analysis method, the first step is to determine the annual percentage of the year when thermal sources are at the margin, which is the percentage of time that the CCMP displaces carbon emissions. This factor is determined from the analysis of an LDC or daily load profile, which is presented in Step 3. This analysis will yield the number of hours in a typical day or year that thermal power is required at the margin. Dividing by the number of hours in a day or year, respectively, will give the desired percentage.

The weighted-average marginal emission rate (expressed in metric tonnes of carbon per megawatt-hour, t C/MWh) can then be calculated using the following equation:

Weighted-average marginal emission rate (t C/MWh) =
% of year thermal plants at margin * Weighted-average emission rate of thermal plants (t C/MWh) +
% of year non-thermal plants at margin * Weighted-average emission rate of non-thermal plants (t C/MWh)

The average emission rate of non-thermal plants is typically zero. The average emission rate of thermal plants is the sum of all marginal thermal plant emissions divided by their total production. Note that this calculation should include only the thermal plants that operate at the margin, which can be determined using the procedures in Step 3.

$$\text{Weighted-average emission rate of thermal plants (t C/MWh)} = \frac{\text{Baseline emissions of marginal thermal plants (t C/yr)}}{\text{Total generation of marginal thermal plants (MWh/yr)}}$$

To determine the baseline emissions of the marginal thermal plants, the emissions from each marginal thermal plant can be summed, as shown by the following equation:

Baseline emissions of marginal thermal plants (t C/yr) =

$$\sum_i \text{[Total generation of plant (MWh/yr) * Emission rate (t C/MWh) of plant]}_{\text{source } i}$$

The carbon emission rate of a thermal plant depends on the type of fuel combusted. The carbon content of various fuels can be found in Table 1 below.

Table 1: Carbon Content of Fuels

Fuel	Carbon Content (t C/GJ)
Liquid Fuels	
Crude Oil	0.0200
Orimulsion	0.0220
Natural Gas Liquids	0.0172
Gasoline	0.0189

each plant. In addition, if upgrades are planned for any plants, these may increase their efficiency, so projected future heat rates would be used. With this projected information, the weighted-average marginal emission rate for each future year can be estimated. This is a critical step in estimating future emission reductions from the CCMP.

Step 5: Calculate emission reductions
After determining the weighted-average marginal emission rate for future years in Step 4, the calculation of net carbon emissions reductions (expressed in metric tonnes of carbon per year, t C/year) from the CCMPs is fairly straightforward. The emission reductions equal the emissions that would have been produced in the absence of the CCMP (the generation displaced by the CCMP multiplied by the emission rate of the baseline source) minus the emissions generated by the CCMP.

Net emission reductions (t C/yr) = [Grid generation displaced by CCMP (MWh/yr) * Weighted-average marginal emission rate (t C/MWh)] – Emissions generated by CCMP (t C/year)

The generation displaced by the CCMP is the reduction in the baseline source's generation due to the CCMP. For an alternative energy production CCMP, in which a less carbon-intensive source (renewables, natural gas, etc.) is used to generate electricity, the grid generation displaced is equal to the electricity produced by the CCMP minus any parasitic electricity use. For an energy efficiency CCMP, the grid generation displaced is equal to the reduction in electricity consumption resulting from the CCMP. To achieve the most accurate estimate of future emission reductions, both the grid generation displaced and the emission rate should reflect future projections.

The emissions generated by the CCMP depend on the type of project implemented. All aspects of the CCMP activities should be evaluated to identify and quantify any such emissions. Mechanisms that can produce such emissions are indirect fossil fuel use, non-CO_2 greenhouse gas (GHG) emissions, and land use change. Table 2 and the discussion that follows identify the possible mechanisms for and significance of these emissions.

Table 2: Potential Sources of Emissions from Electricity CCMPs

CCMP Type	Potential Sources of Emissions from CCMP
Electricity generation:	
Fossil fuel	Fossil fuel combustion
Biomass and geothermal	Release of non-CO_2 greenhouse gases
Reservoir hydro	Land-use change
Other renewable (wind, solar, run-of-the-river hydro)	Typically none
Energy efficiency	Increased on-site fossil-fuel usage

The emissions generated by the CCMP can be significant in projects involving electricity generation using cleaner-burning fossil fuels. Examples of such projects include converting a power plant from coal to natural gas, a methane recovery project, or an on-site cogeneration project. These emissions can be calculated by multiplying the carbon emission rate of the plant (t C/MWh) by the plant's annual generation (MWh/yr). (Follow Steps 4 and 5 in Baseline Procedure 2 below.)

The emissions generated by other types of CCMPs will typically be negligible, because the primary source of net emission reductions for CCMPs that displace grid electricity is the reduction in fossil-fuel use at thermal generating stations that can be displaced by the CCMPs. As such, detailed procedures for calculating the emissions generated by the CCMP are not presented in this toolkit. These procedures can be found in UNEP/OECD/IEA/IPCC 1996 and World Bank 1998.

Any type of electricity generation CCMP may have associated increases in fossil fuel use resulting from standby generator operation, transportation of materials or fuel, project construction, biomass fuel production and other upstream or downstream activities.

Electricity generation through combustion of biomass fuel produces no net carbon emissions if the biomass is produced sustainably within the project, because the carbon emissions produced during combustion are assumed to be offset by the capture of carbon as the biomass regrows. Geothermal projects also typically produce no carbon emissions. However, for both biomass and geothermal projects, one must in some cases account for the project's emissions of methane or nitrous oxide (N_2O), GHGs more potent than CO_2. After the quantity of these emissions (in metric tonnes per year) are estimated, they are converted to converted to CO_2-equivalent emissions by multiplying by the appropriate IPCC global warming potential (GWP) coefficient for 100-year time horizon from Table 3 below.[7] The result represents the emissions generated by a CCMP in terms of CO_2-equivalent, and is deducted from the project's annual CO_2 emission reductions.

Table 3: Direct Global Warming Potentials (GWP) of Selected Gases

Gas	Direct Effect for Time Horizon of 100 years
Carbon dioxide, CO_2	1
Methane, CH_4	21
Nitrous oxide, N_2O	310

Source: UNEP/OECD/IEA/IPCC 1996

Losses in terrestrial carbon storage due to land-use change at a hydro project site might be significant if, for example, forest land is inundated by a hydro reservoir. However,

[7] The Global Warming Potential (GWP) allows one to express all GHGs on a comparable basis. The strength of all other GHGs is compared to that of CO_2, which is assigned a value of "1".

data. From the generating source(s) affected by the CCMP project, the following information is required (both current and projected future data).

- Annual thermal generation (GJ/yr)
- Type of fuel used for each source
- Source net thermal efficiency (%) or source annual fuel consumption (GJ/yr)

For the CCMP, the following information is necessary (both current and projected future data)

- Annual thermal generation (GJ/yr) (*generation projects only*)
- Reduction in annual thermal energy consumption (GJ/yr) (*efficiency projects only*)
- Type of fuel used (*generation projects only*)
- Source net thermal efficiency (%) or source annual fuel consumption (GJ/yr) (*generation projects only*)
- Emissions generated by CCMP (t C/year)

Step 2: Define project boundary
For a project that displaces thermal energy generation, the project boundary is typically compact. In these cases, the boundary includes the project site and the equipment that generates the thermal energy.

Step 3: Identify the appropriate baseline source
Because there are only one or a few generation sources in a CCMP displacing thermal energy generation, the baseline source is easy to identify. It is simply the source whose output the CCMP will displace.

Step 4: Calculate baseline carbon emission rate
The next step is to calculate the carbon emission rate of the baseline generation source. The emission rate can be calculated using the carbon content of the fuel combusted (from Table 1 in Baseline Procedure 1) and one of the following two equations. The information available for each plant will determine the proper equation to use. Note that the calculated emission rate is t C per GJ of thermal energy output, while the carbon content is t C per GJ of fuel input.

If the dimensionless thermal efficiency of the generation source is known, use the following equation:

$$\text{Baseline emission rate (t C/GJ)} = \frac{\text{Carbon content of fuel (t C/GJ)}}{\text{Net thermal efficiency of plant}}$$

Finally, the emission rate can be derived directly from annual fuel consumption data, together with the corresponding annual generation data. If the fuel consumption data are expressed in mass or volume (such as liters of diesel fuel) rather than energy units (GJ/yr), the heating value of the fuel (GJ per mass or volume) will also be required.

$$\text{Baseline emission rate (t C/GJ)} = \frac{\text{Annual fuel consumption (GJ/yr)} * \text{Carbon content of fuel (t C/GJ)}}{\text{Annual energy generation (GJ/yr)}}$$

Step 5: Calculate emission reductions

After determining the baseline emission rate in Step 4, the calculation of net carbon emissions reductions (expressed in metric tonnes of carbon per year, t C/year) from the CCMPs is fairly straightforward. The emission reductions equal the emissions that would have been produced in the absence of the CCMP (the generation displaced by the CCMP multiplied by the emission rate of the baseline source) minus the emissions generated by the CCMP.

Net emission reductions (t C/yr) = [Generation displaced by CCMP (GJ/yr) * Baseline emission rate (t C/GJ)] – Emissions generated by CCMP (t C/year)

The generation displaced by the CCMP is the reduction in the baseline source's generation due to the CCMP. For an alternative energy production CCMP, in which a less carbon-intensive source (renewables, natural gas, etc.) is used to generate thermal energy, the generation displaced is typically equal to the energy produced by the CCMP. If, however, the CCMP totally eliminates the operation of the baseline source, the generation displaced is simply the baseline source's generation.[9] For an energy efficiency CCMP, the generation displaced is equal to the reduction in thermal energy consumption resulting from the CCMP. To achieve the most accurate estimate of future emission reductions, both the generation displaced and the emission rate should reflect future projections.

The emissions generated by the CCMP depend on the type of project implemented. All aspects of the CCMP activities should be evaluated to identify and quantify any such emissions. Mechanisms that can produce such emissions are indirect fossil fuel use, non-CO_2 greenhouse gas (GHG) emissions, and land use change. Table 4 and the discussion that follows identify the possible mechanisms for and significance of these emissions.

[9] An example of this would be a solar hot water system that replaced a fossil-fuel water heating system. The fossil-fuel system, due to high fuel costs, may have limited operation. The solar system would be much less costly to operate, so it may produce much more hot water than did the generator. In this case, the generation displaced would be equal to the fossil-fuel system's output, not the solar system output.

Table 4: Potential Sources of Emissions from Thermal CCMPs

CCMP Type	Potential Sources of Emissions from CCMP
Thermal generation:	
Fossil fuel	Fossil fuel combustion
Biomass	Release of non-CO_2 greenhouse gases
Other renewable (solar)	Typically none
Energy efficiency	Increased on-site electricity usage

The emissions generated by the CCMP can be significant in CCMPs that involve fuel switching or methane recovery, where cleaner burning fossil fuels are used for thermal energy generation. These emissions can be calculated by multiplying the carbon emission rate of the source (t C/GJ) by the source's annual generation (GJ/yr). (Follow Steps 4 and 5 in this Baseline Procedure 3.)

The emissions generated by other types of CCMPs will typically be negligible, because the primary source of net emission reductions for CCMPs that thermal energy production is the reduction in fossil-fuel use at thermal generating stations that can be displaced by the CCMPs. As such, detailed procedures for calculating the emissions generated by the CCMP are not presented in this toolkit. These procedures can be found in UNEP/OECD/IEA/IPCC 1996 and World Bank 1998.

Any type of thermal generation CCMP may have associated increases in fossil fuel use resulting from standby generator operation, transportation of materials or fuel, project construction, biomass fuel production and other upstream or downstream activities.

Thermal generation through combustion of biomass fuel produces no net carbon emissions if the biomass is produced sustainably within the project, because the carbon emissions produced during combustion are assumed to be offset by the capture of carbon as the biomass regrows. Geothermal projects also typically produce no carbon emissions. However, for both biomass and geothermal projects, one must in some cases account for the project's emissions of methane or nitrous oxide (N_2O), GHGs more potent than CO_2. After the quantity of these emissions (in metric tonnes per year) are estimated, they are converted to converted to CO_2-equivalent emissions by multiplying by the appropriate IPCC global warming potential (GWP) coefficient for 100-year time horizon from Table 3 in Baseline Procedure 1. The result represents the emissions generated by a CCMP in terms of CO_2-equivalent, and is deducted from the project's annual CO_2 emission reductions.

Energy efficiency projects will typically result in no carbon emissions. However, some efficiency projects reduce thermal energy consumption but increase electricity use. In addition, parasitic electricity use in thermal generation projects can result in increased

emissions. The indirect emissions from increased electricity use can be calculated using the procedures in Baseline Procedure 1 for CCMPs that displace electricity generation.

The emissions reductions are finally converted to metric tonnes of carbon dioxide per year (t CO_2/yr) by multiplying by ratio of the molecular weights of carbon dioxide and carbon.

Net emission reductions (t CO_2/yr) = Net emission reductions (t C/yr) * [44 t CO_2 / 12 t C]

The procedure outlined here applies if there is only one generation source displaced by the CCMP. If there are multiple sources, the carbon emission rate can be calculated by dividing the total carbon emissions (t C/yr) of all sources by the total generation (GJ/yr). The total carbon emissions are the sum for each source of the source's emission rate (t C/GJ, calculated above) multiplied by the total generation of the source (GJ/yr).

A related CCMP is the replacement of kerosene lighting with electric lighting. (The burning of kerosene is analogous to generating thermal energy.) The net emissions reductions from such projects are given by:

Kerosene lighting net emission reductions (t C/yr) = [Reduction in kerosene consumption (GJ/yr) * Carbon content of kerosene (t C/GJ)] – Emissions generated by CCMP (t C/year)

If the kerosene consumption data are expressed in mass or volume rather than energy units (GJ/yr), the heating value of kerosene (GJ per mass or volume) will also be required. The kerosene carbon content can be found in Table 1. The emissions generated by the CCMP should be carefully evaluated and will depend on the electricity source. Renewable electricity sources, such as solar or wind, will typically have no associated emissions. If electricity is provided by the grid, the resulting emissions from increased grid electricity generation can be calculated using the procedures in Baseline Procedure 1 for CCMPs that displace electricity generation.

Step 6: Perform monitoring and verification

Using the methods described in this document, and by making projections of future conditions, we can estimate the future carbon emission reductions that will result from the CCMP. The projections used may or may not prove to be accurate, as the specific details of the baseline sources or the CCMP might change or new sources might be added. To later determine the true quantity of emission reductions, monitoring and verification must be performed, as discussed further in the M&V Toolkit.

Baseline Procedure 4: Methane recovery CCMPs

This procedure specifically addresses CCMPs that generate electricity or thermal energy by burning methane recovered from coal mines, landfills or agribusiness facilities.[10] Two Baseline Procedures are required for these methane recovery projects, because they reduce greenhouse gas emissions in two ways. First, they reduce carbon dioxide emissions by displacing electricity or thermal generation from some baseline source. These carbon emission reductions should be quantified using Baseline Procedure 1, 2, or 3, as appropriate. Secondly, methane recovery projects reduce the emissions of methane (a greenhouse gas) by burning the methane in a generator. This procedure, Baseline Procedure 4, is used to quantify these methane emission reductions.

Step 1: Gather required data
Data will be gathered for methane recovery CCMPs as required for either Baseline Procedure 1, 2, or 3. The one additional piece of information necessary for Baseline Procedure 4 is the amount of methane burned to produce electricity or thermal energy. This can be expressed in mass, volume, or energy terms (t CH_4/yr, m^3 CH_4/yr, or GJ/yr).

Step 2: Define project boundary
For a methane recovery CCMP, the project boundary includes the source of methane and the generation equipment in which it is combusted.

Step 3: Identify the appropriate baseline source
The baseline source is simply the source from which the methane is recovered. This may be a coal mine, landfill, agribusiness facility, or other source.

Step 4: Calculate baseline carbon emission rate
This step is not applicable to calculating methane emission reductions for methane recovery projects.

Step 5: Calculate emission reductions
In methane recovery projects, methane emissions are reduced by burning the methane to generate electricity or thermal energy. Thus, the annual methane emission reductions are equal to the annual methane input to the generator.

The methane input to the generator must first be converted to tonnes of methane per year (t CH_4/yr) using one of the following equations. If the methane input is known in volumetric terms (m^3/yr), it can be converted to tonnes per year using the density of methane. Ideally, the actual density of the on-site methane should be measured. Otherwise, the standard density of 7.167×10^{-4} t CH_4/m^3 CH_4 can be used.

Methane emission reductions (t CH_4/yr) = Methane input to generator (m^3 CH_4/yr) * Methane density (t CH_4/m^3 CH_4)

[10] Recent policy initiatives governing waste material that may be deposited in landfills in India may limit the attractiveness of landfill methane gas recovery projects. Nevertheless, there are likely to be significant opportunities for biogas production and utilization in agricultural as well as municipal settings.

If the methane input is known in terms of energy (GJ/yr), it can be converted to tonnes per year using the heating value of methane. Again, the actual heating value of the on-site methane should ideally be measured. Otherwise, the standard value of 45.0 GJ/t CH_4 can be used.

$$\text{Methane emission reductions (t } CH_4\text{/yr)} = \frac{\text{Methane input to generator (GJ/yr)}}{\text{Methane heating value (GJ/t } CH_4\text{)}}$$

The methane emission reductions are then converted into CO_2-equivalent emissions, which is the common unit by which GHG emissions are measured. This is done by multiplying the methane emission reductions by the methane global warming potential (GWP) from Table 3, which is 21.

$$CO_2\text{-equivalent emission reductions (t } CO_2\text{-equiv./yr)} = \text{Methane emission reductions (t } CH_4\text{/yr)} * [21 \text{ t } CO_2\text{-equiv. / t } CH_4]$$

If necessary, the emissions reductions can be expressed in terms of carbon-equivalent emissions by multiplying by ratio of the molecular weights of carbon and carbon dioxide.

$$\text{Carbon-equivalent reductions (t C-equiv./yr)} = CO_2\text{-equivalent reductions (t } CO_2\text{-equiv./yr)} * [12 \text{ t C / 44 t } CO_2]$$

When the recovered methane is burned, CO_2 emissions are produced, reducing the net emission reductions from the project. These CO_2 emissions need not be accounted for in this procedure, as they are quantified in the "Emissions generated by CCMP" term in the Baseline Procedure 1, 2, or 3 that must also be performed for methane recovery projects.

Step 6: Perform monitoring and verification

Using the methods described in this document, and by making projections of future conditions, we can estimate the future methane emission reductions that will result from a methane-recovery CCMP. The projections used may or may not prove to be accurate, as the specific details of the CCMP performance might change. To later determine the true quantity of emission reductions, monitoring and verification must be performed, as discussed further in the M&V Toolkit.

Application of procedures to non-energy CCMPs

The procedures presented above specifically address energy generation and energy efficiency CCMPs. These are by no means the only type of CCMP that a project developer may encounter. For other types of CCMPs, a project developer can construct an appropriate baseline by following the structure of the procedures presented in this toolkit. The first steps are to define the project boundary and determine the baseline emissions source, the source that would operate in the absence of the CCMP. The next step is to quantify the emissions that would occur in the baseline case and the emissions that would occur with the CCMP in place. The difference between these two case

scenarios represents the emission reductions attributable to the CCMP. In performing these steps, careful evaluation of the project is necessary to accurately characterize all of the emission sources in the baseline case and the CCMP case.

This general procedure can be used to develop an appropriate baseline for any CCMP that has been carefully evaluated. For example:

- A methane flaring project, in which methane is burned rather than released directly. This reduces methane emissions, though increases carbon dioxide emissions
- A transportation project that reduces emissions from mobile sources, while perhaps increasing emissions from electricity generation or other sources
- A reforestation project that increases carbon sequestration rates
- A project that reduces agricultural methane emissions

In this way, the procedures presented in this toolkit can be used as conceptual tools for use in the broader field of CCMPs.

Risk assessment and mitigation

The baseline is subject to the risk of being adjusted or even rejected at some later date if it is not well-designed and documented. A baseline that does not hold according to initial expectations over a specified period of time can undermine delivery of the projected Carbon Offsets (Offsets). Therefore, an authoritative third party should validate the baseline. Both the buyer and the seller of the Offsets could as a result suffer from any unexpected a shift in the baseline. In the worst scenario, the seller could be prevented from realizing expected revenues from the sale of Offsets, while the buyer may find that fewer or none of his previously anticipated Offset purchases will be fulfilled. At a minimum, shifts in the baseline can change the relative price and value of the Offsets.

In this context, the perceived risks to the baseline can determine the "quality" of the Offsets sold by the project. The lower the perceived risk to the baseline, the higher the Offset quality. In order to maximize the quality of the Offsets, and thus their value, it is in the interest of the seller to engage a well-qualified and experienced expert to quantify the original CCMP baseline. Similarly, it is in the interest of the buyer to engage a well-qualified and experienced M&V agent to verify the actual amount of Offsets produced by the project. Verified or validated Offsets will be perceived by the market as having high quality. Thus, the higher the quality of the baseline, the lower the overall risk to all the parties to the project. Risks to the baseline must therefore be identified and mitigated early. If it is not possible to mitigate all the identified risks to a project baseline, the parties to the project could instead agree to a more conservative figure for any related transactions or recorded reductions.

Supporting Materials

Published baseline development procedures

Michaelowa, A., 1999. "Template for baseline studies for World Bank AIJ, CDM and JI projects," Study for the World Bank Climate Change Team. Washington, D.C.

UNEP/OECD/IEA/IPCC (United Nations Environment Programme, Organisation for Economic Co-operation and Development, International Energy Agency, Intergovernmental Panel on Climate Change). 1996. *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual (Volume 3)*. IPCC: Bracknell, UK. Available at http://www.ipcc.ch/pub/guide.htm.

World Bank. 1998. *Greenhouse Gas Assessment Handbook*. Environment Department. Washington, DC. Available at http://wbln0018.worldbank.org/essd/kb.nsf/ab34a7716339450985256666007c9ca9/901594d74185a58885256761007cbefd?OpenDocument.

World Bank. 2000a. "Baseline Methodologies for PCF Projects; PCF Implementation Note Number 3." Prototype Carbon Fund. Washington, D.C.

Case studies

Swisher, J.N., 1994. "Forestry and Biomass Energy Projects: Bottom-Up Comparisons of CO_2 Storage and Costs," *Biomass and Bioenergy*, vol. 6 no. 5, pp. 359-368.

World Bank. 2000b. "Latvia Baseline Study." Prototype Carbon Fund. Washington, D.C.

Reference materials

Figueres, Christiana; "The Achievements of COP 6: Yes, the Achievements!"; Center for Sustainable Development in the Americas; December 2000.

International Energy Agency (IEA), 1997. Activities Implemented Jointly: Partnerships for Climate and Development, OECD, Paris.

Annex: International Policy Development

It is important for project developers, business representatives, government policymakers and other interested parties to understand that the international policy context is still uncertain, and that national policies can help define the direction and shape of international rules. The Kyoto Protocol requires emission reductions generated by the CDM to be real, measurable, and additional to what would have happened in the absence of certified project activities (KP §12.5), but these terms are not defined nor is it clear how these requirements should be implemented. Clarification of these issues is the focus of the on-going negotiations of the Conference of the Parties (COP). Given the lack of definition at present, project developers must rely on existing tools employed to date and invent new ones in assessing environmental additionality, whether designing project-specific and multi-project baselines.

The basic requirement for additionality under the CDM is that reductions are "additional to any that would occur in the absence of the certified project activity." Since non-Annex I countries have not yet taken on any reduction commitments, one can assume that no special efforts to reduce emissions would be made in the absence of the CDM. However, the prospect of gaining CDM credit for any and all measures that reduce emissions could create an incentive for policies that unnecessarily encourage emissions, so that even obvious or trivial measures might be claimed for CDM credit.

Thus, from the policy perspective, the absence of project activity is generally considered to be "business as usual," i.e. neither special measures to reduce emissions nor any measures to increase emissions. Specifically, with regard to energy policy, this means development of energy resources to minimize costs, without climate-related requirements. Although it is widely recognized that energy services can be provided at minimum cost by including end-use efficiency measures with supply resources in integrated resource planning (IRP), such measures are still not in the mainstream of energy planning and development.[11] The restructuring and privatization of the energy sector that is underway in many developing and restructuring economies are only accentuating this situation.

Thus, "business as usual" can be summarized as least-cost energy-supply development, without special regard for climate protection. This policy criterion helps to define the baseline activities "that would occur in the absence of the certified project activity." Based on this *policy criterion*, a consistent *economic criterion* is that the baseline represents least-cost development under "business as usual" financial conditions. However, the baseline economic criterion relates directly to financial decision-making practices in the host country, and the energy technology choices that are favored as a result of this "business as usual" financial thinking and sector investment planning.

[11] See Swisher et al, 1997, which also contains detailed explanations and examples of the utility planning concepts mentioned here.

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Greenhouse Gas Pollution Prevention-Climate Change Supplement (GEP-CCS)

Fostering Climate Change Initiatives for Sustainable Development

Baseline Toolkit

The Louis Berger Group, Inc.

What is a Baseline?

- The baseline represents the emissions that would occur in the absence of a climate change mitigation project.
- The difference between the baseline and the project case represents the value of the carbon emissions reduction.

Why is the Baseline Important?

- International standards for CCMPs demand a credible, quantifiable and verifiable baseline of emissions
- Key step in determining additionality for projects for market based funding
- Project specific baseline necessary to accurately determine the CCMP's emission reductions

Training Required for Baseline Development

- Baseline preparation must typically be performed by individuals with formal training in engineering or the physical sciences
  - If experienced in energy economics, others should be able to perform required analysis
  - Proficiency with electronic spreadsheets and processing numerical data are required
  - Completion of training workshop recommended

Static vs. Dynamic Baselines

- Static baselines have the advantage of being simpler and easier to develop
  - However, they may overstate Offsets and may lead to less market value
- Dynamic baselines have the advantage of greater accuracy
  - Periodic review and adjustment of baseline
  - May provide a more conservative estimate of Offsets which in turn leads to greater market value
  - Results in more value to regulatory authorities
- Dynamic baselines are generally more credible and robust for projects having long periods of performance

Baseline Development Checklist

- ❑ Has a CCMP been identified and defined?
- ❑ Does project developer have the training necessary to develop a credible baseline?
- ❑ Has the project boundary been accurately defined?
- ❑ Does project developer have the data required to perform baseline calculations?
- ❑ Are the data of sufficient quality?

Establishing the Baseline

- Baseline = "without" case: "business as usual" emissions (pre-evaluation)
- Project = "with" case: estimate actual emissions savings (post-evaluation)
- Emissions Savings = Baseline Emissions - Project Emissions

Establishing the Baseline

- Three procedures are presented for different project types:
  - CCMPs that displace grid-generated electricity
  - CCMPs that displace off-grid electricity
  - CCMPs that displace thermal energy generation
- Fourth procedure for methane recovery projects

Establishing the Baseline

- Step 1 – Gather required data
- Step 2 – Define project boundary
- Step 3 – Identify the appropriate baseline source
  - Part A – Determine if non-thermal sources are marginal
  - Part B – Determine which of the thermal sources are marginal
- Step 4 – Calculate baseline carbon emission rate
- Step 5 – Calculate emission reductions
- Step 6 – Perform monitoring and verification

Step 1 - Data Collection: General Recommendations

- Data quality is crucial to the construction of a defensible and robust emissions baseline.
- Data should be recorded prior to, during, and after project implementation so that baselines and project cases can be better established.
- Fuel consumption data is preferred over MWh/yr energy data, because:
  - more accurate calculations can be made based on the carbon content of the fuel

Step 1 - Data Collection: General Recommendations

- More detailed energy data is needed in environmental audits from independent consultants. It is useful to include a technical description of on-site generating equipment when relevant.
- Energy-efficiency project investments require specific energy savings results in order to estimate resulting emission reduction benefits.
- Savings information needs to be accompanied by either resulting energy consumption or pre-project energy consumption so that gross emissions can be calculated.

Step 1 – Gather Required Data

- Data required from each generating source affected by the CCMP (both current and projected future data):
  - Installed capacity (MW)*
  - Annual electricity generation (MWh/yr) (Annual thermal generation (GJ/yr) for projects that displace thermal energy generation)
  - Type of fuel used for each plant
  - Plant heat rate (GJ/MWh)* or plant net thermal efficiency (%) or plant annual fuel consumption (GJ/yr)
  - Dispatching order, if available (for projects that displace grid-generated electricity only)

* Not necessary for projects that displace thermal energy generation

Step 1 – Gather Required Data

- Data required for the CCMP (both current and projected future data):
  - Installed capacity (MW) (*generation projects only*)
  - Annual electricity generation (MWh/yr) (*generation projects only*)
  - Reduction in annual electricity consumption (MWh/yr) (*efficiency projects only*)
  - Type of fuel used (*thermal plants only*)
  - Plant heat rate (GJ/MWh) or plant net thermal efficiency (%) or plant annual fuel consumption (GJ/yr) (*thermal plants only*)
  - Emissions generated by CCMP (t C/yr)

Step 1 – Gather Required Data

- Additional useful data if available (for CCMPs that displace grid-generated electricity):
  - Load duration curve
  - Typical daily load profile
  - Projected demand growth rate (%)
  - Schedule of plant additions and retirements

Step 2 – Define Project Boundary

- For CCMPs that displace…
  - ***Grid generated electricity*** – project site, electricity generation and transmission system to which the project will be interconnected, and future generation and transmission facilities added to the existing grid
  - ***Off grid electricity*** – project site, electricity generation and transmission system to which the project will be interconnected, but only one or a few generation sources
  - ***Thermal energy generation*** – project site and equipment generates the thermal energy

Step 3 – Identify the Baseline Source

- For *CCMPs that displace grid-generated electricity* the base case represents the least cost solution, best determined through microeconomic investment analysis and benchmarking approach, with sub-steps:
  - Determine if the non-thermal sources are marginal
  - Determine which of the thermal sources are marginal
- For *CCMPs that displace off-grid electricity or thermal energy* the baseline source is simply the source whose output the CCMP will displace

Step 4 – Calculate Baseline Carbon Emissions Rate

- For an energy project, the baseline emissions are the emissions expected in the absence of the proposed project.
- The baseline carbon emissions depends on the carbon content of the fossil fuel replaced.
- Generally, it is assumed that the total energy services delivered are the same in the baseline as in the project case, but the efficiency and/or the carbon intensity may be reduced

CCMPs that Displace Grid-Generated Electricity

- The relevant carbon emissions rate of baseline sources is the weighted average of marginal emissions rates for the generation plants on the margin.

Weighted average marginal emission rate (t C/MWh)=
% of year thermal plants at margin * Weighted average emission rate of thermal plants (t C/MWh) + % of year non-thermal plants at margin * Weighted average emission rate of non-thermal plants (t C/MWh)

CCMPs that Displace Grid-Generated Electricity (cont.)

- The average emission rate of thermal plants is the sum of all marginal thermal plant emissions divided by their total production.

Weighted average emission rate of thermal plants (t C/MWh) =

$$\frac{\text{Baseline emissions of marginal thermal plants (t C/yr)}}{\text{Total generation of marginal thermal plants (MWh/yr)}}$$

Baseline emissions of marginal thermal plants (t C/yr) =

Σ[total generation of plant (t C/yr)*emission rate (t C/MWh of plant] source

Carbon Content of Common Fuels

The carbon emission rate of a thermal plant depends on the type of fuel combusted. (See Table 1 in toolkit.)

Fuel	Carbon Content (t C/GJ)
Crude Oil	0.0200
Gas/Diesel Oil	0.0202
Residual Fuel Oil	0.0211
Bituminous Coal	0.0258
Sub-bituminous Coal	0.0262
Lignite	0.0276
Natural Gas	0.0153

CCMPs that Displace Grid-Generated Electricity (cont.)

- The carbon emission rate can be determined using the carbon content of fuel replaced and one of these equations:

If the plant's heat rate is known:

Emission rate (t C/MWh)=Plant heat rate (GJ/MWh)*Carbon content of fuel (t C/GJ)

If the dimensionless thermal efficiency of the generation source is known:

$$\text{Emission rate} = \frac{\text{3.6 GJ/MWh [by definition]} * \text{Carbon content of fuel (t C/GJ)}}{\text{Net thermal efficiency of plant}}$$

Or derived directly from annual fuel consumption data & annual generation data:

$$\text{Emissions rate} = \frac{\text{Annual fuel consumption (GJ/yr)} * \text{Carbon content of fuel (t C/GJ)}}{\text{Annual electricity generation (MWh/yr)}}$$

Sample Calculation for CCMP that Displaces Grid Generated Electricity

A renewable energy project will feed into a grid consisting of both hydro and thermal plants…

		A		B	C	D=B*C	E=A*D
Marginal Thermal Plants	Installed Capacity (MW)	Generation (MWh/yr)	Type of Fuel	Plant Heat Rate (GJ/MWh)	Carbon content of fuel (t C/GJ)	Carbon Emission rate (t C/MWh)	Carbon emissions (t C/yr)
Plant 1	100	350,000	Nat gas	8.0	0.0153	0.12	42,000
Plant 2	50	88,000	Diesel	12.0	0.0202	0.24	21,120
Plant 3	50	44,000	Diesel	18.0	0.0202	0.36	15,840
Total	200	482,000					78,960

Weighted average emission rate of thermal plants = 78,960/482,000 = 0.16
% of year thermal plants at margin = 90%
Weighted avg. marginal emission rate = (0.90)*(0.16)+(0.10)*(0) = 0.14 t C/MWh

CCMPs that Displace Off-grid Electricity

- Carbon emissions rate of the generation source is calculated using the carbon content of fuel replaced and one of these equations:

Baseline emissions rate (t C/MWh) = Plant heat rate (GJ/MWh) * Carbon content of fuel (t C/GJ)

$$\text{Baseline emission rate} = \frac{3.6\ \text{GH/MWh [by definition]} * \text{Carbon content of fuel (t C/GJ)}}{\text{Net thermal efficiency of plant}}$$

$$\text{Baseline emission rate} = \frac{\text{Annual fuel consumption (GJ/yr)} * \text{Carbon content of fuel (t C/GJ)}}{\text{Annual Energy Generation (MWh/yr)}}$$

CCMPs that Displace Thermal Energy Generation

- Carbon emissions rate of the generation source is calculated using the carbon content of fuel replaced and one of these equations:

$$\text{Baseline emission rate (t C/GJ)} = \frac{\text{Carbon content of fuel (t C/GJ)}}{\text{Net thermal efficiency of plant}}$$

$$\text{Baseline emission rate} = \frac{\text{Annual fuel consumption (GJ/yr)} * \text{Carbon content of fuel (t C/GJ)}}{\text{Annual energy generation (GJ/yr)}}$$

Step 5 – Calculate Emissions Reductions

- Net emission savings for energy projects are compared on the basis of the carbon content of the fossil fuel replaced or avoided:
- The principal parameters are:
  - Baseline carbon emission rate
  - The project emissions (if any) and
  - The project's energy production rates, once the baseline has been identified.

Step 5 – Calculate Emissions Reductions

Expressed in metric tonnes of carbon per year (t C/yr)

CCMP displacing grid generated electricity: Net emissions reductions (t C/yr) = [Grid generation displaced by CCMP (MWh/yr) * Weighted average marginal emissions rate (t C/MWh)] – Emissions generated by CCMP (t C/yr)

CCMP displacing non-grid electricity: Net emission reductions = [Generation displaced by CCMP (MWh/yr) * Baseline emission rate (t C/MWh) – Emissions generated by CCMP (t C/yr)

CCMP displacing thermal energy generation: Net emission reductions = [Generation displaced by CCMP (GJ/yr) * Baseline emission rate (t C/GJ)] – Emissions generated by CCMP (t C/year)

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Step 5 – Calculate Emissions Reductions

Converted to metric tonnes of carbon dioxide per year (t CO_2/yr)

For all project types:

Net emissions reductions (t CO_2/yr) =

Net emission reductions (t C/yr) * [44 t CO_2/12 t C]

Step 5 – Calculate Emissions Reductions

- A special case is the replacement of kerosene lighting with electric lighting.

Kerosene lighting net emission reductions (t C/yr) = [Reduction in kerosene consumption (GJ/yr) * Carbon content of kerosene (t C/GJ)] – Emissions generated by CCMP (t C/year)

Step 5 – Calculate Emissions Reductions

- Emissions from CCMP must be carefully evaluated
- Some potential sources of emissions are:
  - Electricity or thermal generation CCMPs
    - » Fossil fuel: Fossil fuel combustion
    - » Biomass and geothermal: Release of non-CO_2 GHGs
    - » Reservoir hydro: Land-use change
    - » Other renewable (wind, solar): Typically none
  - Energy efficiency CCMPs: Increased on-site fossil fuel or electricity usage

Step 6 – Perform Monitoring and Verification

- Future conditions of the baseline or CCMP may change or new sources might be added, therefore, it is necessary to revise the emission reduction calculations periodically, using the same methods, procedures and assumptions outlined in the baseline toolkit.
- Recommended methods for updating emission calculations are covered in the M&V toolkit.

Methane Recovery CCMPs

- Methane recovery projects reduce greenhouse gas emissions in two ways:
  - Reduce CO_2 emissions by displacing electricity or thermal generation. These carbon emission reductions should be quantified using Baseline Procedure 1, 2, or 3, as appropriate.
  - Reduce the emissions of methane (a greenhouse gas) by burning the methane in a generator. Baseline Procedure 4 is used to quantify these methane emission reductions.

Methane Recovery CCMPs

- The annual methane emission reductions are equal to the annual methane input to the generator.

If the methane input is known in volumetric terms (m^3/yr):

Methane emission reductions (t CH_4/yr) = Methane input to generator (m^3 CH_4/yr) * Methane density (t CH_4/ m^3 CH_4)

If the methane input is known in terms of energy (GJ/yr):

$$\text{Methane emission reductions (t } CH_4\text{/yr)} = \frac{\text{Methane input to generator (GJ/yr)}}{\text{Methane heating value (GJ/t } CH_4\text{)}}$$

Methane Recovery CCMPs

- Methane emission reductions are converted into CO_2-equivalent emissions by multiplying by the methane global warming potential.

CO_2-equivalent emission reductions (t CO_2-equiv./yr) =

Methane emission reductions (t CH_4/yr) * [21 t CO_2-equiv. / t CH_4]

Methane Recovery CCMPs

- If necessary, the emissions reductions can be expressed in terms of carbon-equivalent emissions.

Carbon-equivalent reductions (t C-equiv./yr) =

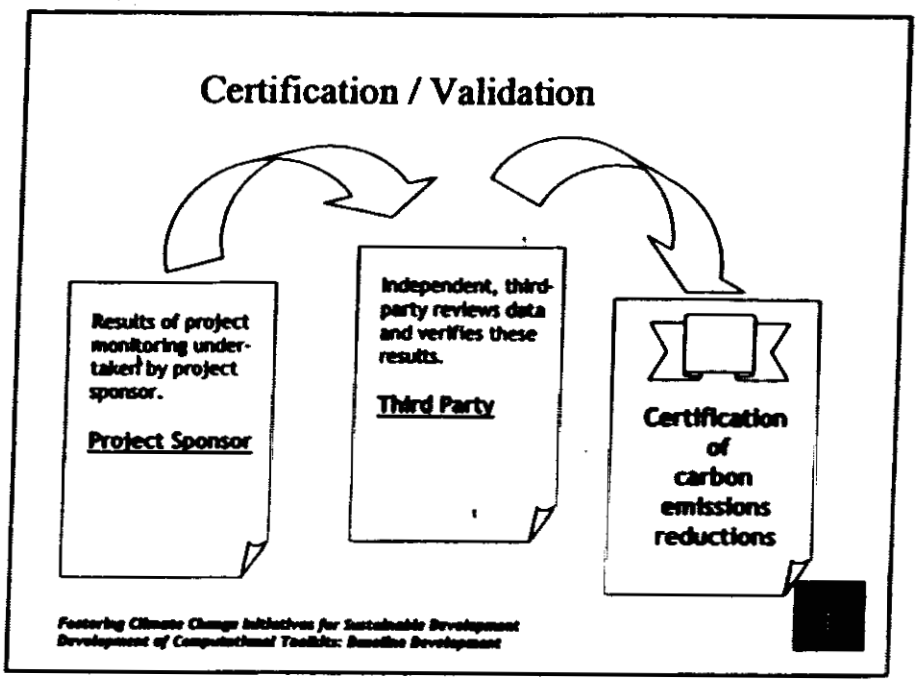
CO_2-equivalent reductions (t CO_2-equiv./yr)* [12 t C / 44 t CO_2]

Application of Procedures to Non-energy CCMPs

- The toolkit addresses energy CCMPs.
- Project developers can construct an appropriate baseline for non-energy CCMPs by following the structure of the procedures presented in this toolkit.

Risk Assessment and Mitigation

- Risk: adjustments to baseline during M&V phase
  - Risk to buyer and seller if projected Offsets not delivered
- Mitigation: better quality baseline lowers the risk that Offsets will fall short of expectations, increases the value of Offsets


Certification / Validation
Results of project monitoring under-taken by project sponsor.
Project Sponsor
Independent, third-party reviews data and verifies these results.
Third Party
Certification of carbon emissions reductions
Fostering Climate Change Initiatives for Sustainable Development
Development of Compatibilized Toolkits: Baseline Development

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Computational Tool Kit: Carbon Finance Model

Computational Tool Kit: Baseline Development

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DRAFT

United States Agency for International Development
Greenhouse Gas Pollution Prevention Project
Climate Change Supplement
(GEP-CCS)

Fostering Climate Change Initiatives for Sustainable Development

Task 1C
Computational Tool Kit: Carbon Finance Model

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May 14, 2001

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This toolkit is structured to take project developers step-by-step through the process of developing the financial structure of a project using the carbon finance model. The major section of this toolkit (*3. Implementing the Carbon Finance* Model) describes the steps necessary to develop a project financial structure based on the carbon finance model. Much of the material in this section reflects traditional financial concepts. The critical path diagram above outlines the steps necessary to construct a successful project using carbon financing.

The process begins with a Project Concept and takes the project developer through a series of steps to develop a Complete Project Structure and Financial Analysis. These steps are identified below:

Steps to Create a Project Valuation conforming to the Carbon Finance Model

Step 1: Review the check-list to see if carbon finance is appropriate for this project.
Step 2: Review the project to insure that: 1) it can be realistically implemented, 2) reduces GHG emissions, and 3) can assist the developing countries in achieving sustainable development.
Step 3: Choose a business model: Incorporating the project into a parent or host company vs. the use of a project specific special purpose vehicle company.
Step 4: Valuing the project
Step 5: Complete a basic projected Income Statement for the project.
Step 6: Estimate the discount or hurdle rate.
Step 7: Calculate the Project's Net Present Value
Step 8: Calculate the Levelized Cost of the Project
Step 9: Identify project risk factors.
Step 10: Distinguish between Qualitative and Quantitative Risk
Step 11: Develop a Risk Matrix
Step 12: (optional) Estimate the equity beta from a comparable firm or industry.
Step 13: (optional) Calculate the project specific risk based on Beta, market risk, and the risk free investment rate.
Step 14: Decide what level of Debt the project should take on.
Step 15 : Decide what the company's investment hurdle rate is (or Cost of Capital) based on the debt-equity ratio stated above.
Step 16 : Recalculate the project's net present value (NPV) using the hurdle rate calculated above (Step 15).
Step 17 : Decide what the appropriate level of Debt for the project should be.
Step 18 : Decide what risk mitigation procedure is best for the project.
Step 19: Put in place the appropriate contract(s).
Step 20: Decide what type of 'back-up' the project needs to cover non-project based Risk (Risk Insurance, Guarantee, Leases, etc...).
Step 21: Calculate the Price per metric ton of carbon.
Step 22: Calculate the total revenue from potential carbon sales.
Step 23: Incorporate carbon revenues into the cash flow analysis.
Step 24: Decide on the right model to sell the Reductions.
Step 25: Sell the Reductions.

I. Introduction

This toolkit is designed to help developers of clean energy and climate change mitigation projects to incorporate additional revenues that can be generated through the sale of carbon emissions reductions. The toolkit also provides substantial grounding in key areas of financial analysis and project finance. The toolkit provides the user with a detailed critical path beginning with initial conceptual stage through the stage where investment may be sought. By following the steps set forth in this toolkit, project developers will be able to understand the opportunities offered by the carbon finance model, as well as the methods for valuing projects and the emissions reductions.

The carbon finance model is a methodology used to commoditize and sell the environmental benefits of reducing emissions of greenhouse gas pollutants. This model incorporates the revenue stream associated with the sale of emission reductions into the traditional *project finance model*. Project finance involves the structuring of transactions in a way that links risk and returns to those parties that can most efficiently manage various types of risk inherent in a given project. By taking on risk, investors are entitled to certain specific revenues from a project. By locking-in this risk-return relationship, a project can reduce the overall risk of project failure. By adding revenues from emissions reduction credit sales and using the project finance model, clean energy projects can be made more financially sustainable (higher returns and lower risk) while still providing environmental benefits.

As regulations evolve and more carbon-based transactions occur, it is important to recognize the tremendous opportunity to foster commercially viable, environmentally beneficial projects through the project financing model. The vast majority of GHG emissions result from private sector activity around the world. Project finance has made possible several sustainable private sector energy projects. By showing the private sector a methodology offering higher returns and reduced risk, larger numbers of emission reductions should occur.

Lenders of project financing will consider any reliable revenue stream as a potential security against their investment in project development. The lenders' primary concern is that the revenue streams be large enough to cover the debt service obligations of the project and secure enough to mitigate risks of interruption or default. The market value of carbon credits will determine whether or not revenue streams are large enough to cover debt obligations, while additional mechanisms such as performance contracts mitigate the risks of interruption or default.

By introducing the potential revenue streams from the sale of carbon emission reduction sales into project financing, the threshold for commercial investment in renewable energy and energy efficiency projects could begin to fall around the world. At present, emission reduction sales only represent a small portion of a project's return, but as the international community comes to agreement on a climate change mitigation vehicle this portion will grow. Projects that are completed and become operational will achieve global environmental benefits without taxing scarce public resources devoted to national and

local objectives, and in many cases contributing to those objectives, as well. As more projects become operational after project financing, the same initial investment resources will be freed for reinvestment in additional projects that achieve the same goals, ensuring a sustainable, long-term path to beneficial project development.

Background

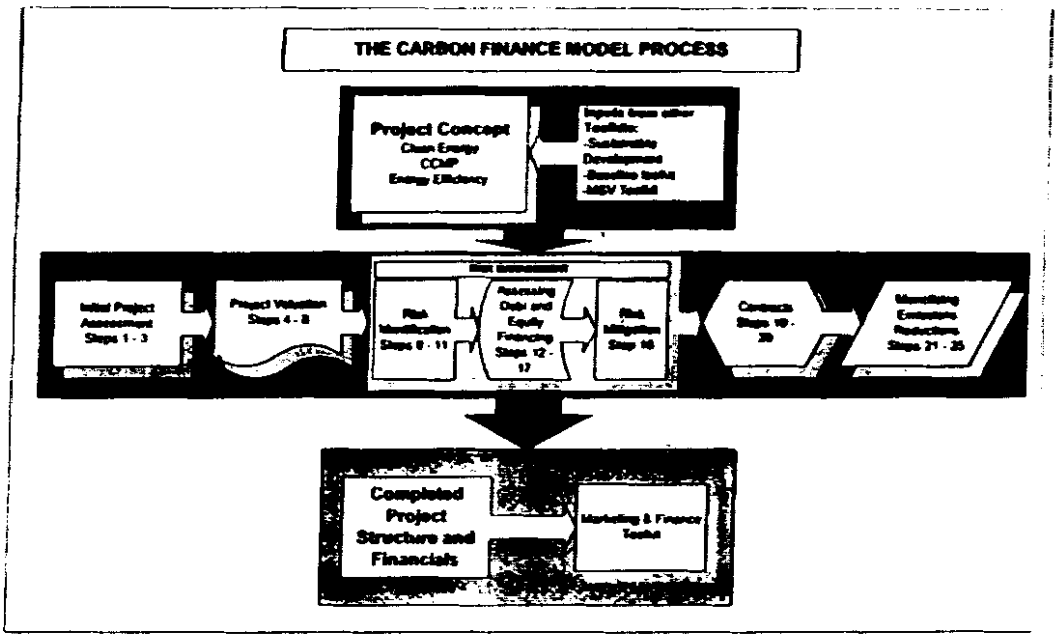
Renewable and clean energy technologies are generally characterized by relatively high capital costs and low operation and maintenance costs. These characteristics make them attractive in the long run, but less so in a competitive setting where the premium is on near-term cost minimization. Renewable generating technologies continue to make advances, thereby increasing their efficiency and lowering cost; however, outside of some niche market applications, they still are not economically competitive with conventional sources of power. The *Carbon Finance Model* can, in many cases, make these projects more attractive to possible investors by helping the project return their investment faster.

As regulations evolve and more carbon-based transactions occur, it is important to recognize the tremendous opportunity to foster commercially viable, environmentally beneficial projects through the project and carbon finance models. Today the vast majority of greenhouse gas (GHG) emissions result from private sector activity around the world, rather than government mandated activities, as most would assume. At the same time, sustainable private sector development has accelerated with the wider use of the project finance model.

By developing financing models that rely on a commercially sustainable base such as carbon offsetting finance, the clean energy projects could be freed from a subsidy regime and stand on their own inherent strength, for the resultant environment benefits from these projects.

Organization

This toolkit is structured to take project developers step-by-step through the process of developing the financial structure of a project using the carbon finance model. The following section (*2. Understanding the Carbon Finance* Model) outlines the basic foundations of carbon finance. The major section of this toolkit (*3. Implementing the Carbon Finance* Model) describes the steps necessary to develop a project financial structure based on the carbon finance model. Much of the material in this section reflects traditional financial concepts. This was done to insure that carbon finance is understood through traditional finance terms. The critical path diagram outlines the steps necessary to construct a successful project using carbon financing. The diagram below describes the basic steps necessary to integrate the carbon finance model into a project.



Below is a basic list of the steps necessary to complete a project's financial structure using the carbon finance model.

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2. Understanding the Carbon Finance Model

The purpose of this section is to help developers better understand the carbon finance model and how it relates to their project. This section further goes into a discussion of the linkages between the carbon credit market and traditional financial concepts. The use of the carbon finance model requires an understanding of the carbon credit market as well as basic project finance concepts. With a solid understanding of these basic concepts and linkages, users will be able to better understand the carbon finance model and the Project Lockbox concept in order to 'lock-in' the revenue stream from a clean energy or climate change mitigation project (CCMP).

What are Emission Reductions?

Trading of allowances, quotas and emissions credits is recognized in many countries as a market-oriented and efficient way to reduce harmful pollution. Credit trading harnesses the forces of supply and demand by enabling firm- or individual-level decision-making that steers scarce resources to the greatest marginal benefit at the lowest cost. Credit trading allows the benefits of renewable energy generation, primarily pollution reduction or other "green" benefits, to be "monetized" (brought into the price system). The creation and trading of credits allows various specific benefits (e.g., emissions avoidance of a particular pollutant that would have been emitted by conventional technologies) to flow to those that value them most. Lastly, and not least, credit trading operates independently of energy markets. Credit markets are not tied to the time-sensitive energy markets where time of delivery is of paramount importance in determining what values are earned from energy sales. In addition, buyers of credits need not be located near the source of emissions reductions.

The sale of emissions reductions represents an opportunity for clean energy and CCMPs to monetize at least some of its environmental benefits and to generate additional revenue beyond the value of the service delivered by it.

How does Carbon link to traditional Finance?

Carbon finance is a combination of some very basic concepts in Corporate and Project Finance. In carbon financing, basic principles of corporate finance are used to value a project in order to characterize how financially viable it will be compared to other projects. Basic tools in project finance are then used to commoditize the revenue stream from the sale of carbon emissions reductions and insure it gets to the appropriate party. Under a traditional project finance structure it is usually the debt financier who receives the locked-in revenue streams. In the carbon finance model, it is usually the equity holders of the project that own the rights to the carbon emissions reductions and the associated revenue stream.

Corporate Finance

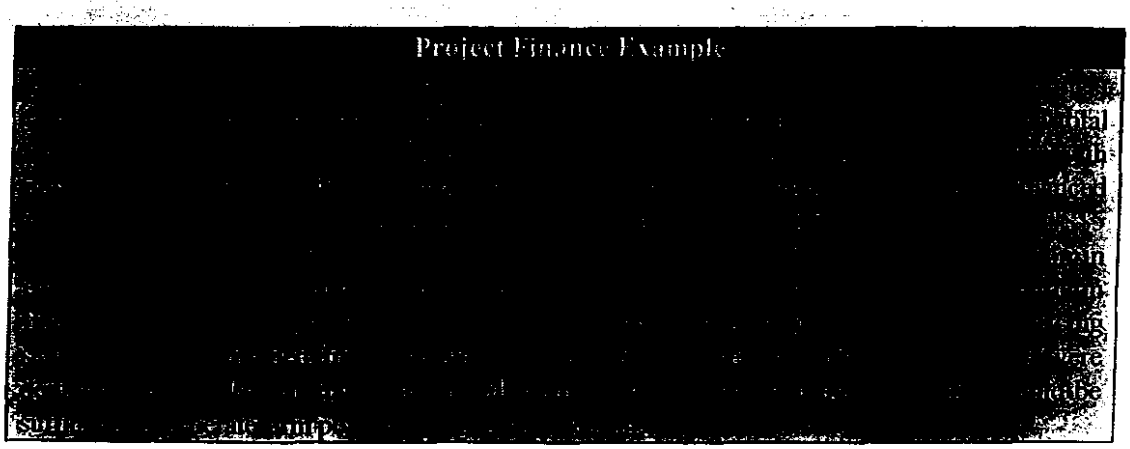
Typically, private sector energy projects are financed through corporate financial transactions ("on balance sheet"), issuing stock to the private or public capital markets or borrowing from lenders, where corporate assets serve as the fundamental guarantees to the investors and the lenders. In the case of debt financing, lenders (i.e. commercial and investment banks) always enjoy, by law, senior or preferred access to repayment over equity holders (investors and stakeholders). There are a variety of financial instruments that fall in between these two categories (i.e. mezzanine/junior debt, convertible debentures, etc.), which are employed in a great number of cases to fill in the financing gaps. Debt financing is considered less risky, because of the legal and contractual guarantees employed, and therefore carries a lower cost, i.e. an interest rate that is lower than the expected rate of return on equity. The holders of these financial instruments then avail themselves of the capital markets to trade these instruments ("securities"), because the underlying value of the instrument changes over time allowing the inherent risks and benefits to be shared among a wide variety of financial intermediaries (broker/dealers), investors and debt holders. The corporate issuer of the financial instrument is ultimately responsible for the performance of the instrument, and therefore liable for any losses incurred by investors and lenders.

Corporate Finance Example

Project Finance

In the 1980s, project finance ("off balance sheet"), as opposed to corporate finance, became increasingly popular as it shielded the corporation from liabilities ("limited or non-recourse financing") and provided mostly lower cost long term debt financing, which allowed the private sector to become increasingly involved in managing and operating long term public infrastructure assets. CCMP type projects are, generally speaking, considered infrastructure projects and will increasingly turn to project structured financing mechanisms in the future.

Under the project financing scheme, a project is funded against the cash flow that is generated by the project. Risks are balanced against the project's cash flow and assets. The project is isolated from the parent firm as much as possible, sometimes established under a separate operating company to provide minimum exposure. Investments are made directly to the operating company, or by other mechanisms when a number of intermediate firms are involved in the contractual arrangement. Borrowing for the project does not show up as debt on the parent company's balance sheet. This arrangement removes or limits the parent company's assets from recourse action, so most if not all of the project risk is transferred to the lender. Thus, the structure of the project finance arrangement must provide the lender with sufficient security in another form (such as a larger percentage of the cash flows). The additional costs associated with establishing a separate entity and managing the legal arrangements lead to projects being viable only when they are somewhat large. Since 1993 many infrastructure projects especially IPPs have been developed through project finance in India.



What is the Project Finance Lockbox

The phrase 'lockbox' comes from the idea that once the project financial structure defining which equity and debt holders have the legal right to a revenue stream, it cannot be altered. In this way, if the project developer comes under financial distress due to other business activities, the project shareholders are not impacted. Thus, the project is *by definition* viable or sustainable in the long run because it is isolated from this possible financial distress of the parent company.

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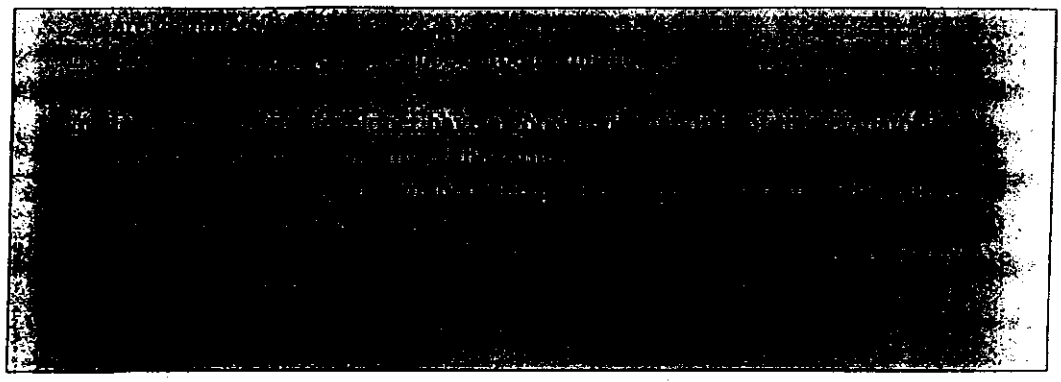
Services provided by the project are usually subject to a pricing formula wherein a fixed revenue stream is generated by the project under take-or-pay clauses[1]. This fixed revenue stream for a long period (10 to 20 years) becomes the basis for long-term financing and allows the lenders to provide credit with a reasonable assurance of repayment. Contracts normally require guarantees to ensure repayment, and guarantees can be in the form of collateral or other asset securitization, local government guarantees based on the contract's full faith and credit, and/or insurance. The debt financing therefore covers the fixed revenues stream, whereas the equity financing covers the variable revenue stream based on performance of the project, which will either punish the equity investors for non-performance or reward them for exceptional performance.

This type of structured project finance rewards the party that was exposed to the most risk: which are the private sponsors or developers. However, this is the party that has the most experience and, therefore, is best suited to bear this risk, through their experience in developing, building and operating projects. Developers will not only contribute time and in-kind resources but also in most cases they provide a portion of the total financing requirements via equity contributions. (Typical infrastructure project debt-to-equity ratios are 80:20 in OECD markets (India typically, 70:30) that have lower debt ratios than economies in transition and developing countries.) Formal long-term contracts establish a legal framework for more passive investors and lenders to get involved with the financing of the project.

Thus the variable revenue stream can be shared among several investors, and these then may even buy and sell their shares in the project through private or public capital markets. Institutional investors (i.e., investment funds) may invest in the project, thereby providing an exit strategy to the developers, who can in turn use that freed-up capital for additional projects and the market value of the shares will vary with the perceived value of the asset. Similarly, lenders to the project will syndicate the loans into the bank marketplace and share the benefits and risks of their debt revenue stream with other institutions. The effect of these mechanisms allows different parties with different risk profiles to benefit from the project.

This construct is sometimes referred to as the financial "lock box" because it effectively locks in the inputs (revenue stream) and the outputs (payment stream). This mechanism was successfully employed in the commercial real estate development industry and is now increasingly successful in the global infrastructure arena. In the future, it is likely that new financial instruments for environmental projects will be created by pooling projects and investments. This is occurring now through global investment funds (such as the Renewable Energy and Energy-Efficiency Fund and other private sector investors) and will likely turn towards new instruments akin to Real Estate Investment Trusts

[1] A take-or-pay agreement is a contractual obligation between a purchaser of a project's output and the project company where the purchaser agrees to make payments to insure the project maintains the capacity to produce and deliver a good or service. The payment obligation is mandatory and is not linked to the actual delivery of the goods or services. Often these agreements do not cover all the cost of a good or service, but only the fixed costs associated with production.



This checklist is intended to allow the facilitating CCC and project developers to do a soft assessment of the potential to benefit from the carbon finance model. It is not intended to be used as a strict requirement for project developers (i.e. if these questions cannot be answered, the developer should not proceed). In order to proceed, each project developer must evaluate the project opportunity based on his or her own criteria. If, the developer has trouble answering these questions, the model may not be appropriate for this particular project. If most of these questions can be easily answered, the carbon finance model is probably appropriate for this particular project.

Step 1: Review the checklist to see if carbon finance is appropriate for this project.

Step 2: Review the project to insure that: 1) it can be realistically implemented, 2) reduces GHG emissions, and 3) can assist the developing countries in achieving sustainable development.

Choosing a Business Model

A project developer must decide on the business model that will result in a project with the lowest possible risk level, while offering a return that is acceptable to the developer and investors. In the process of trying to reduce risk the project developer must take into account the concerns of the project debt and equity holders. Each project participant will have different considerations in this regard. Two project ownership and management structures are offered in this toolkit: 1) the parent company approach, and 2) the special purpose vehicle company. These models are also sometimes called on-balance sheet financing versus off-balance sheet financing.

The parent company model allows project developers (or another sponsor) to keep the project on their own balance sheets making the project (for all intentions and purposes) part of the project developer's parent company. All interested debt and equity holders will then invest in the project developer's company, relying on the project developer to invest the funds in the new project. This model has its advantages and disadvantages

from the perspective of the project developer. The main benefit of this model is the flexibility it gives to the project developer. If the project ends up performing better then expected, the project developer can benefit greatly. If this project has a high risk profile the traditional corporate model may put undue risk and responsibility on the project developer.

Special purpose vehicles are used when a project developer wants to isolate the project from their and the other stakeholders business activities. This model creates a corporation with only one asset, the project. By having only one project, the success of the project is not impacted by other activities of the company. Under the traditional corporate model a successful project can fail if the parent company has other business activities that are financially in trouble, causing a drain on the project's resources. This model also offers the equity and debt holders a more clear right over certain assets or revenue streams (the rights to which are usually outlined in the investment contract0. Under this model the project may have a credit rating higher then the project developer or the investors, thus allowing it to get debt at a lower rate then if the project was on the project developers spreadsheets.

This is only a very limited look at these two business models; much more could be said about their advantages and disadvantages. When deciding which model is right for the purpose of the project, other (more extensive) sources should be referenced.

Step 3: Choose a business model: Incorporating the project into a parent or host company vs. the use of a project specific special purpose vehicle company.

Valuing the Project

This section introduces the key concepts related to valuation of project based assets. Projects are typically not traded in markets, unlike real estate or stocks, and therefore need to be valued using present values of the project's cash flows. The value of a project is a function of the cash flow produced by the project's end products and the risks (and the probabilities) associated with the cash flow. This section also introduces several key concepts for project investment decisions: the Discount Rate, Return on Investment (ROI), the Cost of Capital (COC), the Net Present Value (NPV), Incremental Costs, Levelized Cost, and the Rate of Return (ROR).

The most important tool presented in this section is how to conduct a valuation of a project using the discounted cash flow procedure. To value a project or investment, it is necessary to look at the free cash flows produced by the endeavor. The free cash flow is the cash flow that can be withdrawn from the business each year after meeting all of its investment needs. Growing firms typically reinvest more than the current years earnings in the next year's operations and may even exceed their annual earnings. During these years their free cash flow will be negative. When the investment requirements are less than their earnings or the investments begin returning, the business begins to generate

free cash flows. The value of the business will be the present value of the free cash flows generated by the business. The discounted cash flow (DCF) procedure includes estimating free cash flows to a time horizon when the cash flows follow a steady growth pattern. The steps involved in a DCF valuation of a project are given below:

Step 4: Valuing the project

1. **Estimate free cash flow.** (Cash flow may be negative in early years of project implementation and start-up).
2. **Choose the horizon date.** Free cash flows are estimated to the horizon date from which point the cash flows form a simple growth pattern, so that one of the valuation formulas can be applied.
3. **Estimate the horizon value (Discount Rate)[2].** This may be very sensitive to the assumptions and will have to be cross-checked with other criteria or benchmarks such as P/E ratios, and market to book ratios of other similar companies. For the purpose of valuing the project the weighted average cost of capital will work.
4. **Calculate the necessary payback period for the initial investment.** This is the number of years it takes to accumulate enough capital to payoff the initial debt and equity investment.

Step 5: Complete a basic projected Income Statement for the project.

Some Basic Concepts

The key to valuing the project depends on the project developer's ability to accurately forecast the project's future cash flow. The Present Value is the current value of future cash flows discounted at the appropriate discount rate. One dollar of cash received next year is worth less than one dollar received today. The discount rate can simply be the minimum percent return needed or expect in return from the project to account for the developer's cost of capital (the opportunity cost). This is in essence, simply discounting future cash flows back to the present time. Thus, the present value of any future cash flow is its current equivalent. The process of computing PV of future cash flows is called discounting and the rate of interest or return used in computing the PV is called the discount rate.

[2] This is different from the 'Horizon Date' which is the can be considered the financial lifetime of the project.

Present value calculations can be done for three types of cash flows (for the purposes of CCMP project development the toolkit will focus on the third, an annuity):

- Perpetuity: a fixed payment each year forever
- Cash flows growing at a constant rate: payments increasing at a constant rate each year forever
- Annuity: a fixed payment each year for a limited number of years Annuities are simply limited life perpetuity).

Equation 0-1: Present Value Formula

$$PV = \frac{CF}{(1+r)^t}$$

Or another way to think of this concept is through the ***discounted cash flow formula.***

Equation 0-2: discounted cash flow formula:

$$PV = \sum_{t=1}^{n} \frac{CF}{(1+r)^t}$$

CF= Cash flow
r = interest rate
t = number of time periods (years)

To calculate the Present Value, these values are needed:

- Cash Amount in future
- Interest Rate
- Number of compounding periods in a year i.e., 2 = Semiannual, 4 = quarterly, 12 = Monthly
- Time in years

In cases where interest is compounded more frequently than once a year, it is necessary to find the interest rate per period and number of sub-periods in a period.

[redacted]

The Income Statement

An income statement is a simple way to show how the costs and revenues of a project breakdown. Income Statements are internationally recognized as the method for displaying this data about a project or company. The table below illustrates the basic relationships between revenues and expenses to get the Net Income for a project (Net Income can be considered the annual cash flow which will be used in the NPV formula). This table displays one year's financial data. These statements can also contain several years' data to show a project's long-term financial outlook. For a more detailed example see the appendix.

Income Statement		
Revenue		Year 1
Energy Sales	$15,000	
Carbon Credit Sale	$5,000	
Total	$20,000	(Energy Sales + Carbon Credit Sales)
Expenses		
Depreciation	$3,000	
Rent	$1,000	
Operations & Maintenance	$10,000	
Total	$14,000	(Depreciation + Rent + O&M)
Operating Income	$6,000	(Total Revenue - Total Expenses)
Interest	$500	
Net Income	$6,000	(Income +Interest)
Income Tax (35%)	$2,100	(Net Income x Tax Rate)
Net Income after tax	$3,900	(Net Income - Income Taxes)

Discount Rates

In order to evaluate a project's financial viability, a process of discounting future year cash flows has been developed to take into account the lost opportunity of doing something else with the investment capital (the capital could have been sitting in a safe back account earning interest). This rate is the opportunity cost of capital and determined as the rate of return that can be expected from alternate investments, other similar renewable energy projects or simple government bonds. The rate should also reflect the investment's risk. In simple terms, it is the rate of return on investments of comparable risk. One typically looks to the market to identify an investment of comparable risk. Later the toolkit will be dealing more explicitly with examples that measure this risk and its impact on rates of returns. The terms "opportunity cost" and "hurdle rate" will be used in reference to this discount rate.

The discount rate is a key component to calculate the present value of future cash flows (NPV).

To calculate a discount rate, the following values are needed:

- Future cash flows
- Number of compounding periods during the year (2=semiannual; 12=monthly)
- Time in years

In case of interest compounded more frequently than once a year, it is necessary to determine the annual percentage rate (APR). APR can be found by multiplying the periodic rate with the number of periods in one year.

For now, while calculating the value of the project, simply identify a discount rate, which reflects the project developer's required rate of return. The toolkit will return to the issue of discount rates when discussing the Weighted Average Cost of Capital (WACC) later. This section will help incorporate a project's debt and equity holder's considerations into the calculation of a discount rate.

Consider the following example:

Step 6: Estimate the discount or hurdle rate.

Profitability Index

The Profitability index (PI) is the best tool for comparing projects when it is necessary to only choose one. Like other methods, the PI helps investors to better understand a project's future prospects. This index is defined as: ***NPV of the future cash inflows*** divided by the initial investment level (always a negative number). The decision rule for the profitability index is to accept all projects with a PI greater than one. This rule is equivalent to the NPV rule. The modified rule applied in the case of capital rationing (limited funds) is to accept projects with the highest profitability index first, followed by the one with next highest, and so on until the investment dollars are exhausted. This rule will maximize the NPV and investor wealth. If the constraint is on some other resources, the profitability index needs to be modified to measure the NPV per unit of the resource that is rationed.

Project	Cash flows			
	1	2	3	4
Biomass	-45,000	20,000	20,000	20,000

Levelized Cost

When determining what type of technology to use in a new renewable energy generation project, "levelized" cost is usually used to determine what technology and energy source will be least cost. Levelized costing considers all capital, fuel, operating, and maintenance costs. In general, **"levelized cost" is the present value of the total cost of building and operating a generating plant over its economic life, converted to equal**

annual payments. In levelized costing, capital costs are amortized over the expected power output for the life of the plant. This cost metric will not be useful for all project types. Only use this for energy generation projects.

In the context of most energy projects, levelized costs are the calculated average costs per kilowatt-hour of generating electricity over the plant lifetime, including overnight capital costs per kilowatt, fixed operations and maintenance (O&M costs per kilowatt, variable O&M per kWh, and fuel costs per kWh, using a specified discount rate).

The first step is to calculate a project cost using the following formula:
Cost = [(operating costs + interest - depreciation) + taxes + principal on debt + equity]

The principal plus interest plus equity gives the annual capital costs, while the operating costs are the annual variable costs. Depreciation is netted out because it is a capital expense. The equity value can be confusing because normally it is not necessary to repay equity on an annual basis. Treat this as the payment the project would make to equity if the project were giving them the return they expected annually. So treat it like a loan (the initial equity contribution acting as the principal) with an interest rate equal to the discount rate being used for this project.

Next, take the present value of each year's costs calculated above.
Use the Present Value methodology described in the *Net Present Value Section*.

Annualize the PV
Annualizing the present value of the project costs will give an annual cost of the project based on constant payments and a constant interest rate. To calculate this value simply take the sum of present value of each year cash flows and divide by the number of years in the project horizon (or lifetime). This can be considered the annual payment necessary to cover the cost of the project.

Calculate a per kilowatt hour value
Take the annualized present value and divide by the total number of kilowatt hours produced per year. This will give a dollars per kWh value.

Step 8: Calculate the Levelized Cost of the Project

Part 1: Calculate the cost for each year
[(operating costs - depreciation + interest) + taxes + principal on debt + equity]

Part 2: Take the present value of each years costs

Part 3: Annualize the PV

Part 4: Calculate a per kilowatt hour value

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Risk Management

Risk management involves assessing and managing a project's exposure to various sources of risk through a process of identifying, labeling, and mitigating these risks. Risk, generally speaking, should not be thought of as the *'chances of something going wrong,'* but instead should be viewed as the volatility in future events that could impact a project (both positive and negative). This may be a very new way to think about risk for many people. By defining risk as the probability of an expected event not occurring as predicted, it is possible to begin developing strategies to reduce the unpredictability in a project. By reducing the unpredictability of a project it is possible to very accurately predict project outcomes and the subsequent revenues from these outcomes. Knowing (with a high level of predictability or confidence) what the project's future revenue stream will be, makes financers more willing to fund a project. Low risk projects with positive returns are highly valued to debt and equity investors. This will result in funding offers on better terms to the project developer.

This section begins with a basic background discussion of what exactly risk is, and then it moves on to how to identify, quantify and reduce a project's exposure to risk. Specific attention will be paid to risk mitigating contracts.

Background on Risk

Risk has traditionally been measured against U.S. Treasury bills (t-bills), which are considered risk-less and the benchmark for the safest investment possible. On the other extreme, small-company new ventures have provided the highest historic returns, but also carry the highest level of risk. The historic returns for the Treasury bill portfolio have averaged 3.8 percent in nominal terms compared to the S&P 500 portfolio return of 13 percent and the small-firm portfolio's return of 17.7 percent. These historic averages are often used to estimate required rates of returns or opportunity cost of capital. These increasing rates of return are in tandem with increasing rates of risk.

Interest rates change frequently, and the expected return on the market will change with them. The energy market until recently had very stable and predictable returns, today this is changing. However, the risk premium on the market (the difference between the market return and the return on a risk-free investment, t-bills) is fairly stable. Therefore, to estimate today's expected return on a project, take the current treasury-bill yield and add to it the normal risk premium (the long-term average) that other similar projects have earned above treasury bills.

The idea of risk is a familiar one and implies uncertain outcomes, many of which could be negative. The return from an investment in a project often cannot be predicted with any accuracy but using effective risk evaluation techniques can help reduce the uncertainty surrounding predictions. The use of statistics helps us to analyze this type of risk in a precise way. The returns of previous similar projects give a good indication of

the range of uncertainty about a new project's future return. The *spread*, or the *uncertainty* of outcomes, is measured by the *standard deviation* or the *variance*. These terms are usually transferable for the definition of *risk*.

More precisely, risk is usually described by two parameters- the mean and standard deviation. Individual investors are assumed to be risk-averse, meaning that if they take on more risk, they would like to be compensated for bearing this additional risk. The standard deviation of a project's returns measures the project's risk. Throughout this toolkit, references to risk should be interpreted as the standard deviation (or variance) of a project's potential return.

Risk Analysis

In the world of project development no two projects are ever quite the same, while the plant specifications of two projects may be similar any number of site or country specific factors can radically change the economic and financial characteristics of a project. Each project represents a varied and complex transaction with its own unique set of characteristics and impacting factors. In order to properly evaluate a project, taking into account its uniqueness, analysts over the years have developed a set of risk criteria or factors to compare projects. These factors will apply to all projects in one form or another. Among the numerous risks that are associated with project development, some relate to internal factors specific to financial structure, the nature and viability of the project itself, and others relate to external factors like political, economic and other country specific factors.

This section identifies the different types of risk that impact a project's success and offers ways that project developers can identify and measure the risks that could impact their project. The section concludes with a discussion of risk mitigation procedures.

Types of Risk

Project risk factors generally occur at the macro/country level or project level. Country level risk will impact all projects and businesses within the country, although the level of impact may vary depending on the type of industry and the level of risk mitigating activities those projects have undertaken. Project specific risk has to do with the actual project and the immediate environment the project is working in. The specific types of these risks are described below.

Macroeconomic Risk

Country Risk (Political Risk)
Political and country risks are often considered the same risk category. This is mainly a function of whether a project developer considers political risk a subset of country risk.

Country risk is generally defined as risk caused by actions of the government that may adversely affect the economic environment in which a project operates and, in turn, may negatively impact the project's ability to meet its financial obligations in a timely fashion. This risk incorporates the impact of government policies that influence the financial and business environment faced by the project, including uncertainties related to the exchange rate, interest rates, labor market conditions, taxation, regulation, and infrastructure. Country risk can directly impact a project's ability to get financing, the cost of debt servicing, the availability and cost of inputs, and the demand for outputs or services. Country risk can incorporate *'Sovereign Risk'* which is associated with the national governments debts to outside lenders. Sovereign Risk is the country's credit rating in reference to the probability of the country paying back this debt.

Political Risk

Political risk is specifically associated with a major change in political climate or government policy that could impact a project. Political risk will impact most CCMP or clean energy projects in emerging markets because these governments still have considerable regulatory control over the energy sector in which most projects operate. This risk can be measured at both the country level and the project level. The most common example of country level political risk is a change in government, which impacts foreign ownership and investment in energy projects. If a project has outside investors, such a change in policy could result in the loss of operating capital. At the project level, a new government could drastically increase a project's tax rate, causing it to no longer be cost effective.

Economic Risk

One of the most important factors when evaluating a project (clean energy, CCMP, or otherwise) is whether it is likely to provide a competitive price for a product or service, which will generate sufficient cash flow to meet all of its obligations (most importantly its debt). Economic risk is the risk that a project will not generate the forecasted revenue stream to meet these obligations. This risk is impact by multiple variables:

- **Demand:** A project may be designed and functioning within acceptable parameters, but fail to generate sufficient income due to a lack of demand or interest in the project's end product.
- **Pricing:** Again, a project may be designed and functioning within acceptable parameters, attracting an adequate number of customers (demand), but be over or under priced causing the project to not be able to meet anticipated revenue projections.
- **Variable Costs:** When designing a project, basic predictions are used to forecast the cost of important project inputs. In many cases these forecasts can be wrong or the macroeconomic environment in which they were estimated may change, causing the project needs to also change. This can have both a positive and negative impact on the project.

Currency Risk

While not pertinent to projects financed entirely within India, any project with foreign owners, investors, or debt sources (including most World Bank loans) can be severely

impacted by unpredicted changes in the currency exchange rates. This is a major factor when loans are denoted in foreign currency but revenues are projected in local currency. Should the local currency be suddenly devalued, the revenue stream would become worthless while the debt obligation has not changed. So a project that is operating properly and is still receiving payments for services or products could suddenly find that it cannot meet debt obligations.

While not discussed in this toolkit, there are several strategies that can be pursued to mitigate this risk. These include:

- Dollar Indexing
- Hedging Contracts
- Coverage Ratios
- Dollar Debt Service Reserves

Regulatory Risk

The regulatory conditions in which a project operates are very important to the project's ability to continue to meet its obligations to debt and equity holders. Most energy sector projects depend on a country or region's tariff rate structure to insure a constant revenue stream (whether on or off grid). Changes in tariff rates are usually controlled by a government body that does not necessarily take into account a project's needs, this can cause undue (and unplanned) stress to the project.

Project Specific Risk

The major project specific risk associated with CCMPs or clean technology projects is Single Asset Risk (stand-alone project risk). Many clean energy and climate change mitigation projects are developed in isolation and are not associated with a diverse group of other projects and therefore cannot fall back on a larger parent company for assistance. In a setting like this, if revenues are disrupted due to an operational problem, there is no alternative source of revenue to meet debt obligations. For this reason, an investor may view the stand-alone project as more risky than a project, which is part of a larger group of projects. Projects that are not stand-alone normally receive more and cheaper investment capital. The project developer must weigh the benefits and deficits of the stand-alone project type specific to their situation.

These perceived risks should be reflected in the pricing of the end product that the project will eventually produce (electricity, methane, energy savings, etc). Incorporating risk in the pricing of a product can be difficult, but can be made easier when a benchmark is available, such as another project with a similar risk structure and design. In many countries, clean energy projects are uncommon, so investors may require more security on their investment or a higher rate of return than projects in Western Europe or the United States.

From the investor's perspective there are several other project specific risk factors that a project developer will need to address in order to receive debt or equity financing and insure they have an adequate revenue stream to pay their debt obligation:

- *Legal Risk:* A project that does not take into account the legal requirements of its operations can fail to begin operations. Project developers should review all operating and contract laws in a region before they begin construction.
- *Construction Risk:* The potential for any large clean energy project or CCMP failing to complete construction on time, in accordance with the planned specifications, and on budget is often very high.
- *Transaction Structure Risk:* Well-designed projects may not have a sound financial structure. While the project specifications are important, the financial analysis is also necessary to insure the project is financially viable.
- *Operating and Technology Risk:* Projects using new or unproven technologies (an issue with some clean energy technologies) run a higher risk of technical difficulties then traditional technologies.
- *Project Performance:* Lack of historical or meaningful performance data may make it difficult to predict performance.
- *Third-party Performance and Reliability:* Reliance on physical asset (property, plant, and equipment) services, short-term credit support providers, and other equity/debt parties may result in increased risk.
- *Repayment Rate:* Investors may face uncertainty with regards to the timing of the principal return of their investments.

Clean energy projects and CCMP may also be influenced by macroeconomic factors specific to the type of project. Perhaps one of the largest factors impacting risk is the uncertainty surrounding a host nation's efforts in the climate change arena. If a project developer intends to generate carbon emission reductions from a clean energy project and sell them abroad, it will be necessary to insure that the foreign government recognizes the credits as valid.

CCMP and Clean Energy Project Specific Risk

There are many sources of risk associated with the types of projects, technologies and locations likely to be involved in a clean energy or CCMP investment. In particular, small energy efficiency and renewable energy projects in developing countries face risks related to size, location, technology, dispersed customer bases, lack of credit-worthy customers, etc. In a commercial environment, these risks drive the required rates of return for commercial finance higher than those required for conventional energy project investments. Three other types of risk are worth mentioning in more detail: 1) climate change regulatory policy risk, 2) baseline risk, and 3) monitoring and verification risk.

- *Climate Change Regulatory Policy Risk:* At present the regulatory environment will not drive or monitor the market for emission reductions. Project developers moving forward to develop their project today may find in the future that their project does not meet the specifications of the future regulations.

- *Baseline Risk:* If a country is moving rapidly to reduce the level of national emissions, the country or region's baseline will move quickly. If the emissions reductions are based on a stationary baseline not taking into account these changes, in the future the project could be claiming to produce emissions reductions that do not, in reality, exist. The Baseline Toolkit provides methodologies for mitigating this risk.
- *Monitoring and Verification Risk:* If a project does not have a proper monitoring and verification protocol in place, changes to the project may cause the project to become less effective at reducing emissions reductions. Thus, even in a case where a project's baseline is accurate, 'leaks' in the system may cause the actual emissions reducing potential to drop. The monitoring and verification toolkit offers methodologies to mitigate this risk.
- *Host Country Acceptance:* It is realistic to believe that and international trading program will require the host country to review and 'accept' or certify a project for emissions trading. Getting Host country acceptance could be a hurdle to selling the credits.

Project Risk Identification

An important step in the risk identification process is the development of a basic risk matrix. A risk matrix is a simple table listing the project risk factors in the left column, and the risk mitigation tools in the top row. As risks are identified, the project developer simply includes them in this table. Once the project developer has a good understanding of all the risk factors impacting the project, they can then decide how to mitigate the risk. An example risk matrix can be found in the Appendix.

Risks will vary for each project. To identify a project's risk factors start with the list in the section above, and if necessary refer to the risk factors in the example matrix for more specific suggestions. Many of these will impact the project, and this list should also give an idea of what project specific factors to look for as they are identified.

In this process, it will be necessary to identify some risks that may be quantified for their potential to impact on the project. Label these factors in order to measure their impact on the project cash flows later.

Step 9: Identify project risk factors.

Step 10: Distinguish between Qualitative and Quantitative Risk

Step 11: Develop a Risk Matrix

At this point, a clear list of factors that could impact the project has been identified. The next step will involve measuring the impact of these risk factors on the project outcome and identifying risk mitigation strategies to reduce project exposure.

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Measuring the Impact of Risk Factors

Note: The information in this section may not be available for many projects. If this data is not readily available, skip this section and the Capital Asset Pricing Model (CAPM) section and go to the Weighted Average Cost of Capital Section.

The relationship between risk and return, Beta

In order to better evaluate a project investment's risk, it is necessary to first measure its market risk (i.e. the impact of the overall market on the project). This is the risk to the project that cannot be mitigated. Ideally, investors desire a project that is impacted only by positive market events and resistant to negative market risk (a hard goal to achieve). **To measure a project's sensitivity to market risk, financial experts have developed a tool called beta (β) to measure how a project is influenced by the direction of the market.** This can be done in two ways: 1) use the general market to evaluate only macro level risk factors, or 2) use the specific market the project is operating within (probably the Indian energy market) to more closely predict market and project specific risk factors. Under mature market conditions it is possible to get beta (β) information on organizations similar to the project developer's own, allowing the developer to accurately examine the impact of market risk. In less mature, less fluid markets it may not be possible to perform this analysis.

Equation 0-5: Expected risk premium

$$r - r_f = \beta(r_m - r_f)$$

r_f = risk of a risk free investment
r = project specific risk
r_m = market risk
β = *Beta*

The equation above describes the relationship between beta and the project's associated risk factors (or the project's sensitivity to market changes). If beta is found to be above one, the project reacts strongly to changes in the market and the reverse when beta is below 0 (values between 0 and 1 move with the market, but not as much). So a project with a beta of greater then 1 would do better then the market average under positive market conditions, and worse under negative conditions. The risk premium $(r_m - r_f)$ varies in direct proportion to beta.

A beta coefficient will not be available in most projects, but in certain cases it is possible to apply an industry average or U.S.-based firm's beta coefficient, if the proposed project is similar enough to the a U.S. or other OECD industry benchmark. It should be noted that this formula applies to equity capital and not debt capital. A project will likely be financed with both debt and equity and therefore the risk-adjusted cost of capital will

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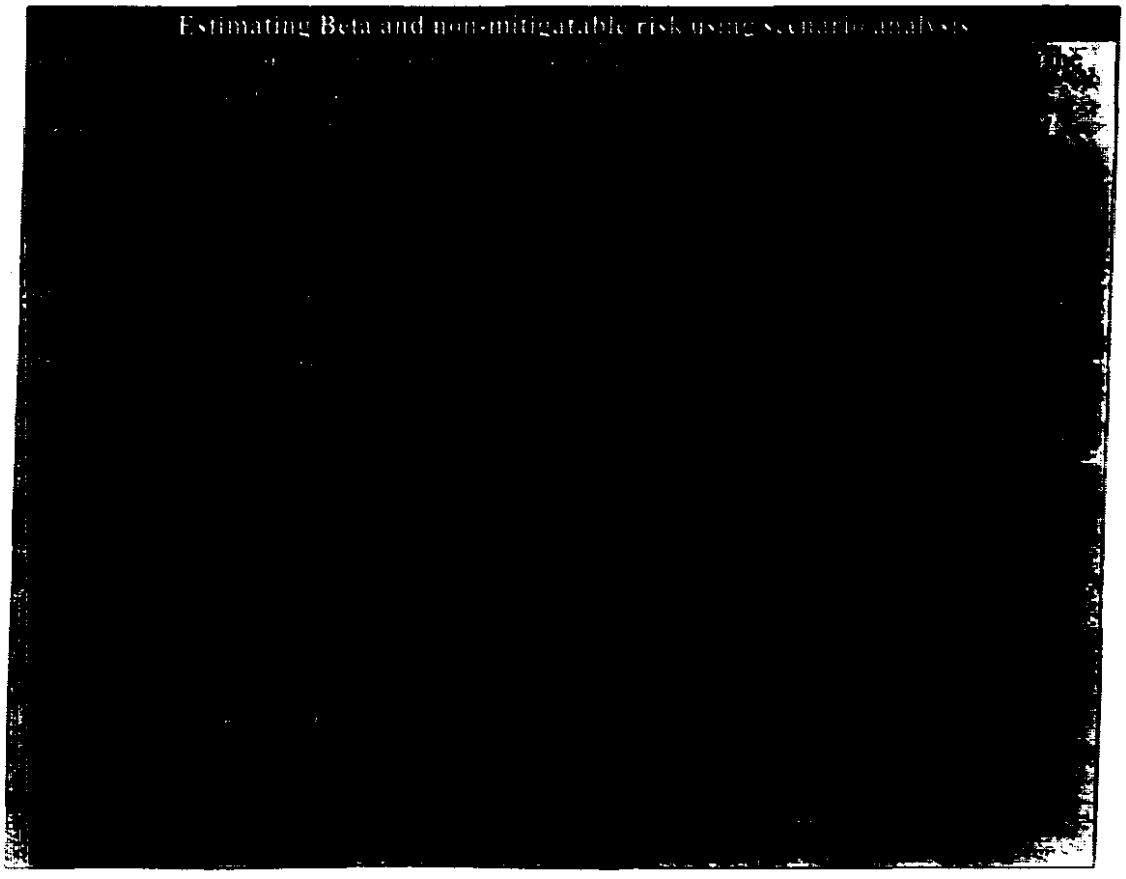
reflect a weighted average cost of capital (WACC), which will be weighted according to the debt and equity breakdown. The WACC will be described in more detail below.

In situations where no beta value is available, and the developer feels it is not appropriate to use U.S. or other OECD country data, the following procedure is suggested.

Ask bankers or other financial specialists what Beta is right for a region and project. Often, financial research firms publish this information.

An Alternative: Finding Beta through scenario analysis
An alternative method for finding beta (β) is to use scenario analysis. Scenario analysis involves identifying several different project outcomes (and the probability of those outcomes) based on the risks the project cannot mitigate. For example, it may not be possible to accurately predict the direction a country's economy will take next year. The direction of the economy will directly impact a project's revenue for that year (and the value of Beta). By examining three different possible outcomes: Recession, Status quo, and Boom, a developer can take into account the possible future fluctuations in revenue, giving lenders greater comfort in their investment the project. The example below illustrates the methodology necessary to conduct this analysis and find Beta.



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Outcome	Probability	Market Return	Annual Revenues	Return on Project
Recession	[illegible]	10%	75,000	-31.8%
Status Quo	[illegible]	15%	125,000	13.6%
Boom	[illegible]	40%	200,000	81.8%

In this example, three possible market outcomes are explored. When this procedure is being [illegible] more or fewer possible outcomes. The probability [illegible] of this outcome occurring. Special information may be available on the [illegible] allow for the very accurate reporting of these probabilities. [illegible] projections into analysis of the political environment, new government [illegible] Market Return could be based on a developer's educated assessment or more formal market analysis from specialized firms. Estimating the **Annual Revenues** [illegible] specialized information is available, may simply be the developer's best estimate. The Return on Project is calculated the same way as in Part 1.

[illegible] expected return

[illegible] 30% = 16.5%

[illegible] expected return

[illegible] 8%) = 18.0%

[illegible] and the project [illegible]

Part 3: Calculate the [illegible] Return

[illegible] Calculate [illegible]

[illegible] 30% = 16[illegible]

[illegible] Calculate [illegible] the project's cash flow with [illegible] expected [illegible]

[illegible] 0.6% [illegible] 16.5%)]

[illegible] 0.6% [illegible] 16.5%)]

[35[illegible] 0.6% (30% [illegible] 16.5%)] = -0.027

Part 3c: Calculate the retu[illegible]

[illegible]

Part 4: Calculate the imp[illegible] of a landfill gas recovery project's cash flow

Based on the calculations in Part 2, the project's expected return on the $110,00 investment

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ion one year (based on the sensitivity analysis) is 30.6% or $143,660 (with an NPV today of $131,798).

The risk-adjusted return

$$= \frac{\$143,660}{(1+0.09)(3.75(0.0165-0.09))} = \$105,197$$

So, this project not worth pursuing. The risk-adjusted [illegible] $110,000. Had the project developer just looked [illegible] incorrectly decided the project was a good investment.

Undertaking risk analysis does not always mean that a project's returns are discounted to be 'cautious.' In this example, under status quo market conditions (Part 1), the project would make a 13.6% return while the market (as a whole) is making 15%. Under this situation it would be difficult to find interested investors because they could get better returns elsewhere with little change in risk. When the scenario analysis was conducted in Part 2, the results showed that by taking into account the uncertainties of the future economy (macro risks) the project return actually improves.

Step 12: (optional) Estimate the equity beta from a comparable firm or industry.

- Use the Beta of another firm or Industry.
- If this information is not available, try the scenario analysis process
- If scenario analysis does not seem appropriate, skip down to the Weighted Average Cost of Capital section below.

Step 13: (optional) Calculate the project specific risk based on Beta, market risk, and the risk free investment rate.

1. Identify the risk free investment rate (often government bonds)
2. Identify the appropriate Beta.
3. Identify industry specific market risk.
   - Most simply, this will be the average variance or standard deviation of entire market[4].
4. Calculate project risk based on Equation 0-5.

[4] Depending on the project's specific industry area, the developer may have access to estimates of how well the industry is expected to do this year or old data from last year. Where this information is not available, it is advisable to us volatility data on companies listed on the Bombay Stock Exchange, National Stock Exchange of India, or Inter-Connected Stock Exchange

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Weighted Average Cost of Capital

In almost all cases project developers will be looking for outside financing for their projects. Outside financing comes with a cost. Providers of equity and debt will require a payback for giving the funding necessary to finance the project. Each source of funds will come at different rates. The weighted average cost of capital (WACC) is designed to (measure) account for the cost of debt and equity financing to the project developer. Historic data are often used for valuation or cost of capital estimation. Two types of average measures are calculated from the historic data: the arithmetic average and the geometric mean. The arithmetic average will be higher than the geometric mean and is the appropriate yardstick to use in valuation or cost of capital estimations.

Step 14: Decide what level of Debt the project should take on.

This step will be done more then once. For now base this decision on what the developer thinks is the best debt/equity ratio.

The Weighted Average Cost of Capital (WACC) can be used as a more accurate hurdle rate (discount rate) when calculating the return and net present value of a project. The WACC is used like the discount rate described above when estimating a new project's returns. The benefit of this method versus more simple cost of capital calculations is the fact that WACC takes the impact of project debt financing into account.

This formula can also be used to identify the most cost effective level of debt to take on. By adjusting the debt capitalization level (debt over debt plus equity), a project developer can see how returns are impacted. If increasing debt lowers the weighted-average cost of capital, then (assuming that the leverage does not lower cash flows correspondingly) the value of the firm will increase, and the project developer should pursue more debt financing.

Equation 0-6: Weighted Average Cost of Capital

$$WACC = r_D(1 - T_C)\frac{D}{V} + r_E\left(\frac{E}{V}\right)$$

E = Equity	r_D = return to debt holder (interest payments)
D = Debt	T_C = Corporate tax rate
V = D + E	r_E = return to equity holders (expected)

Step 15 : Decide what the company's investment hurdle rate is (or Cost of Capital) based on the debt-equity ratio stated above.

Use Equation 0-6 from above to calculate this value

Using Equation 0-6 calculate the organization's required hurdle rate. If the investors have a cost of capital requirement for investing in new projects, this figure could also be used. In either case, the hurdle rate should still be calculated for the firm to make sure the project is cost effective. There could be cases where the project exceeds an investor's hurdle rate, but not the project developer's (or vise-versa). In which case it would not be prudent to proceed with the project. When calculating the WACC, be sure to use the debt and equity ratios for the project, and not the parent firm.

Step 16 : Recalculate the project's net present value (NPV) using the hurdle rate calculated above (Step 15).

How does this recalculated NPV compare to the original unadjusted NPV? If the adjusted NPV is smaller then the original NPV, it may be advisable to consider adjusting the debt equity ratio. By changing the debt and equity levels, the project's NPV can be improved. This may be constrained by the amount of debt or equity that is obtainable, but this exercise should allow developers to more effectively see what the 'optimal' level of debt and equity to take on should be[5].

Step 17 : Decide what the appropriate level of Debt for the project should be.

Redo Step 14 through Step 16 to find the optimal debt-equity level.

Risk Mitigation and Allocation

Risk mitigation and allocation are paramount to developing a successful project. A successful risk allocation strategy is one that designates risk to those parties that can most efficiently manage it. Those risks that cannot be allocated will not necessarily stop the project development process, but they will impact the cost of getting the project up and running. Some very basic strategies such as insurance, force majeure provisions, and government or multilateral bank support can substantially reduce risk and improve a project's chance of funded. Without these basic approaches, viable projects can experience delays or may never get off the ground.

Projects typically go through three phases of risk. A project will need to implement different risk reduction strategies dependent upon what phase of completion the project is currently in.

- **Construction:** The project takes on a large amount of debt to finance construction activity, equipment purchases, and other startup costs. No revenues are coming in at this time.

[5] Optimal here means the profit maximizing solution.

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- **Project Start-up:** This period is used to test equipment, hire staff, prepare raw materials, and begin project sales and marketing activities. Costs may increase during this period of new business activity, increasing risk.
- **Normal Operation:** Revenue begins to grow as the project matures and the services and products are sold. During this period, risk begins to drop as the debt is repaid.

Table 1 below offers some project specific risks and mitigation strategies associated with developing a project.

Table 1: Common project specific risk factors and mitigating actions

RISK FACTORS	RISK MITIGATION ACTION
Project Performance	Prefer strong, experienced sponsors/developers with significant equity stakes
High cost of service	Competitive entry, Concession agreement (or IPP) stipulating cost and service quality standards, backed up with penalties. Comparison with other similar [illegible]
Sponsors sell out	Share Retention Agreement to tie original sponsors to the project.
Project Completion	Seek sponsor support until project [illegible] mechanical completion certified.
Delays	Construction/equipment supply [illegible] specify performance obligations [illegible] penalty clauses.
Cost overrun	[illegible] Funding agreement [illegible] include contingency and escalation amounts in origin[illegible]
Site Availability	[illegible] Land Use Agreement [illegible]
Technology Risk	Prefer tried and tested technology [illegible]
Nonperformance	Performance bond/guarantee from equipment suppliers on quantity and quality. Operation agreement linking operating performance to compensation.
Fuel/other inputs	[illegible]
Fuel	Supply contracts specifying quantity, quality, and pricing. Match term of supply [illegible] term of off-take contr[illegible] through fuel price changes.
[illegible]	[illegible] competitive supply [illegible]
Skilled labor	[illegible] training provided by [illegible]
Market risk	Undertake independent market [illegible] Off-take contract specifying [illegible]
Payments	[illegible]
Financial	[illegible]
Debt service	Financial Support Agreement [illegible] worst case, [illegible] reserve [illegible]
Security	Mortgage and pledge [illegible]
Overcommitment	[illegible]
Accidents	[illegible]
Country Environment	Risk cover where [illegible] private entry, and where [illegible]
Expropriation	Risk insurance [illegible]
Regulatory [illegible]	Contractual arrangement [illegible]
Concession [illegible]	Transparent initial award [illegible]
[illegible]	[illegible]
Legal Framework	Change of law risk assessment [illegible]
Environmental approval	Independent assessment [illegible] include in loan covenants [illegible]
Foreign exchange	Agreement with central [illegible]
[illegible]	Tariff adjustment mechanisms [illegible] of tariff. Increase share of local [illegible]

Source: International Financial Corporation, 1996

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1. Understanding Project Risk

When potential investors are aware of project risks they usually become less interested in the project. It will not be possible to directly control many types of risk, which may lead lenders to lose interest in the project. There are several vehicles available to project developers to help them manage these risks. This section outlines some of the major types of risk mitigation strategies.

One of the simplest ways to insure investor interest, is to offer a higher yield to offset these perceived risks. Often, higher yields can be offered to investors when the project benefits from concessional financing. This topic will be discussed in more detail in the Marketing and Financing toolkit, at this point simply note the implications that risk can have on raising capital.

Step 18 : Decide what risk mitigation procedure is best for the project.

2. Hedging

The risks a firm faces during project design, construction, startup, and operations have been identified in the sections above. Also discussed have been practices that will help mitigate these risks, but sometimes the exposure to risk cannot be resolved by adjusting normal business practices. In these situations, hedging may assist project developers to reduce their exposure to risk beyond what they normally may think is possible.

One type of risk described above is the uncertainty surrounding future cash flows. The toolkit has previously stated that a key element to the project lockbox is locking-in the future cash flows. If there is uncertainty concerning the size and how reliable these future revenue streams will be, the project may be at risk. This may be enough to scare possible investors away. In situations like this, it is possible to create financial instruments that will reduce the uncertainty associated with the future cash flows. These instruments can include simple contracts like leasing or factoring agreements (discussed in the ***Backing up the Carbon Financing*** section below) or more complex tools such as options, future, and swap agreements (discussed in the ***Selling the Carbon*** section below). While many believe that these tools are more appropriate for investment bankers, they can be very simply tailored to the specific project. So long as there is agreement between two interested parties, contracts utilizing these tools can be implemented at any level.

As will be discussed below, hedging practices can also be used to reduce the risk associated with emission reductions. This is accomplished with options, futures, and often with specially designed derivatives[6]. One of the primary purposes of hedging is to control individual types of risk thereby controlling a firm's total risk. The point of hedging is to minimize the risks that the project owner or manager is not equipped to handle thereby freeing them up to worry about the things that are worth worrying about

[6] An asset whose value derives from that of some other asset.

(their core area of expertise) and that they are in the best position to handle. With respect to CCMPs, the object of hedging is to determine the number of emission reductions that are needed to offset changes in the value of the overall firm. This can take the form of producing extra reductions via increased offsetting activities to insure greater liquidity in the firm. By "outsourcing" risk mitigation to partners who can handle it better, project managers are able to focus on their core area of expertise and not worry about risks which they are not able to properly handle.

Contracts

Stable long-term contracts are necessary both for the security of the project developers and investors in a project and insuring that the project operates in an efficient and reliable manner. The contract is the basis for a project's expenses and earnings. It insures that, should one partner or contractor within the project development and operation process not meet their commitments or deliver promised goods or services on time, there is an agreed upon solution. In this way a project developer can account for any contingencies that may impact the future success of the project. Showing project financers the contracts, informs them that project risks have been adequately addressed. Based on this information, project financiers can assess a project to evaluate its credit worthiness for possible funding.

Construction Contracts

The construction contract for a clean energy or CCMP serves to insure that the project is completed in a timely and satisfactory manner. This includes meeting the project developer's evaluation criteria and meeting the agreed upon price. Construction contracts normally require all construction oriented work, purchasing, startup and testing to be preformed by the contracted firm and usually includes the following detailed information: a scope of work, a fixed price for all work necessary to complete the project, performance guarantees, performance tests, and assurances of the construction firm's credit worthiness.

The proper allocation of construction risk between the project developer and the construction firm is an important part of the overall project development process. One of the most important factors in this process is the identification of creditworthy construction firms, insuring that they will not experience financial distress and fail to complete the project construction.

Construction contracts can take the form of one or a combination of the following specific types of construction contract:

- **Procurement Contract:** This contract provides for the timely and efficient purchasing and receiving of all supplies, materials, individuals, and organizations necessary to begin project construction. This contract usually

includes gathering all the required government permits necessary to complete and begin operation of the project.

- **Engineering Contract:** This contract provides for the preparation of preliminary and general project designs, specifications, initial cost estimates, preparation of initial bidding documents. These contractors are usually also responsible for inspections and testing of the construction contractor's work.
- **Construction Contract:** Simply put, this contract covers the actual construction phase of the project. The contractor agrees in the construction contract to provide all construction related services, including labor, management, field engineering, and procurement (not covered in any procurement contract).

Input Contracts

This contract type covers the cost of fuel and other inputs to the project company. Changes in the cost of inputs such as fuel and basic raw materials can have a large impact on the cost to produce a good or service. The main purpose of this contract is to lock in prices to reduce the impacts of future price volatility. This can take the form of long-term, supply or pay contracts, where the supplier agrees to provide goods or services at a set price and at a set time. The contract also should include a clause stating that if the supplier cannot provide the goods or services at the required time, it is their responsibility to find (and pay for) alternative suppliers.

Operations & Maintenance Contracts

In some situations it may be preferable to allow an outside organization run the day-to-day operations and maintenance aspects of a project. For many energy projects the maintenance of the energy plant may require specialized skills, which are not needed on a fulltime basis. Outsourcing of operations and maintenance can be more cost effective and result in a more effective project because specialized staff can be used, which would not normally be available to the project developer.

Project Finance Turnkey Contract

Project finance transactions are made possible because the projects are relatively predictable (including their cash flows), resulting in reliable payments to debt and equity investors. The project finance turnkey contract is a specialized construction contract, which covers all work and results in a complete project that is ready for operation (all the owner has to do, is "turn the key"). It is generally acceptable to charge a risk premium for taking on a project like this to insure that any unaccounted for costs are covered. This type of contract usually requires the contractor to take out substantial loans to cover costs until complete payment is made, increasing the contractor's risk substantially. Incentives are usually also included for completing the project ahead of time.

Off-Take Contracts

Off-take contracts simply lock-in the sale of the project's goods or services. The most common of which (described below) is the Power Purchasing Agreement, which establishes the terms for selling electricity produced by a project (usually to one buyer). This is often considered the most important contract in a project because it locks-in the

revenue flow. In some situations, where the demand for a good or service is stable and prices are relatively predictable, these contracts are not needed.

Power Purchasing Agreement (PPA)
Power Purchasing Agreements are only pertinent to those projects that generate electricity. In the context of India, the purpose of a PPA is to establish the terms and conditions under which the state electricity board (SEB) will purchase, bank, or wheel power generated by an independent power producer. A major outcome of a PPA is setting a price for the purchased power.

Step 19: Put in place the appropriate contract(s).

Note: Generally speaking, if the developer believes they might need any of these contracts, but is not sure, it is better to have a contract in place.

Backing up the Carbon Financing

Once the project risks have been identified and a risk mitigation strategy has been developed, the project developer may realize that the project still has some exposure to risk. Much of this risk may be related to financing. Tools such as Letters of Credit, financial guarantees, Insurance, Factoring and Leasing can give a project the reduced financial risk necessary to see the project through to development.

Letters of Credit
The Letter of Credit is a financial tool that is essential for reducing the risk involved with international transactions, usually between an importer and exporter. If an exporter does not know an importer well, or if potential exchange restrictions apply in the importer's country, then the exporter who sells on credit may demand that the importer's debt be backed by a foreign or domestic bank. Likewise, an importer may not want to pay an exporter until the goods are delivered. A Letter of Credit is used to satisfy both conditions.

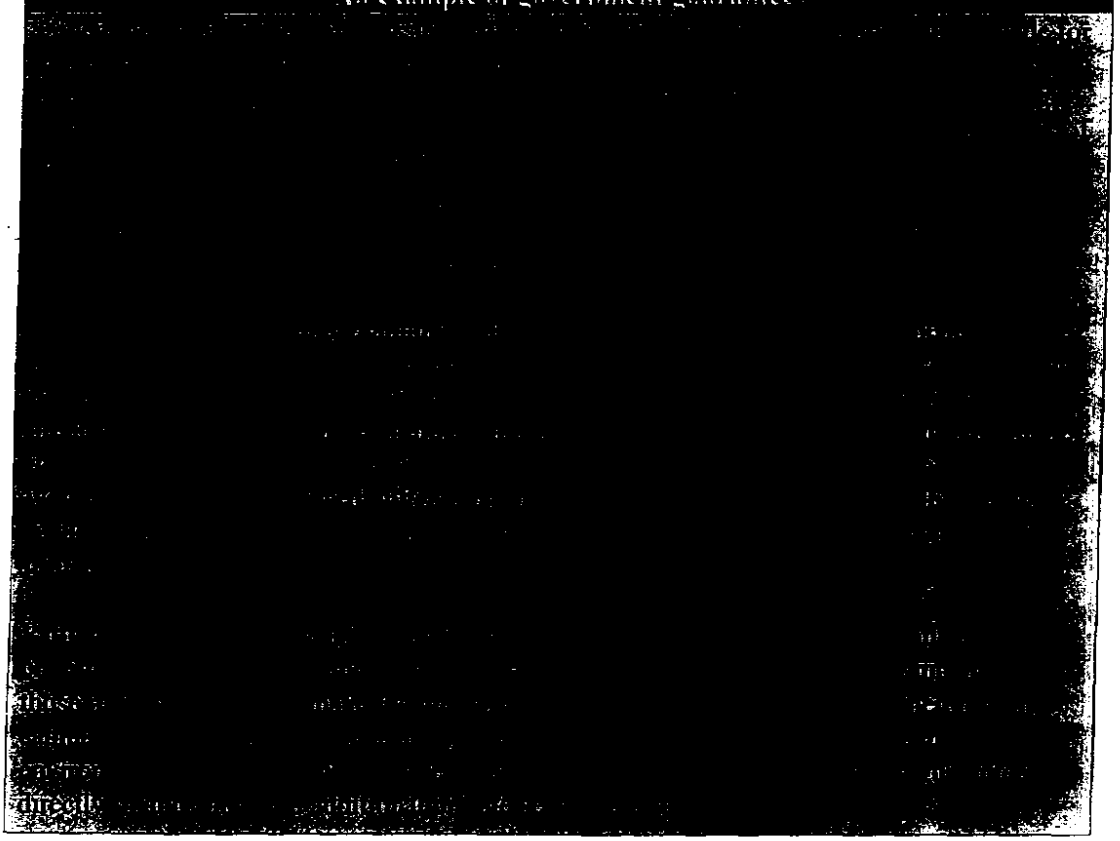
A Letter of Credit is addressed to the exporter and is written and signed by a bank acting on behalf of its customer, the importer. The letter establishes the criteria that must be met for the exporter to draw down a draft on the bank. Through a Letter of Credit, the bank agrees to pay for the commitments of the importing firm. So, the Letter of Credit is a financial contract between the issuing bank and the designated beneficiary, in this case the exporter. This financial tool reduces the risk of a payment not being made or that the goods promised will not be delivered within the agreed upon terms. Thus, with a Letter of Credit, the importer is often able to reduce the overall cost of the transaction. It is possible to structure Letters of Credit for carbon transactions, but it is unlikely to develop as a financial structure until the carbon commodity has the low-risk perception awarded to typical commodities.

Insurance and Guarantees

Insurance and guarantees are frequently used for international trade and investment transactions to reduce the risks related to: expropriation -- the loss of an investment due to expropriation, nationalization, or confiscation by a foreign government; currency inconvertibility -- the inability to convert profits, debt service, and other remittances from local currency into U.S. dollars; and, political violence -- losses of assets due to war, revolution, insurrection, and civil strife. The insurance and guarantees reduces risk for the investor and helps attract additional investors due to lower level of project risk. For large or high risk programs, obtaining insurance coverage is nearly always a prerequisite for the program to go forward.

These insurance and guarantee programs are available from a wide range of sources, which are almost always public entities, such as the U.S. Overseas Private Investment Corporation, the U.S. Export-Import Bank, and the World Bank's Multilateral Investment Guarantee Agency. The insurance coverage limitations and requirements vary across countries and industries. Fees are generally based on a small percentage of the total project cost. These fees are not insignificant and far easier accommodated by large programs. In terms of carbon, one can think of providing insurance or a guarantee in exchange for carbon payments, as well as other guarantee payments.

An example of government guarantees



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Factoring

Factoring is the process where a firm, or factor, purchases the accounts receivable of another firm. The factor may be a commercial finance company that specializes in factoring, or simply a commercial bank. A small firm can benefit from using a factor, since it presents insurance against bad debts that result from the inability to collect. The factor bears the risk of not being able to collect the receivables, but the firm is assured of a specified amount of cash for a given amount of receivables. This reduces the potential earnings of the firm, but reduces operating costs since it does not have to staff and maintain a credit and collection department.

The fee paid to the factor for servicing the account is usually based on the face amount of all receivables, and will tend to parallel the risk that customers will not pay and the term of the receivables in question. For OECD countries, factoring fees generally are low, at 1% to 3 %, of a given amount of receivables. For many developing countries, collecting receivables is more risky, so factoring costs are higher.

The factor and the firm agree to the specified details on the factor's accounts, such as credit limits and other constraints that apply to the firm's customers. For non-recourse factoring, the factor may impose strict limits on the firm's deliveries to certain customers. A requirement to obtain the factor's approval to sell certain customers may led to a loss of sales, but since the factor can better estimate the risk of non-payment, the firm is prevented from making a larger loss. Factoring is generally not considered viable for carbon transactions.

Leasing

A lease is essentially a medium- to long-term source of credit for a firm. The firm obtains the use of an asset, and makes a continuous stream of payments back to the asset owner over the term of the lease. Leases can reduce the overall cost of capital, since a lessee may be able to obtain an asset and maintain it at a lower cost than the lesser could if it purchased the asset outright. Lease accounting has an important effect on financial statements.

Leasing is a potentially viable option for small- and medium-sized businesses that cannot afford to tie up large amounts of cash, either with or without bank loans, in the purchase of assets. Initial down payments are usually low, and importantly, equipment leases generally have longer repayment terms than bank loans. Also, lease payments can be structured to match the cash cycle of a particular project. Leases are usually set up so that payments in the early years equal depreciation plus interest cost incurred under the buy-and-borrow alternative. It may also be easier for a small firm to attract the interest of a leasing company, as opposed to a bank, in an investment.

There are three types of leases, (i) direct, (ii) sale and leaseback, and (iii) leveraged. Direct leases are available through a number of financial institutions. Under a sale and leaseback agreement, a firm sells land, buildings, or equipment that it owns to a lessor

and simultaneously enters into an agreement to lease it back. The selling firm receives cash and agrees to make periodic rental payments. With a leveraged lease, a firm acquires the use of an asset from a lessor though a combination of internal equity and third party assistance (commercial bank or insurance company). There are, however, certain restrictions on the sale and lease back transactions in India. Furthermore, a particular lease agreement can be either a financial or operating lease. A financial lease, the most abundant form, is non-cancelable. An operating lease is cancelable at any time during the lease period. Financial leases normally extend over a long time frame with total monthly, quarterly, or annual payments approximating the purchase price of the asset plus financing charges.

Of all leases, only those which can be classified as capital leases must be included in the balance sheet (though operating leases are detailed in the footnotes to the financial statements). All others are considered operating leases for accounting purposes. A lease is a capital lease if it meets one of the following criteria:

- The lease transfers ownership of a property to the lessee by the end of the lease term;
- The lease contains a bargain repurchase option;
- The lease term is equal to 75% or more of the estimated economic life of the leased property;
- The present value of the minimum lease payment equals or exceeds 90% of the excess of the fair value of the property over any related investment tax credit retained by the lessor.

For a firm with a large number of non-capital leases, the balance sheet may not adequately reflect the firm's true financial situation, especially debt amounts. Thus, some of the firm's financial leverage indicators, such as the debt-to-equity ratio, will understate the firm's true leveraged condition.

Leasing has been employed in some infrastructure projects recently, mostly by public sector agents which would not have access to off-balance sheet project finance. For example, Mexico's Federal Utility (CFE) recently financed a 700 MW natural gas power plant in northern Mexico through a long-term leasing arrangement with Citibank, N.A., the U.S. Ex-Im Bank, the Inter-American Investment Company (IIC), and the private sector lending arm of the Inter-American Development Bank (IDB). Depending on the tax structure and the depreciation treatment for the leased assets, leasing can be a cost-effective option for public/private ventures.

In terms of carbon transactions, long-term leases can be a viable solution to financing a project. In this situation, lessors may receive the rights to the carbon from the lessees in exchange for a lower lease payment or a longer maturity, for example.

Step 20: Decide what type of 'back-up' the project needs to cover non-project based Risk (Risk Insurance, Guarantee, Leases, etc...).

Commoditizing Emission Reductions

To review, renewable energy and energy efficiency projects can generate an important, additional revenue stream beyond revenue generated from energy sales and savings, from the potential sale of carbon offset credits. Today, this "carbon revenue stream" is extremely uncertain due to the lack of a formal, international market for carbon credits. However, there have been a number of international carbon trades that constitute the beginnings of an offset market.

The mechanism with the most potential to offer a market for carbon credits is the Clean Development Mechanism under the Kyoto Protocol. This market allows developing countries to host GHG reducing projects and then sell the reductions to developed nations. These projects produce no (or very little) GHG emissions in a sector which traditionally would produce these emissions to produce a good or service. The difference between the GHG reducing project and the business as usual scenario is the amount of carbon reductions which can be sold (typically measured in tons of CO_2 or carbon equivalent).

Financial Additionality

The carbon revenue stream also plays a potentially important role in a broader debate about the "additionality" of commercial activity that leads to reductions in GHG emissions. The issue involves the treatment of projects that are commercially viable, i.e. profitable, for the investors. Some analysts and experts argue that if a project is profitable, sponsors could be expected to implement the project regardless of the carbon offset benefits, and that the reductions therefore would not be additional to what would have occurred in the absence of the project. In such a case, the project would fail the "but for" condition for additionality.

This condition of financial additionality requires examination of the economics of project finance. For example, an offset project with a modest cost per ton of emission reduction, on a net-present-value basis, would generally produce revenues that, over the life of the project, could exceed the corresponding investment (i.e., profit), on an un-discounted basis. However, a project that earns a very low rate of return would not be considered economic on a project finance basis under any normal conditions, and thus additional funding would be needed to make it viable.

The analysis becomes more difficult, however, when a project's rate of return is high enough that it might be able to secure financing under certain conditions. Such conditions generally involve relatively low risks, which could make a project attractive to investors at relatively modest rates of return. A conventional fossil fuel project, for example, might receive financing because it is considered a relatively low risk and therefore does not require a corresponding high rate of return to secure investors' funds. (Swisher 1997)

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Additional funding may be necessary to raise a riskier (in conventional financial terms) CCMP project to a high enough rate of return to make it viable, while other more familiar (and safer) projects may be viable at lower rates of return. This relationship is implicit to the perspective of risk-return analysis that determines most commercial financing decisions. To those unfamiliar with such analysis, however, it may appear that projects that are "already profitable" are demanding both incremental financing and offset credit.

Table 2: The hierarchy of the economic viability of carbon offsets projects

Rate of Return	Financial Strength
Projects with negative rates of return	Clearly not viable without concessional financing resources or carbon offsets available
	Offset cost per mtC would be expensive
Projects with rates of return below normal market threshold	Probably not viable without concessional financing resources or carbon offsets available
	Offset cost per mtC would be moderate
Projects with rates of return above normal market threshold, but below risk premium for project type, technology, country	Marginal with private finance only, viable with concessional finance or carbon offsets available
	Offset cost per mtC would be inexpensive
Projects with rates of return above normal market threshold, including applicable risk premium	Viable with private finance only; concessional finance unnecessary; carbon offsets precluded by lack of additionality

The relevant projects here show positive rates of return yet are still unable to secure project financing. In this case, they are profitable but can only be completed if the revenues from carbon sales make them commercially viable. The potential benefit of carbon sales is greatest in this gray area of risk assessment and financial decision-making. The project-financing model is the best tool for determining if a project is viable but lacking marginal "additional" funding, or simply not profitable. Arguably, the greatest amount of project-level reductions – at the lowest cost and on the most sustainable basis – can be achieved through project financing that captures the potential revenue of carbon credit sales.

Pricing the Carbon

In situations where no price signals are readily available (markets which have not matured), two simple methodologies can be used to calculate the price of the carbon reductions produced by a project.

These are:

1. **The difference in the total cost of production between the project and a similar project using a traditional technology divided by the total tons of carbon reductions produced.**
2. **The total amount necessary to make the project profitable (or meet the hurdle rate) divided by the total tons of carbon reductions produced.**

These methodologies will give two possible values per metric ton of carbon.

The first method allows the developer to put a dollar value on the added expense associated with producing the energy product and the 'green attribute.' This green attribute is the extra cost associated with producing an energy product (e.g., a kilowatt hour) using non-traditional clean technologies or methods (i.e. the cost to reduce GHGs). Simply subtract the cost of production using traditional methods, such as fossil fuels, from *the project's* cost of production using renewable fuels or energy efficiency. If it is possible to sell the emission reductions at this price, it would be possible to sell the product at a cost competitive price.

In some cases it will not be possible to sell the emissions reductions at this price due to market conditions (the asking price could be too high). In this situation the developer should try to get a price that is as close as possible to production cost gap. In some situations it may only be possible to get a price that has been dictated by the market (see the next section for more detail). The price should not drop below a price that makes the project unprofitable. At a minimum, the emission reduction revenue stream should be enough to make the project profitable. If the project is not profitable, it should not be pursued. Financial sustainability is an important element of any project.

These two pricing solutions will lead to a convergence of carbon prices for specific project types. For example, the additional cost per kWh (compared to traditional fossil fuel based technology) of producing energy from wind technology versus methane recovery from landfills will be different. Wind will almost always be more expensive. All wind projects will fall into a similar price range (starting at $9.00 per ton). Landfill methane gas recovery and power generation will almost always be cheaper. Ideally project developer would want to get the highest price per ton of carbon possible, but as the market matures (and more carbon transactions take place), buyers will be able to estimate the project's cost per ton of carbon and demand a more standardized price based on the technology used. As the market grows, that credits will become generic based on the technology.

Step 21: Calculate the Price per metric ton of carbon.

To calculate the total annual revenues that can be expected from the carbon sales, simply multiply the total tons of annual emission reductions times the price per ton. This should be done for each year of operation. This will give a basic idea of the value of the carbon. Use this information in the project cash flow analysis (see appendix).

Step 22: Calculate the total revenue from potential carbon sales.

Ultimately, the additional revenue from emission reduction sales could contribute to the project's commercial viability, without the need for subsidies, special tariffs, grants, or other non-commercial mechanisms. From the perspective of investors, the additional revenue would lead to more secure cash flow to cover debt servicing and/or improved credit terms (i.e. longer maturities, lower interest rates, etc.) from lenders.

On a more conventional project finance basis, a commercial bank may in the future be able to lend to the project directly on the basis of the anticipated cash flows from the carbon sales. These need not represent all of the debt required for the project, but rather a portion of the debt that nevertheless makes the overall project commercially viable. Lenders are traditionally seeking coverage of debt service obligations at a ratio of 150% or more for what are perceived to be high-risk projects.

In some situations carbon revenues may not be consistent from year to year. In this case it is important to link the appropriate number of emission reductions to the correct year. This will be import if the project is getting cash flows on an annual basis based on the amount of emission reductions produced.

To incorporate the carbon revenues into the cash flow statement simply add a new line in the revenues section dedicated to this source. The carbon cash flow does not act any differently than any other source of revenue once the reductions have been monetized.

Step 23: Incorporate carbon revenues into the cash flow analysis.

Evidence from the Market

Table 3 is a summary of several international transactions of carbon emission reductions reported to date. Because the market is in its initial stage, it is highly difficult to predict future prices. However, there is a general range of approximately US$0.50 to US$22.00 per ton CO_2 reductions. An analysis of the international commitments suggests a *potential demand* in excess of 600 million metric tons of carbon equivalent (not CO_2, this includes other greenhouse gas emissions) per year. The monetary volumes could be as high as $10 billion dollars per year; however, this has not been reflected in actual trades.

The further back in time one goes to find transaction-based evidence for credit pricing, the less useful that information becomes. Knowledge and rules of the market, such as confidence in national programs, sophistication of risk assessment by buyers, and other factors, are weaker in earlier transactions. An analysis of reported project-based credit costs showed most transactions to be in the range of US$5 to US$10 per tCO_2.

Ultimately, early transactions do not offer substantial price signals for the market. These will only help developer get an idea of how much other projects have received for their carbon emission reductions.

Table 3: A selection of International GHG Trades

Seller	Buyer	Project type	Volume, CO_2	Price	Cost/CO_2	Date
Niagara Mohawk Power	Sunoco Energy	Renewable, energy efficiency, fuel switching	100,000 Option: up to 10 million	n/a	n/a	Mar. 1998
Northeast Utilities	GEMCo	Renewable (Landfill Gas CH_4 in power fuel cell)	n/a	n/a	n/a	Jul. 1997
Southern California Edison (SCE)	Ontario Hydro	n/a	10,000	$48,000	$4.80	1997
Zahren Alternative Power Corp. (ZAPCO)	Ontario Power Generation	Renewable (Landfill gas)	2,600,000	n/a	n/a	Oct. 1998
IGF Insurance Company	GEMCo Consortium Members	Agriculture	2,600,000	n/a	n/a	Oct. 1998
Niagra Mohawk	Arizona Public Service	Fuel Switching	n/a	n/a	n/a	1994
Niagra Mohawk	Arizona Public Service	Inter-pollutant switching	2,600,000		$2.70	1996
Bonneville Environmental Trust	Oregon Climate Trust	Wind	77,010	$408,000	$5.18	2003-2012
Vision Quest Windelectric, Inc.	Enmax (Alberta Utility), resold to Environment Canada and Natural Resources Canada	Renewable (Wind Power)	427 from 1997 up to 2,777 per yr. until 2008	n/a	n/a	Feb. 2000
Star Lake Hydro Partnership	Ontario Power Generation	Renewable (hydro power)	98,612 in 1999	n/a	n/a	1998
Dupont Canada	Ontario Power Generation	Emissions Reduction	100,000	n/a	n/a	Dec. 1998
Epcor Utilities	Trans Alta (through IEF exchange)	n/a	n/a	n/a	n/a	n/a
Pacifica Paper, Inc.	Not yet identified	Cogen, energy efficiency, fuel switching	87,000 in 1998, 117,000 mt CO_2 each year after	n/a	USD3.3 offer price	1998 – 2010
Costa Rican Government	Consorcio Noruego	Renewable (hydro power)	4,000,000 (over 20 years)	n/a	n/a	1996
Costa Rican Government	Environmental Financial Products	Forestry (reforestation)	1,000	n/a	n/a	1997
ICE & EON	Costa Rica & Holland	Renewable (Wind Power)	n/a	$4.5 MM	n/a	Feb. 2000
BP Amoco Business Units	BP Amoco Business Units	Various	48,000	n/a	n/a	1997
BP Amoco Business Units	BP Amoco Business Units	Various	361,000	n/a	$17-22; average $20	Sep. 98 – Dec. 99
Shell Tradable Emission Permit System (STEPS)	Business Units of Shell	Various	n/a	n/a	Avg.: $8-7 High: $14	1998-2008
State Forest of New South Wales, Australia	Pacific Power	Forestry (reforestation)	280,000 over 10-year period	n/a	n/a	1998
State Forest of New South Wales, Australia	Tokyo Electric Power	Forestry (reforestation)	(10,000 hectares of forest)	$1.63 MM	n/a	Feb. 2000
USA and Bolivia	AEP, BP America, Pacific Corp.	Forestry (reforestation)	19,000,000	$8.5 million	$0.56	Mar. 1998
Hamburgische Electricitäts-Werke AG (HEW)	TransAlta Utilities	Renewable (Wind Power)	[illegible]	[illegible]	n/a	Jan. 00
Switzerland and Lyon	Switzerland and Romania	Energy Efficiency (District Heat Systems)	[illegible]	[illegible]	[illegible]	1998
Government of Belize	Sunoco Energy	Forestry (reforestation)	100,000 – 500,000 over 20-year period	n/a	n/a	Dec. 1997
United Energy System	Sumitomo	Fuel Switching	n/a	n/a	n/a	Mar. 1998
City of Decin	WEPCo/NIPSCO/Commonwealth Edison	Fuel Switching	117,492 tons over 20 years	$8.5 million	$5.10	Jan. 1998
Fonds Bio-Climatique	Fédération Internationale de l'Automobile	Forestry (conservation)	5,000	$50,000	$10/mt CO_2	Feb. 1997

CLIN 1: Fostering Climate Change Initiatives for Sustainable Development
Task 1C: Computational Tool Kit

Selling the Carbon

Whatever method of payment is decided upon, the payment contract will commit the project sponsor to a long-term emission reductions delivery obligation to the buyer. The buyer can pay for these emission reductions in a number of ways. The methods discussed in the section are: the *carbon performance contract, the forward contract, an annual payment, a fifty-fifty payment, the carbon option, and the carbon swap*. Once the contract is in place, the lenders can treat the carbon revenues as they would any other revenue stream (as described above).

Carbon Performance Contract

As with other components of the project's performance, it is typical for the carbon buyer to expect that the project sponsor share the risk of non-delivery of the carbon offsets. This can be achieved by executing a contract that includes an upfront payment for the buyer to secure rights to the project's emission reductions and pay for these over time and upon delivery.

A normal performance contract is a unique arrangement that allows a site manager to make necessary improvements while investing very little money up-front. A contractor (or for the purposes of this toolkit, the project developer) usually assumes responsibility for purchasing and installing the equipment, as well as maintenance throughout the contract period. The unique aspect of this type of contract is that the contractor is paid based on the performance of the installed equipment. Only after the installed equipment actually reduces expenses does the contractor get paid.

We can easily adapt this model to the acquisition of emission reductions. Like the financial payment stream in the performance contract, if the project reduces emissions from the baseline, the contractor (project developer) can also slowly accrue emission reductions as a form of payment. These reductions can then be sold to other payers.

Forward Carbon Contracts

A forward contract represents the obligation to buy (or sell) a security or commodity at a pre-specified price (the forward price), at some future date. At the future date, the person or firm with the long position pays the forward price to the person or firm with the short position, who in turn delivers the underlying asset.

A carbon contract is similar to a forward contract, as an agreement is made today for an obligatory exchange of funds in the future. A forward contract secures the buyer against any future price volatility. The buyer of the emission reductions benefits in two ways: 1) they can lock-in prices ahead of time, if they feel the market price is going to rise; and 2) if the project producing the reductions does not deliver, there is no risk because no

payment has been made. This contract type allows buyers who are uncertain about the future regulatory environment to insure a future supply of credits without worrying about the uncertain specific requirements that may be put forth by governments.

Annual Payments

Carbon buyers can make annual payments to a project developer who is selling emission reductions. These are based on how many reductions are produced each year.

Fifty-Fifty

Half of the price agreed upon for the total amount of emission reductions is delivered upfront. The remaining half is delivered after all of the emissions reductions have been realized. This is usually only appropriate for projects with a short lifetime. Projects with ten-year horizons or more are often not desirable because the project developer has to wait so long for the final payment.

Carbon Option (American Options)[7]

The basic concept of using options to trade securities may also be applied when considering emission reductions. An option is the right, but not the obligation, to buy or sell a fixed quantity of an asset or commodity at a given price before or on a specified date. All options may be either puts or calls. A ***put option*** gives the owner the right to *sell* the asset while a ***call option*** gives the owner the right to *buy* an asset or commodity. The price written in the contract for which the option may be bought or sold is called the ***strike price*** and the price paid for the option is called the ***option premium***. By purchasing an option, the seller is agreeing to a set price and will sell (or buy) if the buyer chooses to exercise their option.

Options can be a valuable tool for reducing risk when selling or purchasing emission reductions. Much like future and forward contracts, options allow buyers and sellers to lock-in the price of the emissions reductions ahead of time, but they offer the added benefit of not requiring an option owner to actually complete the transaction. This way, if market conditions change over time, and the owner of the option feels that they could get a better price, there is no commitment to complete the transaction (as the owner of the option). Thus, in the future market for emission reductions, if the new price is less then the strike price plus the option premium, the option owner can decide to not exercise their option, and still get a lower price. If the option were sold, they would be required to complete the transaction if the owner of the option wishes.

By using options, a project developer with emissions reductions can access financing even when the regulatory drivers are not in place for a fluid carbon market. They offer a buyer the ability to lock in a price, which reduces future risk in uncertain regulatory environments.

[7] There are also European call and put options which are the right to buy or sell a unit of the underlying asset at the strike price, *at a specific point in time*, the expiration date. If the developer chooses to use the European Option style, it will still work the same in relation to the carbon transaction.

Carbon Swap

A swap is an agreement between two investors, or counter parties, to periodically exchange the cash flows of one security for the cash flows of another. The last date of exchange determines the swap maturity. The notional amount of the swap represents the size of the principal on which interest is calculated. A common type of swap is the interest rate swap. Two parties agree to exchange cash flows from interest payments on a fixed or floating rate bonds. Swaps can be used to hedge a variety of risks faced by project developers.

This same principal may be applied when considering swaps for emissions trading. There are two types of swaps involved in emissions trading. The first type of swap is between emissions rights; swapping SO_2 for CO_2, for example. The other kind of swap involves different "types" or "vintages"; for example, swamping a 2002 emission reduction for a 2001 emission reduction. In this way, organizations with short-term regulatory requirements above their current level of reductions can trade with another project with an excess of short-term reductions and a deficit of long-term reductions.

Step 24: Decide on the right model to sell the Reductions.

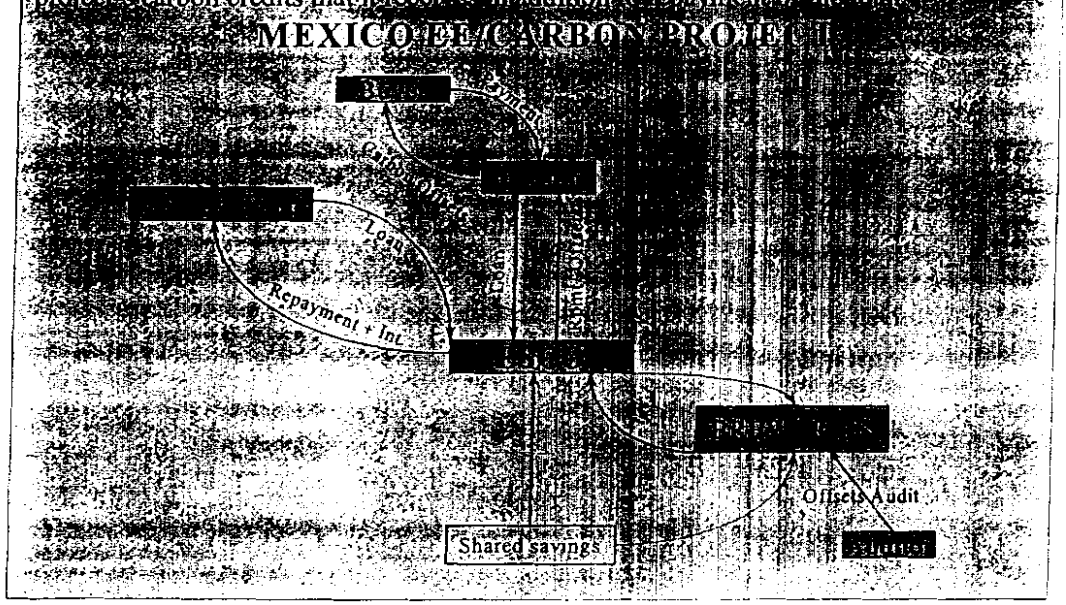
Step 25: Sell the Reductions.

An Example: Using Carbon Contracts in the ESCO Market

This approach was introduced to the economics of a standard energy efficiency project implemented for two breweries in Mexico. The financing was provided to a Mexican Energy Services Company (ESCO) that performed the engineering analysis and design of the EE measures at the breweries. Under a five-year, shared savings, performance-based contract, the brewery makes quarterly lease payments to the ESCO based on actual savings measured by the brewery. The ESCO, in turn, repays the U.S. and Mexican investors.

The reduced energy consumption resulting from the installed efficiency measures will lead to expected carbon offsets of more than 5,000 tons over the five year term of the contract. These offsets are available for sale or trade in anticipation of a formal trading market in the future. Under the terms of the contract, the investor will receive the rights to the carbon credits. This transaction also will be executed under a performance-based contract, which will help minimize the risks that the offsets are not delivered on time or in the agreed amounts.

The financial structure of this project is shown in the diagram below. In this model, the carbon credit buyer provides the investor with the capital to participate in the ESCO project. The buyer may directly invest in the project, but it is possible that intermediaries will take on the role of pooling capital, purchase funds and securing deliveries through carbon contracts on behalf of purchasers. For example, an intermediary may lend to a project at commercial rates that are below its internal cost of capital, intending to make up the difference, the profit through the sale of the project's carbon credits that it receives in addition to repayment of the loan.



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Project Summary

Buyer

Buyer contracts to purchase emissions reductions units of carbon, generated by an energy efficiency project implemented by the ESCO on the premises of two brewery facilities in Mexico.

Seller

The investor (i.e. seller) contracts with the buyer and sells units of carbon to which it has title through agreement with the brewery (the agreement between the ESCO and the brewery [illegible] in this agreement).

Contractual Arrangements

The ESCO contracts to provide the investor with carbon from the project under the following terms and conditions:

1. Volume of carbon

ESCO will provide investor with emissions reductions totaling [illegible] metric tons of carbon equivalent over [illegible] years, with deliveries [illegible] during the period beginning January [illegible] and concluding December [illegible] annual carbon deliveries will be no less than 1024.8 metric tons [illegible] (mtC).

In the event that deliveries exceed 1024.8 tons [illegible] governing payment [illegible] exceed the [illegible] deliveries [illegible]

2. Price

Buyer will pay [illegible] $10.00 to each [illegible] ESCO when carbon deliveries are greater than [illegible] minimum volume [illegible] the minimum volume [illegible]

3. Penalty for Failure to Deliver the Minimum [illegible]

Buyer will not make payment for carbon delivery [illegible] should be less than 1024.8 tons [illegible]

4. Penalty for Delivery of Carbon Offsets [illegible]

In the event that the ESCO should deliver more than [illegible] any given year the buyer will have the option to [illegible] price of US$10.00 nine U.S. dollars [illegible]

[illegible]

This [illegible] provides only the basic elements [illegible] performance contract. Additional clauses in this [illegible] contract [illegible] rights or options that protect the buyer from [illegible] market price [illegible] fail the buyer is not obligated to hold at that [illegible] The [illegible] the contract [illegible] rights and reward performance [illegible] meets or exceeds [illegible] obligations, leading to greater overall confidence [illegible] revenue stream [illegible] for the project finance.

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4. Bibliography

Ashford, Michael S.; "Risk Allocation and Mitigation for Private-Sector Financing of Hydroelectric Projects in Nepal/Technical Assistance for the Electricity Development Center – HMB/Nepal," prepared for USAID and Acres International Corporation, August 1996

Econergy International Corp. (EIC) and Pacific Northwest Lab (PNL), 1997. *Financing Mechanisms for Renewable Energy and Energy Efficiency in Emerging Markets*, Battelle Pacific Northwest National Laboratory, Washington, November.

Ashford, M. and Moscarella, J.P., October 1995, Renewable Energy in the Americas (REIA), Financing Hurdles for Renewable Energy Project Development in Latin America, revised for REIA II, July 1997.

Ashford, M.S. Moscarella, J.P., and Swisher, J.N. July 1999. The Emerging Role of Carbon Credits in Project Finance, *Clean Energy Finance*. pp. 7-8.

Brealey, R. and Myers, S., 2000, Principals of Corporate Finance, McGraw-Hill.

Grinblatt, M. and Titman, S., 1998, Financial Markets and Corporate Strategy, Irwin/McGraw-Hill.

Hassing, P. 1998. Chapter 12: Sustainable Development and Greenhouse Gas Reduction, in *Issues and Options: The Clean Development Mechanism*. United Nations Development Program, pp.147-163.

Hodes, G. and Dolgikh, S. (Editors). 2000. Project Identification, Preparation, and Management, in *Greenhouse Gas Abatement: A Project Developers Manual (for Central Asia)* pp. 2-20 to 2-51.

Hodes, G. and Dolgikh, S. (Editors). 2000. Valuing Greenhouse Gas Emission Reductions as a Financial Asset, *Greenhouse Gas Abatement: A Project Developers Manual (for Central Asia)* pp. 4-95 to 4-116.

Hoffman, S.L., 1998, The Law and Business of International Project Finance: A Resource for Governments, Sponsors, Lenders, Lawyers and Project Participants, Kluwer Law International

IIEC. December 1998. Developing and Financing Energy Efficiency Projects and Ventures in Emerging Markets.

Levich, Richard M, 1998, International Financial Markets, McGraw-Hill.

Moscarella, J.P., 2000, Chapter 7: Carbon Finance. To be published.

Packard, Kimberly O'Neill and Reinhardt, Forest. July-August 2000. What Every Executive Needs to Know About Global Warming. *Harvard Business Review*.

Pathak, M., Srivastava, S., and Sudhir, L. March 2000. Chapter IV. India: CDM Opportunities and Benefits, from *Financing Sustainable Development with the Clean Development Mechanism*, World Resources Institute.

Rubino, M., Younger, D., and Moscarella, J.P., August 1998, Private Capital for the Global Environment, International Finance Corporation (IFC).

Stigson, B. 1998. Chapter 11: Attracting Northern Private Sector Investment for Greenhouse Gas Reduction in the South, in *Issues and Options: The Clean Development Mechanism*. United Nations Development Program, pp.137-146.

Swisher, J.N., 1997. Using Area-Specific Cost Analysis to Identify Low Incremental-Cost Renewable Energy Options: A Case Study of Co-Generation Using Bagasse in the State Of São Paulo, prepared by E4 Inc. for the Global Environment Facility, Washington, DC.

5. Appendix

Sample Cash Flow Statement

Revenue													
Electricity Sales													
Emissions Trading Revenue													
TOTAL													
Investment													
Project Development													
Updates and Purchases													
Advertising Costs													
Other Updates and Purchases													
Consultants													
Unforeseen Expenditure (5%)													
TOTAL													
Operations													
Salaries													
Operation Expenses													
Publicity													
TOTAL													
Total Revenue													
Total Expenses													
Funding of Debt Service Reserve													
Debt Service Reserve													
Operating Cash Flow													
Other Cash Items													
PBT													
Interest on Debt													
Depreciation													
Amortization													
PBT (Taxable Income)													
Capital Expenditure													
Taxes													
Residual													
Present Value													

Discount Rate	
NPV	
IRR	
Years Until Profitability	
Years to Return Investment	
D/E	
Additional Equity	
Additional Debt	
Net Cash Flows	

Sample Risk Matrix

Risk and Mitigation in a Project Package (Energy Project Example)		Risk Mitigation Party or Vehicle													
		Contracts/Insurance					*Financing*		*Multilateral and other risk mitigators*						
Risk Category	Risk/Cost Factor	Offtake/ Power Sales	Fuel Supply	Construction	O&M	Insurance	Debt/ Lenders	Equity/Sponsor/ Owner	Contingent Grant	Contingent Loan	Partial Risk Guarantee	Partial Credit Guarantee	Reserve Funds	Re-factoring
	Investment Risk Factors													
Quantifiable	Country Exchange													
Qualitative	Country Reputation													
Quantifiable	Country Convertibility													
Quantifiable	Taxes													
Quantifiable	Utility budget size, structure risk													
Quantifiable	Risk utility consumption, purchasing agents													
Quantifiable	Risk Transaction Cost													
Qualitative	Length of Development Process													
Qualitative	Lack of Local Counterpart Planning													
Qualitative	Lack of Commercial Guarantees													
Qualitative	Lack of Long-term utility contracts													
	Construction													
Qualitative	Completion Delay													
Qualitative	Cost Overpass													
Qualitative	Regulation Compliance													
	Operation													
Qualitative	O&M Costs													
Qualitative	- new technology													
Qualitative	Plant Performance													
Qualitative	- new technology													
Qualitative	Operating Regime													
Qualitative	- new technology													
Qualitative	Overhauls & Capital Expenditures													
Qualitative	- new technology													
Quantifiable	Fuel Supply													
Qualitative	Regulation Compliance													
Qualitative	Performance Degradation													
Qualitative	Type Of Operator													
Qualitative	Type of Plant													
Quantifiable	Infrastructure													
Qualitative	Force Majeure													
	Contract Risk													
Qualitative	Viability of Individual Projects													
Qualitative	Financial Condition of Plant													
Qualitative	Plant Incompatibility with Technology													
Qualitative	Management Capability of Plant													
Qualitative	Operation Regime of Plant													
Qualitative	- Labor													
Qualitative	- Plant													
Qualitative	Viability of Plant Industry													
Qualitative	Management Capability of Industry													
	Grants													
Qualitative	Uncertainty of utility capacity deferral													
Qualitative	Privatization													
Qualitative	Long Term Price													
Qualitative	Resistance to DO/DR													
	Technical													
Qualitative	Representation													
Qualitative	Rent													
Qualitative	Vandalism													

Greenhouse Gas Pollution Prevention-Climate Change Supplement (GEP-CCS)

Fostering Climate Change Initiatives for Sustainable Development

Carbon Finance Toolkit

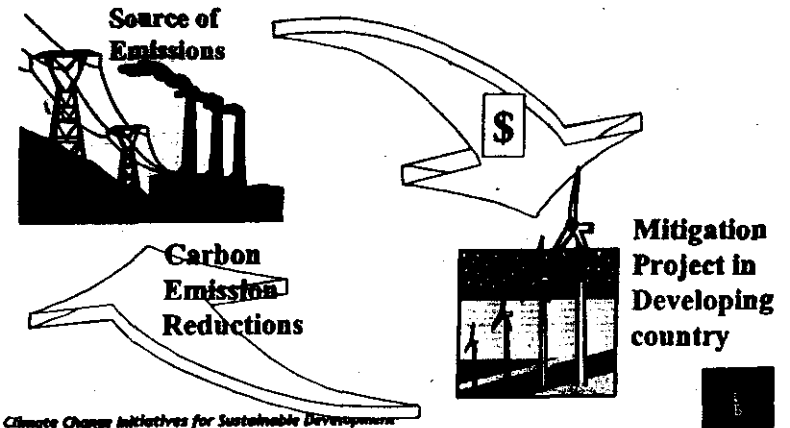
The Louis Berger Group, Inc.

Carbon Finance Toolkit Objectives

⇨ Give project developers the tools they need to:

- Conduct a systematic financial evaluation of projects
- Develop a financial structure that reduces risk and commoditizes a revenue flow from carbon credit sales
- Present a financial structure that clearly defines the financial and environmental benefits to all project sponsors

What is Carbon Emission Reduction Trading



Fostering Climate Change Initiatives for Sustainable Development
Development of Computational Toolkits: Carbon Finance Model

Corporate Finance

⇨On Balance Sheet financing through:

- Issuing stock or
- borrowing from lenders (less risky)

⇨The fundamental guarantees to investors and lenders are the corporate assets backing up the borrower

Fostering Climate Change Initiatives for Sustainable Development
Development of Computational Toolkits: Carbon Finance Model

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Project Finance

- ⇨ **Off Balance Sheet finance**
- ⇨ Shields the corporation from liabilities and provides mostly lower cost, long-term debt financing.
- ⇨ Project is funded against the cash flow generated by the project
- ⇨ Risks are balanced against the project's cash flow and assets
- ⇨ Project is isolated from parent company and funds are channeled directly to the project
- ⇨ Borrowing does not show up on parent company's balance sheet

Project Lockbox

- ⇨ Locks the inputs (revenue stream) and the outputs (payment stream)
  - Fixed revenue stream generated by the project is the bases for long-term debt financing
  - Equity financing covers variable revenue stream based on performance of the project
    - » Benefits and risks can be shared among several investors
    - » Institutional investors can provide an exit strategy for the developers

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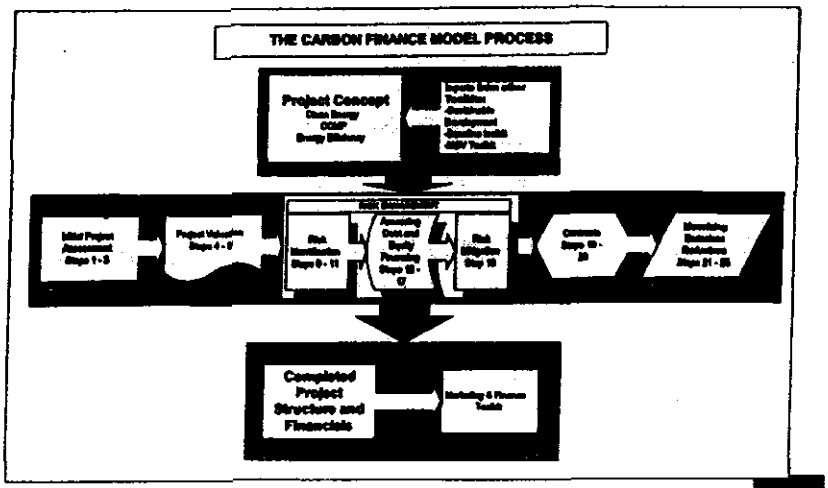
The Carbon Finance Model Process



Fostering Climate Change Initiatives for Sustainable Development
Development of Computational Toolkits: Carbon Finance Model

Initial Project Assessment

Initial Project Assessment Steps 1 - 3

Step 1: Review the Check-list to see if carbon finance is right for your project.
Step 2: Review your project to insure that: 1) it can be realistically implemented, 2) reduces GHG emissions, and 3) can assist the developing countries in achieving sustainable development.
Step 3: Choose a business model: the traditional corporation vs. the special purpose vehicle.

Fostering Climate Change Initiatives for Sustainable Development
Development of Computational Toolkits: Carbon Finance Model

Step 1: Review the Check-list to see if carbon finance is right for your project.

- ❑ Do you have a clear development plan for your project?
- ❑ Do you have the resources/skills to develop the project?
- ❑ Do you have a basic understanding of finance concepts?
- ❑ Have you estimated the startup and annual project costs?
- ❑ Do you have an estimate of annual project revenues?
- ❑ Is your project profitable?
- ❑ Have others developed similar projects in your region? Where they successful? If not why?
- ❑ Do you understand the risk factors effecting the project?

Step 1: Review the Check-list to see if carbon finance is right for your project.

- ❑ Can you get financing for the project?
- ❑ Does the project create steady cash flow after construction is complete?
- ❑ Does the project really reduce carbon emissions?
- ❑ Does the project have access to a carbon market?
- ❑ Does the regulatory environment restrict the sale of emission reductions?
- ❑ Does the area you are planning to develop this project have contract laws? Are they enforced?

Step 2: Review Your Project

⇨Insure that:

- 1) it can be realistically implemented,
- 2) reduces GHG emissions, and
- 3) can assist the developing countries in achieving sustainable development.

Step 3: Choose a Business Model

⇨The Parent Company Ownership

⇨The Special Purpose Vehicle

Project Valuation

Project Valuation
Steps 4 - 8

Step 4: Valuing of your project
Step 5: Complete a basic projected Income Statement for the project.
Step 6: Estimate your discount or hurdle rate.
Step 7: Calculate your Net Present Value
Step 8: Calculate the Levelized Cost of the Project

Step 4: Valuing your project

⇨ Valuation of project assets is based on present values of cash flows generated by the project

- Cash flow produced by the project's end products and the riskiness of the cash flow

•Discount rate
•Return on investment
•Cost of capital
•Net present value
•Incremental cost
•Levelized cost
•Rate of return

Step 4: Valuing your project (cont.)

1. Estimate free cash flow.
2. Choose the horizon date.
3. Estimate the horizon value (discount rate)
4. Calculate the payback period for the initial investment
5. Calculate Net Present Value

Step 5:Complete a basic projected Income Statement

Income Statement		
Revenue	Year 1	
Energy Sales	$15,000	
Carbon Credit Sale	$5,000	
Total	$20,000	(Energy Sales + Carbon Credit Sales)
Expenses		
Depreciation	$3,000	
Rent	$1,000	
Operations & Maintenance	$10,000	
Total	$14,000	(Depreciation + Rent + O&M)
Operating Income	$6,000	(Total Revenue - Total Expenses)
Interest	$500	
Net Income	$6,000	(Income + Interest)
Income Tax (35%)	$2,100	(Net Income x Tax Rate)
Net Income after tax	$3,900	(Net Income - Income Taxes)

Present Value

⇨ The present value is the current equivalent value of future cash flows discounted at the appropriate discount rate

- Discount rate can be the minimum percent return you need or expect in return from the project to account for your cost of capital

Calculate Present Value

Where: CF=Cash Flow
r = interest rate
t = number of time periods (years)

Present Value can be calculated as:

$$PV = \frac{CF}{(1+r)^t}$$

Or, through the discounted cash flow formula as:

$$PV = \sum_{t=1}^{n} \frac{CF}{(1+r)}$$

Net Present Value

⇨ NPV is the best criteria for evaluating a project because:

- It properly adjusts for the opportunity cost of capital,
- It is the only measure which considers the time value of money,
- It gives consistent measures of the project's value, and
- It clearly measures the financial value added to the project developer.

Calculate NPV

⇨ First:

- Forecast the incremental cash flows generated by the project
- Determine the appropriate discount rate
- Calculate the sum of the present values of all cash flows generated by the project
- Subtract the sum of the PVs by the initial investment

Calculate NPV

Where: CF=Cash Flow
r = interest rate
t = number of time periods (years)

$$NPV = -CF_0 + \frac{CF_1}{(1+r)^1} + \frac{CF_n}{(1+r)^n} + \frac{CF_{n+1}}{(1+r)^{n+1}}$$

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Rate of Return

$$ROR = \frac{Profit}{Investment}$$

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Internal Rate of Return

⇨ Internal rate of return (IRR) is the discount rate (r) at which net present value of the project equals zero.

$$P = 0 = \sum F_n/(1+r)^n$$

where P, F_n are known
solve (by iteration) for i = IRR, or use function @IRR

⇩ IRR Rule:

- Accept projects with an IRR greater than the opportunity cost of capital

Calculating the IRR Process

1. The IRR is calculate by trial and error
2. Follow the steps for calculating NPV for several discount rates
3. Start with a low discount rate and then calculate the NPV at progressively higher rates until the NPV calculated has a negative value
4. The NPV will decrease as the discount rate is increased. Plot the NPVs (y-axis) against the discount rate (x-axis). The IRR is that discount rate at which the line crosses the X-axis (NPV = 0)
5. Or, use a financial calculator or spreadsheet program to calculate

Internal Rate of Return

⇨For uniform annual savings D over n years resulting from a present capital expenditure CC:

$$P = 0 = \frac{CC - D}{CRFn,irr} \quad \text{or} \quad \frac{CRFn,irr = D}{CC}$$

where $CRF = \dfrac{r}{[1-(1+r)^{-t}]}$

CRF = Capital Recovery Factor, Ratio between uniform annual savings and PV of stream. Minimum value of savings which make investment cost effective.

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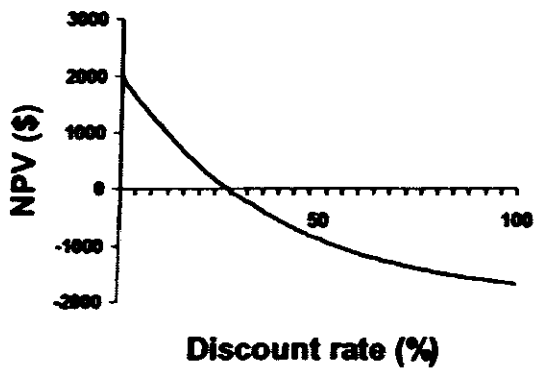
Calculating the IRR



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Profitability Index

$$PI = \frac{NPV}{Initial\ Investment}$$

⇨PI Rule:

- Accept all projects with a PI greater than one
- Or, accept projects with the highest PI first, followed by the next highest and so on.

Step 8: Calculate the Levelized cost of the project

Levelized cost = present value of the total cost of building and operating the project over its economic life, converted to equal annual payments

⇨Helps to determine which technology and energy source will be the least cost.

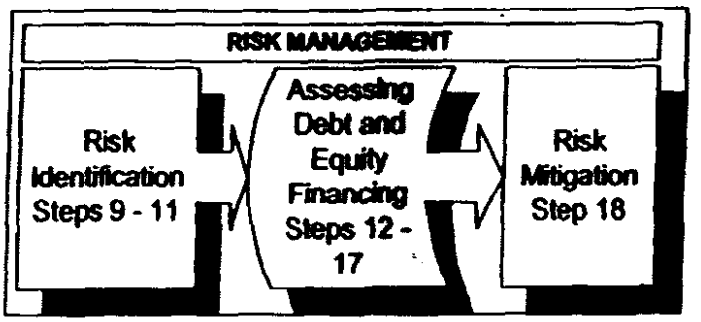
Calculate the Levelized cost of the project

1. Calculate the cost for each year:

[(operating costs-depreciation+interest) + taxes + principal on debt + equity]

2. Take the present value of each year's costs
3. Annualize the PV

Risk Management



Risk Management

Identify ⟶ Label ⟶ Mitigate

Risk is defined as the probability that an expected event will not occur as we predict

Step 9: Identifying Project Risk Factors

- ⇨Macroeconomic Risk
- ⇨Project Specific Risk
- ⇨CCMP and Clean Energy Project Specific Risk

Types of Risk

⇨ Macroeconomic Risk

- Country risk
  - » Regulatory Risk
  - » JI, Allowance Trading Rules?
  - » Exchange rate, interest rates, labor market conditions, taxation, regulation and infrastructure
- Political Risk
  - » Change in government which affects foreign ownership and investment in energy projects

Types of Risk

⇨ Macroeconomic Risks (cont.)

- Economic Risk
  - » Projects do not generate the forecasted revenue stream
    - Demand
    - Pricing
    - Variable costs
- Currency Risk
  - » Projects with foreign investors can be impacted by changes in currency exchange rates
- Regulatory Risk
  - » Changes in tariff rate structure

Country and Political Risk

- ⇨ Country risk takes the following into account
  - Politically motivated embargo or boycott of a project
  - Debt repayments or shipment of product which may reflect the foreign policy of a country
  - Circumstances where the host country cannot permit transfer of funds for debt service due to economic problems
- ⇨ Political and regulatory risks can affect all aspects of a project

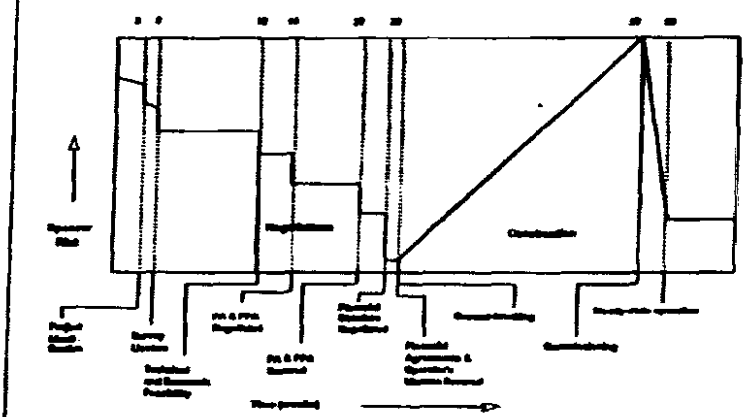
Currency, Inflation & Interest Rate Risk

- ⇨ Currency and foreign exchange risks occur if the financing is across currencies.
- ⇨ Lenders can sometimes hedge this risk
- ⇨ Inflation risk may be a factor
- ⇨ Interest rate risk will exist due to assumptions embedded in the project financials

Project Specific Risk

- Single asset risk
  - » Project can not fall back on larger parent company to meet debt obligations if revenues are disrupted due to an operational problem
- Legal risk
- Construction risk
- Transaction structure risk
- Operating and technology risk
- Project Performance
- Third party performance and reliability
- Repayment rate

Project Sponsor Risk



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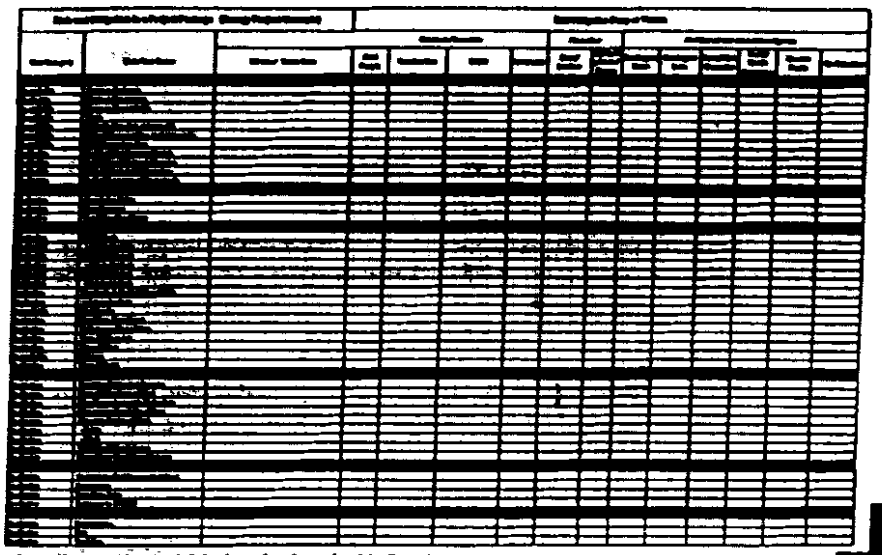
CCMP and Clean Energy Project Specific Risk

- ⇨Size, location, technology, customer base, lack of credit-worthy customers, etc.
- ⇨In a commercial environment, these risks drive the required rates of return for commercial finance higher than those required for conventional energy projects

Step 10: Distinguish between qualitative and quantitative risk

- ⇨ Development of a basic risk matrix
  - Listing the project risk factors in the left column
  - Risk mitigation tools in the top row
  - Label Risks Qualitative or Quantitative
    - Label these factors in order to measure their impact on the project cash flows later.

Step 11: Develop a Risk Matrix



Step 12: (optional) Estimate the equity beta from a comparable firm or industry.

⇨ Development of a basic risk matrix

- If you cannot get this information, try the scenario analysis process
- Use the Beta of another firm or Industry
- If scenario analysis does not seem appropriate, skip down to the Weighted Average Cost of Capital section below.

Note: The Information in this section may not be available for many projects. If you feel this data is not readily available, skip this section and the Capital Asset Pricing Model (CAPM) section and go to the Weighted Average Cost of Capital Section.

Measuring the impact of risk factors

⇨ Market Risk – the relationship between risk and return, or *beta*

- measures a project's sensitivity to market risk
  - » use the general market to evaluate only macro level risk factors, or
  - » use the specific market you are operating in to more closely predict market and project specific risk factors

$$r - r_f = \beta(r_m - r_f)$$

Where: R_f = risk of a risk free investment
r = Project risk
R_m = market risk
β = Beta

Step 13: Calculate the project specific risk

(base on Beta, market risk, and the risk free investment rate)

1. Identify the risk free investment rate (often government bonds)
2. Identify the appropriate Beta.
3. Identify industry specific market risk.
   - ⇨ Most simply, this will be the average variance or standard deviation of entire market.
4. Calculate project risk based on the Expected Risk Premium Equation:

$$r - r_f = \beta(r_m - r_f)$$

Step 14: Decide what level of Debt the project should take on

⇨ The Weighted Average Cost of Capital

- Determines the expected return on a project or portfolio of projects and can be used as a hurdle rate when deciding whether to take on a new project.

$$WACC = r_D(1 - T_C)\frac{D}{V} + r_E\left(\frac{E}{V}\right)$$

Where:
E = Equity
D = Debt
V = D + E
r_D = return to debt (interest payments)
T_c = corporate tax rate
r_E = return to equity holders (ex[redacted]

The Cost of Money

Weighted Cost of Capital

⇨ Equity: 40%
⇨ LT debt 40%
⇨ ST borrowings: 20%

⇨ cost of equity: 20%
⇨ LT debt interest: 9%
⇨ ST interest: 8%

What is the weighted average cost of capital?

[redacted]

Step 15 : Decide what your company's investment hurdle rate is (or Cost of Capital)

⇨Using the WACC figure above recalculate the Cost of Capital

- This will take into account the impacts of your debt equity structure on your project's return

Step 16 : Recalculate the project's net present value (NPV)

⇨We now have a new hurdle rate calculated with the WACC formula

⇨Recalculate the NPV using this new hurdle rate

Step 17 : Decide what the appropriate level of Debt for the project should be.

- ⇨We can adjust the debt-equity level to find the ratio giving us the highest project return (NPV)
- ⇨Redo Step 14 through Step 16 to find the optimal debt-equity level.

Risk Mitigation

Risk Mitigation Step 18

- ⇨**Step 18 :** Decide what risk mitigation procedures are best for your project.

Risk Mitigation and Allocation

⇨ Three Phases of Risk

- **Construction:** The project takes on a large amount of debt to finance construction activity, equipment purchases, and other startup costs. No revenues are coming in at this time.
- **Project Start-up:** This period is used to test equipment, hire staff, prepare raw materials, and begin project sales and marketing activities. Costs my rise during this period of new business activity, increasing risk.
- **Normal Operation:** Revenue begins to grow as the project matures and the services and products are sold. During this period, risk begins to drop as the debt is repaid

Construction Risk

⇨ Project sponsor and construction risks are linked.

⇨ When construction begins the risk increases sharply as funds are advanced to purchase materials, and employ labor.

⇨ Construction financing charges begin to accumulate

⇨ Cost over-runs and construction delays are a primary risk during this phase

Project Specific Risk Factors

Risk Factors	Risk Mitigation Actions
Project Performance	Prefer strong, experienced sponsors with significant equity stakes
High Cost of Service	Competitive entry, concession agreement stipulating cost and service quality standards, backed up with penalties. Comparison with other similar projects
Sponsors sell out	Share retention agreement to tie original sponsors to the project.
Project Completion	Seek sponsor support until physical/financial completion certified
Delays	Construction/equipment supply constraints. Specify performance obligations with penalty clauses.
Cost Overruns	Project funds agreement with main sponsors. Include contingency and escalation amounts in original cost estimates.
Site Availability	Land Use Agreement
Technology	Prefer tried and tested technology
Non Performance	Performance bond/guarantee from equipment suppliers on quantity and quality. Operation agreement linking operating performance to compensation

Project Specific Risk Factors

Risk Factors	Risk Mitigation Actions
Fuel/Other Imports	
Fuel	Supply contracts specifying quantity, quality, and pricing. Match term of supply contract to term of off-take commitment. "Pass through" fuel price changes. Consider alternative supply arrangements/on-site storage.
Skilled Labor	Training provided by equipment suppliers and technical advisors.
Market Risk	Undertake independent market assessment. Off-take contract specifying minimum quantities and prices (take or pay arrangements). Conservative financing structure
Payment Risk	Sell output where possible to creditworthy buyers. If buyer not creditworthy, consider credit enhancements such as government guarantees of contractual performance; direct assignment of part of buyer's revenue stream; escrow account covering several months debt service.

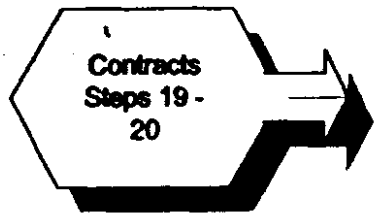
Project Specific Risk Factors

Risk Factors	Risk Mitigation Actions
Financial	
Debt Service Coverage	Financial support agreement until D-E ratio reduced to safe level. Use 'worst case' to set up-front D-E ratio. Escrow account with debt service reserve.
Security	Mortgage and negative pledges on project assets. Assign concession and other relevant agreements. Share pledges.
On-going compliance	Staged disbursements. Disbursement conditions and loan covenants.
Accident/Loss	Insurance policies and force majeure provisions
Country Environment	Risks lower where governments have adopted a clear policy framework for private entry, and where broader sectoral reforms have started
Expropriation	Risk Insurance
Regulatory Interference	Contractual arrangements -- but some risk will remain

Project Specific Risk Factors

Risk Factors	Risk Mitigation Actions
Concession revoked	Transparent initial award process. Some local ownership. Buyout clause
Legal Framework	Change in law risk assumed by government.
Environmental approval	Independent assessment. Agree on guidelines, monitoring and reporting; include in loan covenants.
Foreign exchange	Agreement with central bank for forex availability. Offshore escrow account. Tariff adjustment mechanisms to maintain foreign exchange equivalent value of tariff. Increase share of local financing.

Contracts



- ⇨ **Step 19:** Put in place the appropriate contract(s).
- ⇨ **Step 20:** Decide what type of 'back-up' your project needs to cover non-project based Risk (Risk Insurance, Guarantee, Leases, etc…).

Construction Contracts

- **Procurement Contract:** provides for timely and efficient purchasing and receiving of all supplies, materials, individuals, and organizations necessary for construction and government permits.
- **Engineering Contract:** provides for the preparation of preliminary and general project designs, specifications, initial cost estimates, preparation of initial bidding documents. Contractors usually responsible for inspections and testing of the construction contractor's work.
- **Construction Contract:** covers the actual construction phase of the project.

Step 21: Calculate the Price per metric ton of carbon (cont.)

- ⇨To calculate the total annual revenues that can be expected from your carbon sales, simply multiply the total tons of annual emission reductions times the price per ton.
- ⇨This should be done for each year of operation

Carbon Analysis

- ⇨Cost-of-carbon analysis for energy projects:

$$\$/C_{ton} = \frac{\$/kWh_{proj} - \$/kWh_{base}}{C_{ton}/kWh_{base} - C_{ton}/kWh_{proj}}$$

$\$/kWh_{proj}$	=	cost of project case energy supplied (or saved)
$\$/kWh_{base}$	=	cost of baseline case energy supplied
C_{ton}/kWh_{base}	=	carbon intensity of energy supplied in the baseline case
C_{ton}/kWh_{proj}	=	carbon intensity of energy supplied (or saved) in project case

Cost of Emission Reductions

⇩ Costs of avoided emissions can be calculated by comparing the marginal emission rate and MCOE of an emission reduction option against a baseline:

$$CAE = (EC_A - EC_B) / (EF_B - EF_A)$$

Where:

CAE = cost of avoided emissions
EC_A = marginal energy cost of energy for option A
EC_B = marginal energy cost of energy for baseline option B
EF_B = emission factor for baseline option B
EF_A = emission factor for option A

Step 22: Calculate the total revenue from potential carbon sales

⇨ Additional revenue from carbon sales should lead to more secure cash flow to cover debt servicing and/or improved credit terms from lenders.

⇨ To incorporate the carbon revenues into your cash flow statement simply add a new line in the revenues section dedicated to this source. The carbon cash flow does not act any differently then any other source of revenue once the reductions have been monetized.

Step 23: Incorporate carbon revenues into your cash flow analysis

⇨ Carbon Pricing and Payment Options

- Annual payments – Simple to negotiate because only three variables:
  - (1) the unit price
  - (2) the total number of offsets, and
  - (3) the ratio of up-front to annual payments
- The carbon performance contract –
  - » greater protection from project risk through positive and negative incentives
  - » Increased attractiveness of projects not yet undertaken
  - » Energy efficiency contracts follow this model already

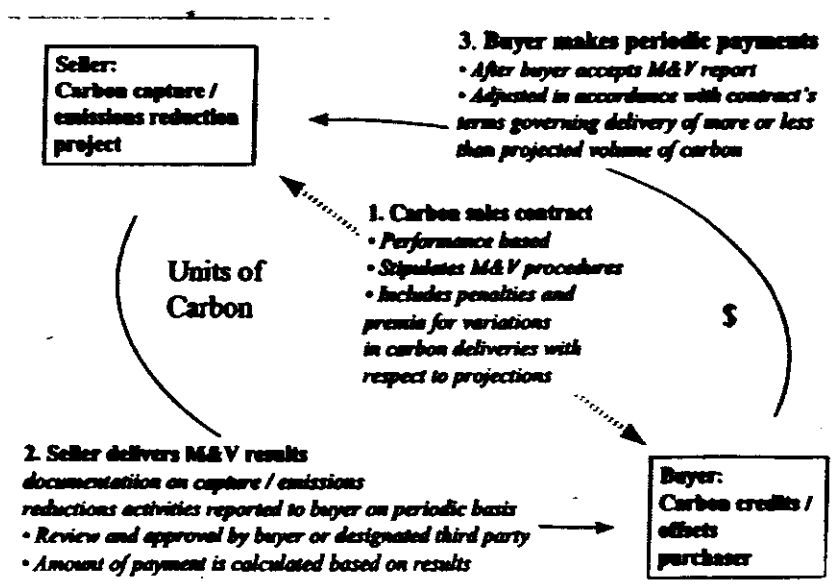
Step 23: Incorporate carbon revenues into your cash flow analysis (cont.)

- Forward contract - obligation to by (or sell) a security or commodity at a pre-specified price, at some future date
- Fifty-fifty payment - half of the price for the total amount of Offsets is delivered upfront. The remaining half is delivered when all the emissions reductions have been realized.
- Carbon option - the right, but not the obligation, to buy or sell a fixed quantity of an asset or commodity at a given price before or on a specified date.
- the carbon swap - two investors, or counter parties, agree to periodically exchange the cash flows of one security for the cash flows of another

Step 24: Deciding on the right model to sell your Carbon

- ⇨Carbon Performance Contract
- ⇨Forward Carbon Contracts
- ⇨Annual Payments
- ⇨Fifty-Fifty
- ⇨Carbon Option (American Options)
- ⇨Carbon Swap

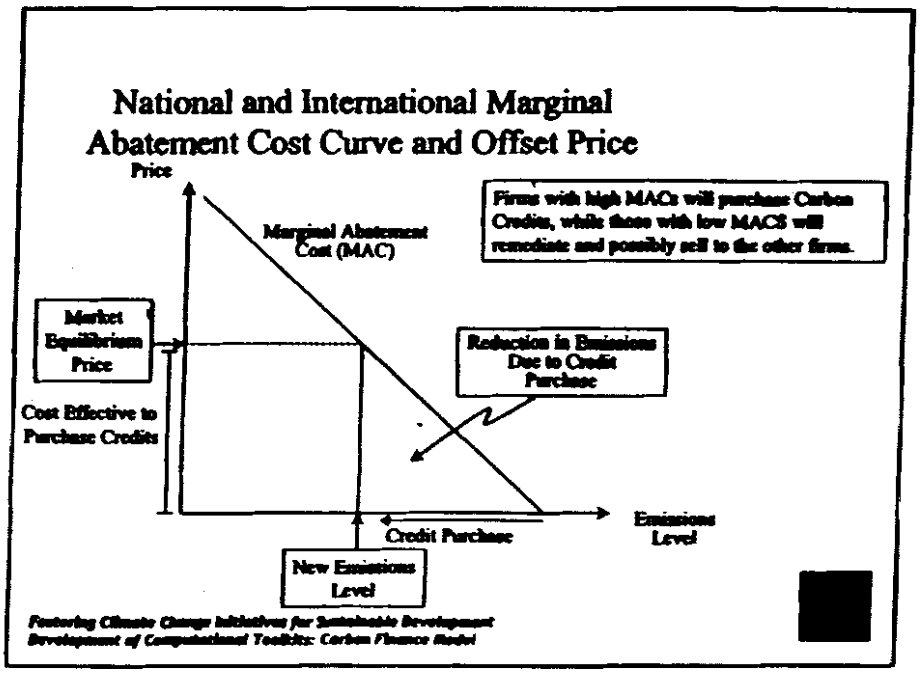
Carbon Performance Contract



Step 25: Sell your reductions!

Hierarchy of Carbon Project Economics

⇨ Projects with negative rates of return	» Clearly not financially viable, Carbon offsets would be expensive
⇨ Projects with rates of return below market threshold	» Probably not viable without concessional financing resources, Carbon offsets would be moderate
⇨ Projects with rates of return above normal market threshold, but below risk premium for project type, technology, country	» Marginal with private finance only, viable with concessional resources, Carbon offsets would be inexpensive
⇨ Projects with rates of return above market threshold, including applicable risk premium	» Viable with private finance only, likely attractive with concessional resources, Carbon offsets precluded by lack of additionality


National and International Marginal Abatement Cost Curve and Offset Price
Price
Marginal Abatement Cost (MAC)
Firms with high MACs will purchase Carbon Credits, while those with low MACS will remediate and possibly sell to the other firms.
Market Equilibrium Price
Reduction in Emissions Due to Credit Purchase
Cost Effective to Purchase Credits
Emissions Level
Credit Purchase
New Emissions Level
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Computational Tool Kit: Monitoring and Verification

DRAFT

United States Agency for International Development
Greenhouse Gas Pollution Prevention Project
Climate Change Supplement
(GEP-CCS)

Fostering Climate Change Initiatives for Sustainable Development

Task 1C
Computational Tool Kit: Monitoring and Verification

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May 14, 2001

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DISCLAIMER

This toolkit is not intended to substitute for engaging a qualified professional who is experienced in the development and implementation of monitoring and verification (M&V) protocols by which are measured the actual reductions in carbon emissions produced by a climate change mitigation project. The quality of emission reductions, as perceived by the marketplace, and therefore the market value of the reductions, may be severely downgraded in the absence of the involvement of an M&V professional who has a proven track record of providing these specialized services.

Executive Summary

The objective of this toolkit is to provide a basic understanding of the process of monitoring and verification (M&V) as it relates to climate change mitigation projects (CCMPs) and is meant for the Climate Change Centers (CCCs) at Development Alternatives. In general terms, M&V refers to the process of ensuring that the projected emission reductions developed initially are actually obtained following project implementation. M&V is critical because it provides the basis for demonstrating to the buyer of carbon offsets (Offsets) that emission reductions are in fact being delivered by the CCMP and, thus, that the annual installment payment on the Offsets sales contract should be made.

This toolkit identifies the parameters that must be monitored in conjunction with the CCMP. Using the procedures from the Baseline Toolkit, these parameters are then used to quantify the actual emission reductions resulting from the CCMP. For example, the annual electricity generation from a renewable project is a crucial parameter to monitor and use in calculating actual emission reductions. Because the quantity of emission reductions determines the carbon credits that can be sold, the process described here is the basis for the topics covered in the other toolkits.

This toolkit discusses how M&V must be incorporated into the design of the CCMP, and the importance of M&V in the validation of a project. Guidance is provided in developing a plan for implementing M&V for the project. Accepted international standards for M&V are also discussed.

CCMPs involving alternative energy production or energy efficiency are the focus of this toolkit, but the principles discussed can be applied to any CCMP.

Checklist

[illegible] they stand in [illegible]

[illegible] M&V plan that is appropriate [illegible] particular [illegible] consideration?

2. [illegible] stage of development is the project and when will M&V begin?

[illegible] project developer have the capacity to develop the M&V plan (human [illegible] technical resources, time allocated, funds)?

[illegible] project developer have the capacity to implement the required monitoring [illegible] set forth in the M&V plan (human and technical resources, time [illegible] allocated, funds)?

[illegible] project developer identified an independent verification agent to carry out [illegible] verification activities as set forth in the M&V plan?

6. Has the information in this toolkit been supplemented with information from other sources for the M&V design? Such other sources include similar projects and an

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[redacted]

Overview of the GHG emission reduction sales process

The process by which the GHG emission reduction produced by a climate change mitigation project (CCMP) might be sold involves several specific steps. First, the CCMP developer must estimate the emission reduction expected to be produced by the project. The procedures for making this estimate are presented in the Baseline Toolkit. Next, the CCMP developer must develop a plan for monitoring and verification of the emission reduction. The emission reduction estimate and the M&V plan are then presented to the appropriate regulatory authority for validation of the project design and certification of the anticipated emission reductions. The regulatory authority then issues a certificate for a specific amount of emission reduction. At this stage of the process, the CCMP has a Carbon Offsets (Offsets). An Offsets has more value in the markets than does a non-certified emission reduction. The Offsets can now be offered for sale on the carbon market. If a sales contract is executed with a buyer, the developer constructs the project and implements the monitoring activities outlined in the M&V plan. An independent agent is engaged to periodically verify that the emission reductions are in fact being delivered by the project over the contracted period of performance.

Thus, the process proceeds in this order:

1. CCMP developer estimates emission reduction
2. CCMP developer develops M&V plan
3. Regulatory authority reviews the project design, including the M&V plan; if approved, the project receives ***validation*** from the authority
4. Regulatory authority provides ***certification*** of emission reduction estimate, thus creating Offsets
5. Offsets are offered for sale by CCMP developer
6. Prospective buyer negotiates a sales contract with CCMP developer
7. Developer constructs the CCMP
8. Developer implements the ***monitoring*** component of the M&V plan
9. Independent ***verification*** agent uses the monitoring data to periodically verify the actual amount of emission reduction delivered by the project

10. Based on the verification results, the buyer pays the developer the appropriate annual installment payment as specified by the terms of the Offsets sales contract

This toolkit discusses the role of M&V as a risk management tool. A good M&V plan is necessary to acquire validation of the project design and to obtain certification of GHG offsets. Without certification, the market value of the offsets will be diminished, possibly with great severity.

Because M&V serves such a key role in facilitating CCMP design validation, GHG offset certification, and assuring market value of those offsets, it is very important that the project developer include M&V costs in CCMP budget and account for M&V in project timetable.

Development of an M&V plan or protocol will not in and of itself guarantee project validation or certification of GHG emission reductions. However, an M&V plan is a key component of CCMP design and is requisite for the project to obtain project validation and GHG emission reductions certification. Consequently, it is imperative that close attention be paid to M&V, that adequate resources be budgeted to create the M&V plan, and that adequate resources be budgeted to fully implement the monitoring requirements of the plan. The cost of M&V is a transaction cost that facilitates the sale of carbon emission reductions.

1. Introduction

Intended applications of toolkit

This toolkit describes the essential elements and steps for monitoring and verification (M&V) procedures to be applied to CCMPs in India in the energy generation and energy efficiency sectors. This toolkit is intended only as a road map by which the CCC can gain a strong conceptual understanding of the M&V process that must be built into the project. M&V is critical because it provides the basis for demonstrating to the buyer of carbon offsets (Offsets) that emission reductions are in fact being delivered by the CCMP and, thus, that the annual installment payment on the Offsets sales contract should be made.

It is the responsibility of the CCMP developer to create a specific plan by which M&V will be accomplished. The CCC will extend necessary assistance to CCMP developer in this regard. This M&V plan, or protocol, defines the methodology by which actual emission reductions are to be calculated by an independent verification agent. The protocol also identifies the specific parameters, contained in the calculational algorithms, that must be monitored over the life of the Offsets contract. It is also the responsibility of the CCMP developer to perform the necessary monitoring and to provide the resulting monitoring data to the independent verification agent who will calculate the actual emission reductions delivered by the CCMP.

The international community has determined that some kind of accreditation process is needed by which to license verification agents. Developing nations such as India are rightly concerned that in-country expertise be created so that indigenous M&V agents can become accredited and thus can capture their fair share of the M&V services market. Development of this in-country M&V expertise is also very important as a means for keeping Offsets sales transaction costs under control. The activity of building capacity of CCCs under GEP-CCS is one such effort.

The procedures in this toolkit apply to two broad project types:

1. Alternative energy production, in which a less carbon-intensive source (renewables, natural gas, etc.) is used to generate electric or thermal energy
2. Energy efficiency, in which electric or thermal energy consumption is reduced.

Both project types can displace carbon emissions from four different sources:

1. Grid-generated electricity
2. Electricity generated off the grid
3. Thermal energy generation
4. Methane sources

Other non-energy project types, such as transportation or land-use CCMPs, are described in a general way here. Specific treatment of such project types is not provided, but the

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impartial observer to the project, and is neither the supplier nor the buyer of the carbon emission reductions generated by the project. At the same time, the preparation of the M&V protocol (the responsibility of the CCMP developer) is a vital part of project design – indeed, it is a prerequisite for project approval as an Offsets project by the host-country government as well as the counterpart government for qualifying under any market based mechanism of funding.

At present, standards for M&V have been developed along two tracks. On the one hand, the requirements of the relevant international agreements and draft rules for implementing the international funding mechanisms include language that guides aspects of the process relevant to them. On the other hand, such initiatives as the Prototype Carbon Fund of the World Bank have included specific requirements and standards for the preparation and implementation of M&V protocols.

Definition and importance of M&V

In developing the baseline for a CCMP and estimating emission reductions, projections are made about future parameters, such as the baseline carbon emission rate and the performance of the CCMP. M&V is the process of measuring these parameters, then updating the emission reduction calculations by replacing the projected data with the measured results. The results are thus measured, verifiable emission reductions attributable to the CCMP. The monitored parameters that are used to document and quantify the project's performance provide the key link between the potential emission reductions estimated during the design of a project and the verified emission reductions actually delivered by the project.

Part of the project design stage therefore must include the design of the M&V, and this plan is one of the components of the project design that must be approved as part of the project's validation, which is the final stage of the design process. Once a project has been independently validated, one can assume that it will deliver emission reductions provided that the project performs generally as designed. In other words, the project design is certified in the validation stage, and the monitoring and verification stages simply serve to verify the actual performance against the validated design.

In order to ensure that the monitoring effort collects the relevant measurements, and that the verification effort is consistent with the project design, the M&V prepared during the design stage must specify the performance indicators that will be measured and verified. These indicators will make it possible to observe and verify conformance of the project's performance with relevant design criteria. In addition to quantitative performance factors, these criteria can include qualitative indicators, for instance the contribution of the project to achieving sustainable development.

An important purpose of M&V for a CCMP is its use as a risk management tool. A good M&V plan is necessary to acquire validation of the project design and to obtain

certification of GHG offsets. Without certification, the market value of the offsets will be diminished, possibly with great severity.

Because M&V serves such a key role in facilitating CCMP design validation, GHG offset certification, and assuring market value of those offsets, it is very important that the project developer include M&V costs in CCMP budget and account for M&V in project timetable. In developing countries, the required data may not be readily available, which can increase the M&V costs for the developer.

Development of an M&V plan or protocol will not in and of itself guarantee project validation or certification of GHG emission reductions. However, an M&V plan is a key component of CCMP design and is requisite for the project to obtain project validation and GHG emission reductions certification. Consequently, it is imperative that close attention be paid to M&V, that adequate resources be budgeted to create the M&V plan, and that adequate resources be budgeted to fully implement the monitoring requirements of the plan. The M&V planning and monitoring costs must be undertaken by the supplier of the carbon emission reductions (unless other arrangements are made). The verification costs of the M&V process are paid by the revenue stream created by the Offsets sales contract, and while the protocol is developed irrespective of whether or not the project actually sells carbon offsets, generally the M&V component is not implemented unless the credits are sold, since there would be no revenue to cover the M&V cost otherwise. The cost of M&V is therefore a transaction cost that facilitates the sale of carbon offsets.

It is important to note that this toolkit provides a plan for M&V at the project level. Other types of emission-reduction measures could involve program-based implementation, for example increasing the market share of efficient lamps nationwide. The impact of such measures depends on the rate of adoption of the technology, and this requires measurement of consumer behavior and statistical extrapolation. This toolkit, however, focuses on the direct impact of individual projects involving alternative energy production or energy efficiency.

International M&V requirements

As of the date of the drafting of this toolkit, there are no internationally mandated requirements or standards for M&V procedures. However, it is only a matter of time before such requirements or standards are developed. The toolkit is developed based on the current understanding of the requirements of funding projects through various market based mechanisms. The best indicators as of today for what future M&V requirements and standards are likely to be are the M&V principles contained in the UNFCCC and the M&V principles developed by the Prototype Carbon Fund. A further indicator of what future M&V requirements and standards will be is the *International Performance Measurement and Verification Protocol* (IPMVP) that has been published by U.S. Department of Energy.

The reason that an independent third party, such as that called for by Article 12.5 of the UN FCCC, is needed to certify emission reductions is that an offset transaction is not "zero-sum." Both the buyer and the seller could benefit from exaggerating the emission reductions that are credited. Because the financial payments in a power supply project are "zero-sum," this type of project involves a significant degree of two-party verification. Part of the strategy in this M&V plan is to employ the appropriate components of the two-party verification of energy performance to streamline the process of third-party verification of the carbon offsets.

Already in the pilot phase of application of the JI mechanism, an adequate M&V plan is considered an essential part of a carbon offset project plan. Technically credible M&V plans are being required as part of some national project-certification programs, such as the US Initiative on Joint Implementation (IJI). At present, M&V methods are mostly being left to an *ad hoc* process, as it is not yet realistic to standardize the methods used. As international norms are established for project-level M&V procedures, compliance with such norms will be required for certification as carbon offsets.

The development of such norms is one goal of the World Bank's Prototype Carbon Fund (PCF), which calls for the validation of project design, including review of the M&V plan to ensure it is appropriate for the proposed project and in compliance with relevant standards or best practice. The PCF also calls for project design to include a baseline study and the development of a project-specific M&V plan or protocol (World Bank 2000a and 2000b). This M&V plan will guide the monitoring of relevant indicators as well as the audit and verification process.

The World Bank calls for potential Prototype Carbon Fund projects to undertake "...a review and assessment of all or a part of the assumptions and plans relevant for the successful implementation and operation of the project. The assessment will mainly be done by reviewing documents prepared when developing the project and other relevant documents plus appropriate research by the validator..." The validator is recommended to be an independent auditor who reviews the project design for approval against the set criteria. One aspect of this validation, or approval of the project design, should involve a review of the M&V to ensure that it is "appropriate for the project and in compliance with relevant standards or best practice" (World Bank 2000b).

Validation is performed on the bases of the project design documents. A positive validation opinion is required before the project can move into the implementation stage.

For PCF projects, the World Bank recommends that "the M&V will include a list of indicators that must be measured (e.g. fossil fuel consumption) and instructions how measurements must be made, what records must be kept, how the collected information must be processed and documented, and who will be responsible for these activities." The World Bank expresses particular concern about potential conflicts of interest in the

M&V process, and stipulates that such conflicts should be examined and prevented if possible (World Bank 2000b).

Similarly, the USIJI criteria stipulate that a project submission must contain "...adequate provisions for tracking the greenhouse gas emissions reduced or sequestered resulting from the project, and on a periodic basis, for modifying such estimates and for comparing actual results with those originally projected." Further, the USIJI Guidelines for Project Proposals require the filing of an annual report that includes "...monitoring data and analysis on emissions reduced or sequestered...significant environmental impacts/benefits...significant economic and other impacts/benefits."

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5. Identify the technical skills required for the monitoring portion of the M&V. Do the necessary skills exist 'in-house' to perform necessary monitoring on an ongoing basis? If not, are there service providers, which can handle the monitoring?
6. Identify funding sources for M&V.
7. Initiate M&V at appropriate time.

Standardized M&V protocols

The purpose of M&V is to obtain monitored data with which an independent verification agent can calculate actual emission reductions from a CCMP. In order to illustrate this process, this section presents standardized M&V protocols for selected alternative energy generation and energy efficiency CCMPs. Each protocol identifies the data that should be monitored and presents the calculation procedures used to quantify emission reductions.

The format of this section is similar to that found in the Baseline Toolkit, because the calculation procedures are the same in both toolkits. The purposes of the two toolkits are different, however. The Baseline Toolkit is forward-looking, estimating future emission reductions from currently available data for the purpose of facilitating an Offsets sales contract. M&V uses measured data to verify, after the fact, the projections made in the Baseline Toolkit. The calculation algorithms included here specify the particular data that must be acquired, from on-site monitoring or other appropriate sources.[1] Thus, this M&V Toolkit contains all the information necessary to create a project-specific M&V protocol and to identify the specific data points that must be subjected to on-going monitoring. These monitoring data will be used by an independent verification agent to verify that the CCMP delivers sustained emission reductions throughout the project life span.

As in the baseline, the M&V procedures will depend on the source from which emission reductions are displaced. Thus, the standardized protocols developed are:

- M&V Protocol 1: CCMPs that displace grid-generated electricity
- M&V Protocol 2: CCMPs that displace off-grid electricity
- M&V Protocol 3: CCMPs that displace thermal energy generation

A fourth procedure is presented specifically for CCMPs that generate electricity or thermal energy by burning methane recovered from, for example, a coal mine, landfill or agribusiness facility. These methane recovery projects reduce greenhouse gas emissions in two ways. First, they reduce carbon dioxide emissions by displacing electricity or thermal generation from some baseline source. These carbon emission reductions are quantified using M&V Protocol 1, 2, or 3, as appropriate. Secondly, methane recovery

[1] Published calculation procedures often include the effect of incomplete carbon oxidation in the combustion of fossil fuels. In the procedures presented here, this effect is not included, because it has a minimal impact on the analysis (typically 1% or less).

For the CCMP, the following information is necessary.

- Installed capacity (MW) (*generation projects only*)
- Annual electricity generation (MWh/yr) (*generation projects only*)
- Reduction in annual electricity consumption (MWh/yr) (*efficiency projects only*)
- Type of fuel used (*thermal plants only*)
- Plant heat rate (GJ/MWh) or plant net thermal efficiency (%) or plant annual fuel consumption (GJ/yr) (*thermal plants only*)
- Emissions generated by CCMP (t C/year)

The task of quantifying the production of electricity from generation projects is quite straightforward. It can be accomplished using measurement and reporting systems that will, in all likelihood, already be a part of each project. These projects usually will, as a matter of course, include measurement systems that measure and record true RMS power on a periodic basis, typically every few minutes. They usually will, as a matter of course, also include reporting systems that take the recorded power production data and translate them into the net amount of electric energy produced by the project (energy production less parasitic energy usage on-site). If such systems are available, no additional monitoring equipment will be necessary for the quantification of electricity generation.

Monitoring reductions in electricity consumption in efficiency projects is inherently more difficult. However, efficiency projects often include an M&V plan to quantify energy savings. If this is not the case, a plan should be developed. A discussion of M&V procedures for the wide variety of possible energy efficiency measures is beyond the scope of this toolkit. One source for such information is the *International Performance Measurement and Verification Protocol* (DOE 1997).

If emissions are generated by the CCMP, additional monitoring of the project may be required to quantify these. See Step 5 below for further information on the mechanisms by which CCMPs can generate emissions.

Step 2: Update project boundary definition

For a project that displaces grid-generated electricity, the project boundary will encompass the project site and the electricity generation and transmission system to which the project will be interconnected.

The central question to answer through M&V is whether the project boundary has changed from the initial definition. For example, plants may have been added to or retired from the electric grid. On a larger scale, it is possible that the existing state grids have been linked into a national grid. If a national grid were completed, a project's boundary would expand to include the existing and future electricity generation and transmission system for the entire national grid.

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In India, most state electric systems are composed almost exclusively of thermal plants, but several states (Kerala, Himachal Pradesh, Meghalaya, Jammu & Kashmir, Orissa, and Karnataka) have significant hydro capacity. As a result of the different resource bases of the different SEB grids, the marginal source(s) displaced by a particular CCMP, and thus the emission reductions of the CCMP, could be very different depending on its location.

Step 3: Identify the appropriate baseline source

As with the project boundary, M&V should determine whether the baseline generation sources have changed over time. This is especially critical for a grid-connected project, so the M&V process should include the same careful determination of the baseline source as was performed prior to the project's operation.

To quantify emission reductions from CCMPs that displace grid-generated electricity, it is first necessary to identify the baseline generation source(s), or the source(s) that will be displaced by the CCMP. Unfortunately, there is no standard method for identifying project baselines. Because of the diversity of CCMP and technology types, as well as host country contexts, it is unlikely that a single method could apply to all cases. However, there has been some progress in identifying the types of methods that apply best to certain project types, and in beginning to harmonize these procedures (see Michaelowa 1999). There are several types of decision rules for determining baselines, including:

1. Direct comparison with current practice (i.e., "before and after")
2. National macroeconomic analysis
3. Microeconomic investment analysis (see World Bank 2000a)
4. Control group analysis (see World Bank 2000a)
5. Benchmarks, technology standards or matrices
6. Barrier analysis (see IEA 1997)

Of these, microeconomic or investment analysis (rule #3) is appropriate to CCMPs. Applied to power sector planning, the investment analysis approach indicates that the baseline case represents the least-cost solution. In the case of CCMPs, the application of microeconomic investment analysis is not as simple as comparing the IRR values for two alternative projects. Instead, we need to identify the generation source(s) that will be replaced or deferred as a result of the CCMPs. This requires blending the investment analysis (rule #3) approach with certain elements of benchmarks (rule #5).

The least-cost solution governs the operation, or dispatching, of the existing generation plants.[2] Least-cost dispatching favors the operation of available generation sources with the lowest variable costs, or short-term marginal costs. Since thermal plants have significant fuel costs, their variable costs are higher than those of hydro plants. Thermal

[2] Dispatch order is the order of priority in which each unit of generation capacity is selected for operation during a given time interval. A traditional economic dispatch strategy ranks supply resources by variable costs (mostly fuel) to determine dispatch order. The most expensive source operating at a given time is the marginal resource, and this varies with the system load.

plants with expensive fuels, low efficiencies and higher maintenance costs are the most expensive plants to operate.

Thus, the baseline source(s) would be the existing source(s) that the operation of the CCMP replaces. The baseline case, of course, is not static, and time variations in the generation fuel mix must be captured in the baseline carbon emission rate. This is where a benchmark approach can be used to simplify the analysis. The simplest benchmarks for baseline emissions from electricity generation are:

1) To use the average emission rate for the entire system (i.e., total emissions divided by total sales), or
2) To use the weighted-average marginal emission rate.

These baseline benchmarks are adequate for small generation CCMPs that do not, by themselves, cause changes to the generation expansion plan.

For CCMPs, it is clear that the appropriate benchmark for the baseline is the weighted-average marginal emission rate (method #2 above). The reason for this is simply the logic that governs dispatching in a generation system containing sources with low variable costs, such as hydro or renewables. Since these resources are almost cost-free in terms of variable cost, they should always be dispatched as much as possible. Thermal sources are dispatched only as necessary.

Thus, the marginal emissions source is the individual generating asset (emissions source) in the baseline case that would be the first to have its operation curtailed if a less expensive source (e.g., CCMP capacity) were available.[3] This is usually a thermal generating asset. This means that thermal sources are a significant component of the baseline case that CCMPs will replace in the short term. Although the total generation mix in some areas of India will still contain significant base-load hydro sources, the operation of these sources would be the same whether or not the CCMP is built. The inclusion of the emissions (zero) of these base-load hydro sources in the baseline carbon emission rate, such as by using the average emission rate benchmark, would be highly misleading.

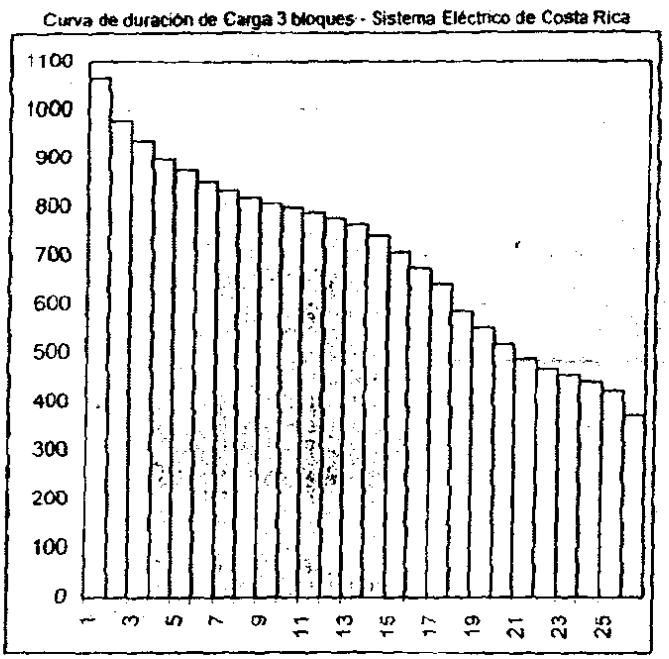
Step 3 can be divided into two sub-steps: determining if non-thermal sources ever operate at the margin and determining which of the individual thermal sources are marginal.

[3] In the utility system, the marginal generating plants are defined as those plants that are dispatched or utilized to meet peak loads only. During those times when end use consumption exceeds the generation capacity available from base-load plants at the utility, which are more or less in continual operation and therefore have plant capacity factors greater than 70 percent, intermediate and sometimes peaking plants are utilized to supplement total power supply to the grid. Marginal plants typically have plant capacity factors less than 20 percent. An exception to this rule may occur if, at times of low demand, there is sufficient output from "must-run" generation sources to more than meet the demand. Thus, no other plants would need to be dispatched to meet this demand.

Step 3, Part A: Determine if non-thermal sources are marginal
If an electric grid contains substantial non-thermal (hydro, renewable, or nuclear) capacity, there may be times of the year when non-thermal sources are able to meet the system demand without any thermal plant operation. During these times, no emission reduction results from the CCMP's output. In these cases, it is critical to determine when thermal sources are at the margin, i.e., the time when incremental production from the CCMP (with lower variable costs than thermal power) would be able to offset thermal generation.

For mostly thermal power generation systems, in which the dispatching is mostly a function of system demand at a given time, one can use the system's load duration curve (LDC).[4] An example LDC is shown in Figure 1.

Figure 1: Example Load Duration Curve – Costa Rica Power System



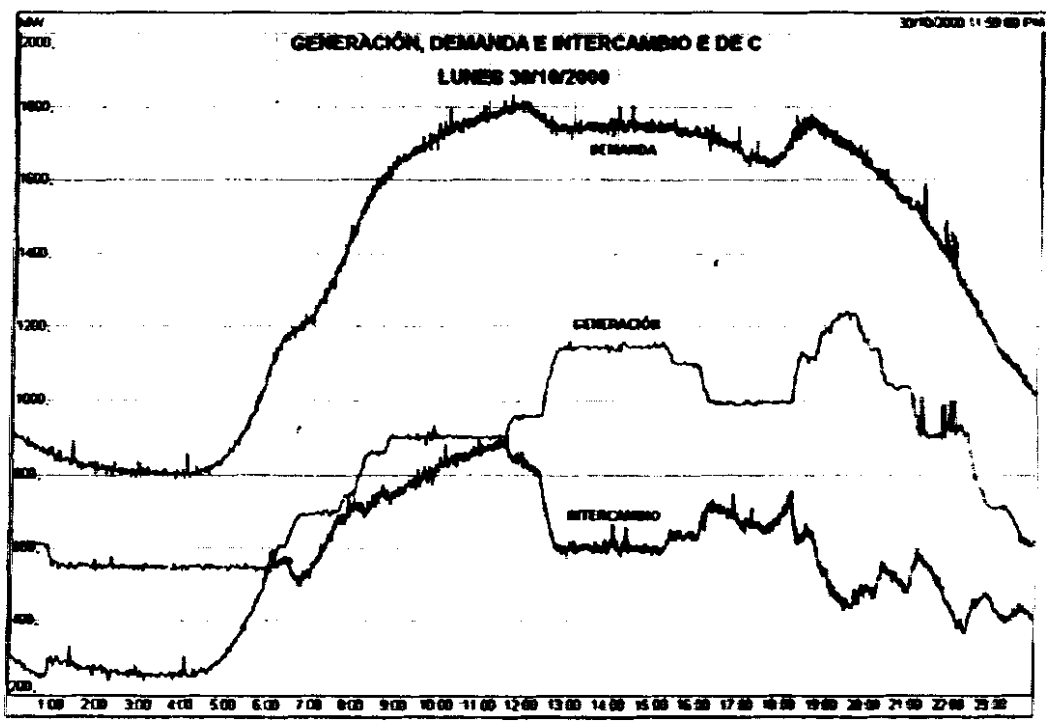
The LDC shows the fraction of the year that a given demand level is exceeded. The vertical axis is demand (MW) exceeded in a given hour and the horizontal axis is the cumulative hours during the year. One can superimpose the available generating capacity

[4] A utility's load duration curve is the cumulative frequency distribution of the utility's hourly demand levels, sorted by decreasing size according to the fraction of the year during which a given level is exceeded.

on the LDC by first applying hydro and intermittent, "must-run" sources such as wind to the load in each period.[5] Then, additional loads are met using remaining (thermal) sources, in order of ascending variable cost, until the total demand is met even in the peak period. For each period, the most expensive source that is needed is the marginal source. To account for hydro output variations, one can divide the analysis into separate wet and dry seasons; however, it can be difficult to obtain sufficient time-differentiated data to complete this analysis.

If an LDC is not available, one can use a daily load profile. As with the LDC, one can superimpose the available generating capacity on the daily load profile to determine which sources are marginal through the course of the day. An example load profile is shown in Figure 2.

Figure 2: Example Daily Load Profile – Mexico Power System



[5] A must-run generation source is one that cannot be dispatched, such that its output is wasted if it cannot be used to meet some simultaneous demand. Examples include wind power and run-of-the-river hydropower

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As discussed above, some SEB grids are dominated by thermal plants, and others by hydro capacity. Thus, the marginal source(s) displaced by CCMPs in India depend heavily on the location of the CCMP.

Step 3, Part B: Determine which of the thermal sources are marginal
After determining whether non-thermal sources operate at the margin, the next step is to determine which thermal sources are marginal. This is especially critical if the system contains base-load thermal plants. As with hydro sources, the operation of base-load thermal plants would be the same whether or not the CCMP is built. Thus, base-load thermal plants should not be included in calculating the weighted-average emission rate, because the CCMP would never displace generation from these sources.

The simplest way to determine which specific thermal generating plants represent marginal sources during some periods of the year is to compare the capacity factor[6] of existing plants. Typically, thermal plants that are dispatched to serve the base load have a capacity factor above 70%. To identify the marginal plants, look for plants with a lower capacity factor. Thermal plants with 40-50% capacity factors are probably dispatched as intermediate load, and these plants might be at the margin during some periods. Peak load plants can have a capacity factor as low as 10-20%, which indicates that these plants are at the margin whenever they are operating.

Note that hydro plants often have capacity factors around 50%, due to variations in rainfall and the need to store water for times of high demand or low production. However, it is unusual that hydro plants are truly at the margin, because as a low variable-cost resource they should be dispatched as much as possible, saving more expensive (in variable cost) thermal plants for dispatching at the margin.

Step 4: Calculate baseline carbon emission rate
After determining which generating plants represent the baseline sources to be displaced by the CCMP, the next step is to calculate the carbon emission rate of these sources using the data gathered through monitoring. As discussed above, the relevant baseline carbon emission rate is the weighted average of marginal emission rates for the generation plants on the margin. The baseline emissions depend on the installed generation capacity and fuel mix. To the extent that electricity is generated by fossil fuel-fired thermal power plants in the base case, the resulting carbon emissions must be accounted for on the basis of the relevant share of energy generated by each source and its carbon emission rate. Although installed capacity is an important parameter in describing the generation system and analyzing its economics, the emissions will be proportional to the total energy generated (MWh) by each source, rather than its generation capacity (MW).

Ideally, the baseline carbon emission rate should be determined on an hourly basis (8760 hours/year), to account for daily variations in loads and seasonal variations in

[6] The capacity factor is the ratio of the average production to the peak capacity, which can be expressed as:
Total annual production (MWh/yr) / [peak capacity (MW) * 8760 hr/yr]

hydroelectric and renewable output. These variations cause variations in dispatching, fuel mix and emissions. System operation can be simulated on an hourly basis using a production-cost model, in which the total demand is increased or decreased incrementally to simulate the marginal change in generation for each hour. If a production-cost model and hourly data are not available, or if the changes in generation sources are simple enough, then baseline carbon emission rate can be estimated on an annual basis.

Using an annual analysis method, the first step is to determine the annual percentage of the year when thermal sources are at the margin, which is the percentage of time that the CCMP displaces carbon emissions. This factor is determined from the analysis of an LDC or daily load profile, which is presented in Step 3. This analysis will yield the number of hours in a typical day or year that thermal power is required at the margin. Dividing by the number of hours in a day or year, respectively, will give the desired percentage.

The weighted-average marginal emission rate (expressed in metric tonnes of carbon per megawatt-hour, t C/MWh) can then be calculated using the following equation:

Weighted-average marginal emission rate (t C/MWh) =
% of year thermal plants at margin * Weighted-average emission rate of thermal plants (t C/MWh) +
% of year non-thermal plants at margin * Weighted-average emission rate of non-thermal plants (t C/MWh)

The average emission rate of non-thermal plants is typically zero. The average emission rate of thermal plants is the sum of all marginal thermal plant emissions divided by their total production. Note that this calculation should include only the thermal plants that operate at the margin, which can be determined using the procedures in Step 3.

$$\text{Weighted-average emission rate of thermal plants (t C/MWh)} = \frac{\text{Baseline emissions of marginal thermal plants (t C/yr)}}{\text{Total generation of marginal thermal plants (MWh/yr)}}$$

To determine the baseline emissions of the marginal thermal plants, the emissions from each marginal thermal plant can be summed, as shown by the following equation:

Baseline emissions of marginal thermal plants (t C/yr) =

$$\sum_i \text{[Total generation of plant (MWh/yr) * Emission rate (t C/MWh) of plant]}_{\text{source } i}$$

The carbon emission rate of a thermal plant depends on the type of fuel combusted. The carbon content of various fuels can be found in Table 1 below.

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Table 1: Carbon Content of Fuels

Fuel	Carbon Content (t C/GJ)
Liquid Fuels	
Crude Oil	0.0200
Orimulsion	0.0220
Natural Gas Liquids	0.0172
Gasoline	0.0189
Jet Kerosene	0.0195
Other Kerosene	0.0196
Shale Oil	0.0200
Gas/Diesel Oil	0.0202
Residual Fuel Oil	0.0211
Liquefied Petroleum Gas	0.0172
Ethane	0.0168
Naphtha	0.02
Bitumen	0.0220
Lubricants	0.02
Petroleum Coke	0.0275
Refinery Feedstocks	0.02
Other Oil	0.02
Solid Fuels	
Anthracite	0.0268
Coking Coal	0.0258
Other Bituminous Coal	0.0258
Sub-bituminous Coal	0.0262
Lignite	0.0276
Oil Shale	0.0291
Peat	0.0289
BKB & Patent Fuel	0.0258
Coke Oven/Gas Coke	0.0295
Gaseous Fuels	
Natural Gas (Dry)	0.0153

Source: UNEP/OECD/IEA/IPCC 1996

The carbon emission rate of each plant can be determined using values from Table 1 and one of the following three equations. The information available for each plant will determine the proper equation to use.

If the plant's heat rate (expressed in gigajoules of fuel consumption per megawatt hour of electricity generation, GJ/MWh) is known, use the following equation:

Emission rate (t C/MWh) = Plant heat rate (GJ/MWh) * Carbon content of fuel (t C/GJ)

If the dimensionless thermal efficiency of the generation source is known, the same relationship can be expressed in these terms by converting the units as follows:

$$\text{Emission rate (t C/MWh)} = \frac{\text{3.6 GJ/MWh [by definition] * Carbon content of fuel (t C/GJ)}}{\text{Net thermal efficiency of plant}}$$

Finally, the emission rate can be derived directly from annual fuel consumption data, together with the corresponding annual generation data. If the fuel consumption data are expressed in mass or volume (such as tonnes of coal) rather than energy units (GJ/yr), the heating value of the fuel (GJ per mass or volume) will also be required.

$$\text{Emission rate (t C/MWh)} = \frac{\text{Annual fuel consumption (GJ/yr) * Carbon content of fuel (t C/GJ)}}{\text{Annual energy generation (MWh/yr)}}$$

To illustrate these calculations, consider the following hypothetical scenario. A renewable energy project will feed into a grid consisting of both hydro and thermal plants. Analysis of the LDC or daily load profile has determined that hydro plants are at the margin 10% of the year, thermal plants the other 90%. The marginal thermal plants consist of three generating units of varying fuel type and heat rate, as shown in Figure 3.

Figure 3: Example Calculations

		A		B	C	D = B * C	E = A * D
Marginal Thermal Plants	Installed Capacity (MW)	Generation (MWh/yr)	Type of Fuel	Plant Heat Rate (GJ/MWh)	Carbon Content of Fuel (t C/GJ)	Carbon Emission Rate (t C/MWh)	Carbon Emissions (t C/yr)
Plant 1	100	350,000	Nat. gas	8.0	0.0153	0.12	42,000
Plant 2	50	88,000	Diesel	12.0	0.0202	0.24	21,120
Plant 3	50	44,000	Diesel	18.0	0.0202	0.36	15,840
Total	200	482,000					78,960
Weighted-average emission rate of thermal plants = 78,960 / 482,000 = 0.16							
% of year thermal plants at margin 90%							
Weighted-average marginal emission rate = (0.90) * (0.16) + (0.10) * (0) = 0.14 t C/MWh							

The carbon emission rate for each plant is calculated using the heat rate and carbon content of fuel. The annual carbon emissions for each plant are then calculated. The total generation and total carbon emissions for all plants are used to determine the weighted-average emission rate of the thermal plants. The emission rate of the hydro plants is zero. These two emission rates, plus the percentage of time that thermal and

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hydro are at the margin, are then used to calculate the weighted-average marginal emission rate.

Step 5: Calculate emission reductions
After determining the weighted-average marginal emission rate in Step 4, the calculation of net carbon emission reductions (expressed in metric tonnes of carbon per year, t C/year) from the CCMPs is fairly straightforward. The emission reductions equal the emissions that would have been produced in the absence of the CCMP (the generation displaced by the CCMP multiplied by the emission rate of the baseline source) minus the emissions generated by the CCMP.

Net emission reductions (t C/yr) = [Grid generation displaced by CCMP (MWh/yr) * Weighted-average marginal emission rate (t C/MWh)] – Emissions generated by CCMP (t C/year)

The generation displaced by the CCMP is the reduction in the baseline source's generation due to the CCMP. For an alternative energy production CCMP, in which a less carbon-intensive source (renewables, natural gas, etc.) is used to generate electricity, the grid generation displaced is equal to the electricity produced by the CCMP minus any parasitic electricity use. For an energy efficiency CCMP, the grid generation displaced is equal to the reduction in electricity consumption resulting from the CCMP. For both cases, measured data from the M&V process should be used.

The emissions generated by the CCMP depend on the type of project implemented. All aspects of the CCMP activities should be evaluated to identify and quantify any such emissions. Mechanisms that can produce such emissions are indirect fossil fuel use, non-CO_2 greenhouse gas (GHG) emissions, and land use change. Table 2 and the discussion that follows identify the possible mechanisms for and significance of these emissions.

Table 2: Potential Sources of Emissions from Electricity CCMPs

CCMP Type	Potential Sources of Emissions from CCMP
Electricity generation:	
Fossil fuel	Fossil fuel combustion
Biomass and geothermal	Release of non-CO_2 greenhouse gases
Reservoir hydro	Land-use change
Other renewable (wind, solar, run-of-the-river hydro)	Typically none
Energy efficiency	Increased on-site fossil-fuel usage

The emissions generated by the CCMP can be significant in projects involving electricity generation using cleaner-burning fossil fuels. Examples of such projects include

converting a power plant from coal to natural gas, a methane recovery project, or an on-site cogeneration project. These emissions can be calculated by multiplying the carbon emission rate of the plant (t C/MWh) by the plant's annual generation (MWh/yr). (Follow Steps 4 and 5 in M&V Protocol 2 below.)

The emissions generated by other types of CCMPs will typically be negligible, because the primary source of net emission reductions for CCMPs that displace grid electricity is the reduction in fossil-fuel use at thermal generating stations that can be displaced by the CCMPs. As such, detailed procedures for calculating the emissions generated by the CCMP are not presented in this toolkit. These procedures can be found in UNEP/OECD/IEA/IPCC 1996 and World Bank 1998.

Any type of electricity generation CCMP may have associated increases in fossil fuel use resulting from standby generator operation, transportation of materials or fuel, project construction, biomass fuel production and other upstream or downstream activities.

Electricity generation through combustion of biomass fuel produces no net carbon emissions if the biomass is produced sustainably within the project, because the carbon emissions produced during combustion are assumed to be offset by the capture of carbon as the biomass regrows. Geothermal projects also typically produce no carbon emissions. However, for both biomass and geothermal projects, one must in some cases account for the project's emissions of methane or nitrous oxide (N_2O), GHGs more potent than CO_2. After the quantity of these emissions (in metric tonnes per year) are estimated, they are converted to converted to CO_2-equivalent emissions by multiplying by the appropriate IPCC global warming potential (GWP) coefficient for 100-year time horizon from Table 3 below.[7] The result represents the emissions generated by a CCMP in terms of CO_2-equivalent, and is deducted from the project's annual CO_2 emission reductions.

Table 3: Direct Global Warming Potentials (GWP) of Selected Gases

Gas	Direct Effect for Time Horizon of 100 years
Carbon dioxide, CO_2	1
Methane, CH_4	21
Nitrous oxide, N_2O	310

Source: UNEP/OECD/IEA/IPCC 1996

Losses in terrestrial carbon storage due to land-use change at a hydro project site might be significant if, for example, forest land is inundated by a hydro reservoir. However, forestry projects designed for watershed protection could store net carbon in protected

[7] The Global Warming Potential (GWP) allows one to express all GHGs on a comparable basis. The strength of all other GHGs is compared to that of CO_2, which is assigned a value of "1".

For the CCMP, the following information is necessary.

- Annual thermal generation (GJ/yr) (*generation projects only*)
- Reduction in annual thermal energy consumption (GJ/yr) (*efficiency projects only*)
- Type of fuel used (*generation projects only*)
- Source net thermal efficiency (%) or source annual fuel consumption (GJ/yr) (*generation projects only*)
- Emissions generated by CCMP (t C/year)

The task of quantifying the production of thermal energy from generation projects is quite straightforward. It can be accomplished using measurement and reporting systems that will, in all likelihood, already be a part of each project. These projects usually will, as a matter of course, include measurement systems that measure and record thermal energy production. If such systems are available, no additional monitoring equipment will be necessary for the quantification of thermal energy generation.

Monitoring reductions in energy consumption in efficiency projects is inherently more difficult. However, efficiency projects often include an M&V plan to quantify energy savings. If this is not the case, a plan should be developed. A discussion of M&V procedures for the wide variety of possible energy efficiency measures is beyond the scope of this toolkit. One source for such information is the *International Performance Measurement and Verification Protocol* (DOE 1997).

If emissions are generated by the CCMP, additional monitoring of the project may be required to quantify these. See Step 5 below for further information on the mechanisms by which CCMPs can generate emissions.

Step 2: Update project boundary definition
For a project that displaces thermal energy generation, the project boundary is typically compact. In these cases, the boundary includes the project site and the equipment that generates the thermal energy. The central question to answer through M&V is whether the project boundary has changed from the initial definition.

Step 3: Identify the appropriate baseline source
Because there are only one or a few generation sources in a CCMP displacing thermal energy generation, the baseline source is easy to identify. It is simply the source(s) whose output the CCMP will displace. As with the project boundary, M&V should determine whether the baseline generation source has changed over time.

Step 4: Calculate baseline carbon emission rate
The next step is to calculate the carbon emission rate of the baseline generation source using the data gathered through monitoring. The emission rate can be calculated using the carbon content of the fuel combusted (from Table 1 in M&V Protocol 1) and one of

the following two equations. The information available for each plant will determine the proper equation to use. Note that the calculated emission rate is t C per GJ of thermal energy output, while the carbon content is t C per GJ of fuel input.

If the dimensionless thermal efficiency of the generation source is known, use the following equation:

$$\text{Baseline emission rate (t C/GJ)} = \frac{\text{Carbon content of fuel (t C/GJ)}}{\text{Net thermal efficiency of plant}}$$

Finally, the emission rate can be derived directly from annual fuel consumption data, together with the corresponding annual generation data. If the fuel consumption data are expressed in mass or volume (such as liters of diesel fuel) rather than energy units (GJ/yr), the heating value of the fuel (GJ per mass or volume) will also be required.

$$\text{Baseline emission rate (t C/GJ)} = \frac{\text{Annual fuel consumption (GJ/yr)} * \text{Carbon content of fuel (t C/GJ)}}{\text{Annual energy generation (GJ/yr)}}$$

Step 5: Calculate emission reductions

After determining the baseline emission rate in Step 4, the calculation of net carbon emission reductions (expressed in metric tonnes of carbon per year, t C/year) from the CCMPs is fairly straightforward. The emission reductions equal the emissions that would have been produced in the absence of the CCMP (the generation displaced by the CCMP multiplied by the emission rate of the baseline source) minus the emissions generated by the CCMP.

$$\text{Net emission reductions (t C/yr)} = [\text{Generation displaced by CCMP (GJ/yr)} * \text{Baseline emission rate (t C/GJ)}] - \text{Emissions generated by CCMP (t C/year)}$$

The generation displaced by the CCMP is the reduction in the baseline source's generation due to the CCMP. For an alternative energy production CCMP, in which a less carbon-intensive source (renewables, natural gas, etc.) is used to generate thermal energy, the generation displaced is typically equal to the energy produced by the CCMP. If, however, the CCMP totally eliminates the operation of the baseline source, the generation displaced is simply the baseline source's generation.[9] For an energy efficiency CCMP, the generation displaced is equal to the reduction in thermal energy consumption resulting from the CCMP. For both cases, measured data from the M&V process should be used.

[9] An example of this would be a solar hot water system that replaced a fossil-fuel water heating system. The fossil-fuel system, due to high fuel costs, may have limited operation. The solar system would be much less costly to operate, so it may produce much more hot water than did the generator. In this case, the generation displaced would be equal to the fossil-fuel system's output, not the solar system output.

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The emissions generated by the CCMP depend on the type of project implemented. All aspects of the CCMP activities should be evaluated to identify and quantify any such emissions. Mechanisms that can produce such emissions are indirect fossil fuel use, non-CO_2 greenhouse gas (GHG) emissions, and land use change. Table 4 and the discussion that follows identify the possible mechanisms for and significance of these emissions.

Table 4: Potential Sources of Emissions from Thermal CCMPs

CCMP Type	Potential Sources of Emissions from CCMP
Thermal generation:	
Fossil fuel	Fossil fuel combustion
Biomass	Release of non-CO_2 greenhouse gases
Other renewable (solar)	Typically none
Energy efficiency	Increased on-site electricity usage

The emissions generated by the CCMP can be significant in CCMPs that involve fuel switching or methane recovery, where cleaner burning fossil fuels are used for thermal energy generation. These emissions can be calculated by multiplying the carbon emission rate of the source (t C/GJ) by the source's annual generation (GJ/yr). (Follow Steps 4 and 5 in this M&V Protocol 3.)

The emissions generated by other types of CCMPs will typically be negligible, because the primary source of net emission reductions for CCMPs that thermal energy production is the reduction in fossil-fuel use at thermal generating stations that can be displaced by the CCMPs. As such, detailed procedures for calculating the emissions generated by the CCMP are not presented in this toolkit. These procedures can be found in UNEP/OECD/IEA/IPCC 1996 and World Bank 1998.

Any type of thermal generation CCMP may have associated increases in fossil fuel use resulting from standby generator operation, transportation of materials or fuel, project construction, biomass fuel production and other upstream or downstream activities.

Thermal generation through combustion of biomass fuel produces no net carbon emissions if the biomass is produced sustainably within the project, because the carbon emissions produced during combustion are assumed to be offset by the capture of carbon as the biomass regrows. Geothermal projects also typically produce no carbon emissions. However, for both biomass and geothermal projects, one must in some cases account for the project's emissions of methane or nitrous oxide (N_2O), GHGs more potent than CO_2. After the quantity of these emissions (in metric tonnes per year) are estimated, they are converted to converted to CO_2-equivalent emissions by multiplying by the appropriate IPCC global warming potential (GWP) coefficient for 100-year time horizon from Table 3 in M&V Protocol 1. The result represents the emissions generated by a CCMP in

terms of CO_2-equivalent, and is deducted from the project's annual CO_2 emission reductions.

Energy efficiency projects will typically result in no carbon emissions. However, some efficiency projects reduce thermal energy consumption but increase electricity use. In addition, parasitic electricity use in thermal generation projects can result in increased emissions. The indirect emissions from increased electricity use can be calculated using the procedures in M&V Protocol 1 for CCMPs that displace electricity generation.

The emission reductions are finally converted to metric tonnes of carbon dioxide per year (t CO_2/yr) by multiplying by ratio of the molecular weights of carbon dioxide and carbon.

Net emission reductions (t CO_2/yr) = Net emission reductions (t C/yr) * [44 t CO_2 / 12 t C]

This procedure outlined here applies if there is only one generation source displaced by the CCMP. If there are multiple sources, the carbon emission rate can be calculated by dividing the total carbon emissions (t C/yr) of all sources by the total generation (GJ/yr). The total carbon emissions is the sum for each plant of the plant's emission rate (t C/GJ, calculated below) multiplied by the total generation of the plant (GJ/yr).

A related CCMP is the replacement of kerosene lighting with electric lighting. (The burning of kerosene is analogous to generating thermal energy.) The net emission reductions from such projects are given by:

Kerosene lighting net emission reductions (t C/yr) = [Reduction in kerosene consumption (GJ/yr) * Carbon content of kerosene (t C/GJ)] – Emissions generated by CCMP (t C/year)

If the kerosene consumption data are expressed in mass or volume rather than energy units (GJ/yr), the heating value of kerosene (GJ per mass or volume) will also be required. The kerosene carbon content can be found in Table 1. The emissions generated by the CCMP should be carefully evaluated and will depend on the electricity source. Renewable electricity sources, such as solar or wind, will typically have no associated emissions. If electricity is provided by the grid, the resulting emissions from increased grid electricity generation can be calculated using the procedures in M&V Protocol 1 for CCMPs that displace electricity generation.

M&V Protocol 4: Methane recovery CCMPs

This procedure specifically addresses CCMPs that generate electricity or thermal energy by burning methane recovered from coal mines, landfills or agribusiness facilities.[10] Two

[10] Recent policy initiatives governing waste material that may be deposited in landfills in India may limit the attractiveness of landfill methane gas recovery projects. Nevertheless, there are likely to be significant opportunities for biogas production and utilization in agricultural as well as municipal settings.

M&V Protocols are required for these methane recovery projects, because they reduce greenhouse gas emissions in two ways. First, they reduce carbon dioxide emissions by displacing electricity or thermal generation from some baseline source. These carbon emission reductions should be quantified using M&V Protocol 1, 2, or 3, as appropriate. Secondly, methane recovery projects reduce the emissions of methane (a greenhouse gas) by burning the methane in a generator. This procedure, M&V Protocol 4, is used to quantify these methane emission reductions.

Step 1: Gather required data
Data will be gathered for methane recovery CCMPs as required for either M&V Protocol 1, 2, or 3. The one additional piece of information necessary for M&V Protocol 4 is the amount of methane burned to produce electricity or thermal energy. This can be expressed in mass, volume, or energy terms (t CH_4/yr, m^3 CH_4/yr, or GJ/yr). Because this parameter may change over time, the primary purpose for monitoring activities is to obtain current, measured data. Doing so will allow for accurate quantification of actual emission reductions resulting from the CCMP. This data should be directly measured to the extent possible.

Step 2: Update project boundary definition
For a methane recovery CCMP, the project boundary includes the source of methane and the generation equipment in which it is combusted. The central question to answer through M&V is whether the project boundary has changed from the initial definition.

Step 3: Identify the appropriate baseline source
The baseline source is simply the source from which the methane is recovered. This may be a coalmine, landfill, agribusiness facility, or other source. As with the project boundary, M&V should determine whether the baseline generation source has changed over time.

Step 4: Calculate baseline carbon emission rate
This step is not applicable to calculating methane emission reductions for methane recovery projects.

Step 5: Calculate emission reductions
In methane recovery projects, methane emissions are reduced by burning the methane to generate electricity or thermal energy. Thus, the annual methane emission reductions are equal to the annual methane input to the generator. In these calculations, data gathered through monitoring should be used.

The methane input to the generator must first be converted to tonnes of methane per year (t CH_4/yr) using one of the following equations. If the methane input is known in volumetric terms (m^3/yr), it can be converted to tonnes per year using the density of methane. Ideally, the actual density of the on-site methane should be measured. Otherwise, the standard density of 7.167×10^{-4} t CH_4/m^3 CH_4 can be used.

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Methane emission reductions (t CH_4/yr) = Methane input to generator (m^3 CH_4/yr) * Methane density (t CH_4/ m^3 CH_4)

If the methane input is known in terms of energy (GJ/yr), it can be converted to tonnes per year using the heating value of methane. Again, the actual heating value of the on-site methane should ideally be measured. Otherwise, the standard value of 45.0 GJ/t CH_4 can be used.

$$\text{Methane emission reductions (t } CH_4\text{/yr)} = \frac{\text{Methane input to generator (GJ/yr)}}{\text{Methane heating value (GJ/t } CH_4\text{)}}$$

The methane emission reductions are then converted into CO_2-equivalent emissions, which is the common unit by which GHG emissions are measured. This is done by multiplying the methane emission reductions by the methane global warming potential (GWP) from Table 3, which is 21.

CO_2-equivalent emission reductions (t CO_2-equiv./yr) =
Methane emission reductions (t CH_4/yr) * [21 t CO_2-equiv. / t CH_4]

If necessary, the emission reductions can be expressed in terms of carbon-equivalent emissions by multiplying by ratio of the molecular weights of carbon and carbon dioxide.

Carbon-equivalent reductions (t C-equiv./yr) = CO_2-equivalent reductions (t CO_2-equiv./yr)* [12 t C / 44 t CO_2]

Application of procedures to non-energy CCMPs

Energy generation and energy efficiency CCMPs are by no means the only type of CCMP that a project developer may encounter. Some examples of other types of CCMPs are:

- A methane flaring project, in which methane is burned rather than released directly. This reduces methane emissions, though increases carbon dioxide emissions
- A transportation project that reduces emissions from mobile sources, while perhaps increasing emissions from electricity generation or other sources
- A reforestation project that increases the carbon sequestration rates
- A project that reduces agricultural methane emissions

For other types of CCMPs, the Baseline Toolkit describes how to construct an appropriate baseline and calculate emission reductions. The M&V principles and procedures in this toolkit also apply to non-energy CCMPs. For any type of CCMP, the goal of M&V is first to collect actual data for the inputs to the emission reduction

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calculations and then use that information to calculate actual emission reductions for the CCMP. In this way, the procedures presented in this toolkit can be used as conceptual tools for use in the broader field of CCMPs.

Supporting Materials

Published M&V protocols

U.S. Department of Energy (DOE). 1997. *International Performance Measurement and Verification Protocol*. Washington, D.C. [An updated version is partially complete. See www.ipmvp.org.]

Vine, E. and J. Sathaye, 1997. *The Monitoring, Evaluation, Reporting, and Verification of Climate Change Mitigation Projects: Existing Protocols and Guidelines*. LBNL-40316. Berkeley, CA: Lawrence Berkeley National Laboratory. Available at http://eande.lbl.gov/EA/ies/sumi6/climatechange/40316.pdf.

Vine, E. and J. Sathaye, 1999. *Guidelines for the Monitoring, Evaluation, Reporting, Verification, and Certification of Energy-Efficiency Projects for Climate Change Mitigation*. LBNL-41543. Berkeley, CA: Lawrence Berkeley National Laboratory. Available at http://eetd.lbl.gov/ea/ies/sumi6/climatechange/41543.pdf.

Vine, E., J. Sathaye, and W. Makundi, 1999. *Guidelines for the Monitoring, Evaluation, Reporting, Verification, and Certification of Forestry Projects for Climate Change Mitigation*. LBNL-41877. Berkeley, CA: Lawrence Berkeley National Laboratory. Available at http://eetd.lbl.gov/ea/ies/sumi6/climatechange/41877.pdf.

World Bank. 2000b. "Validation, Verification and Certification for PCF Projects; PCF Implementation Note Number 4." Washington, D.C.

World Bank. 2000c. "Latvia Monitoring and Verification Protocol (MVP)." Prototype Carbon Fund. Washington, D.C.

Case studies

Swisher, J.N., 1994. "Forestry and Biomass Energy Projects: Bottom-Up Comparisons of CO_2 Storage and Costs," *Biomass and Bioenergy*, vol. 6 no. 5, pp. 359-368.

Reference materials

Figueres, Christiana; "The Achievements of COP 6: Yes, the Achievements!"; Center for Sustainable Development in the Americas; December 2000.

International Energy Agency (IEA), 1997. Activities Implemented Jointly: Partnerships for Climate and Development, OECD, Paris.

Michaelowa, A., 1999. "Template for baseline studies for World Bank AIJ, CDM and JI projects," Study for the World Bank Climate Change Team. Washington, D.C.

UNEP/OECD/IEA/IPCC (United Nations Environment Programme, Organisation for Economic Co-operation and Development, International Energy Agency, Intergovernmental Panel on Climate Change). 1996. *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual (Volume 3)*. IPCC: Bracknell, UK. Available at http://www.ipcc.ch/pub/guide.htm.

World Bank. 1998. *Greenhouse Gas Assessment Handbook*. Environment Department. Washington, DC. Available at http://wbln0018.worldbank.org/essd/kb.nsf/ab34a7716339450985256666007c9ca9/901594d74185a58885256761007cbefd?OpenDocument.

World Bank. 2000a. "Baseline Methodologies for PCF Projects; PCF Implementation Note Number 3." Prototype Carbon Fund. Washington, D.C.

Greenhouse Gas Pollution Prevention-Climate Change Supplement (GEP-CCS)

Fostering Climate Change Initiatives for Sustainable Development

Monitoring and Verification Toolkit

The Louis Berger Group, Inc.

What is Monitoring and Verification?

- In developing a baseline, projections are made about future parameters.
- M&V is the process of measuring these parameters, then updating the emission reduction calculations accordingly.

Why is M&V Important?

- The baseline emission rate and actual CCMP emission reductions must be measured and monitored in order document and quantify the project's performance.
- M&V plan must be prepared and validated during the design stage to ensure consistency in the measurement indicators that will be used throughout the project.

International M&V Requirements

- There are currently no internationally mandated M&V standards, but they are expected in the future.
- Technically credible M&V plans are considered an essential part of a carbon offset project plan and are required in many national certification programs.

International M&V Requirements

⇩ Indicators of future requirements:

- International Funding Mechanisms
  - » Emissions reductions must be independently certified as: Real, Measurable, Long-term, and "additional to any that would occur in the absence of the certified project activity"
  - » Third-party verification
- Prototype Carbon Fund
- *International Performance Monitoring and Verification Protocol* (IPMVP)

M&V Checklist

- ❑ Have you categorized your project for an appropriate M&V plan and identified an appropriate plan?
- ❑ At what stage of development is your project and when will M&V begin?
- ❑ Do you have capacity to develop an M&V Plan that is specific to your project?
- ❑ Do you have capacity to implement the necessary monitoring?
- ❑ Have you supplemented the information in this toolkit with information from other sources on M&V design?
- ❑ Has your M&V plan been approved by an outside party?

Organize an Internal Plan for Implementing M&V

1. Identify a person to manage the M&V process
2. Gather information from similar projects on M&V protocols, consult with experts
3. Review and assess the M&V design
4. Identify technological requirements for M&V
5. Identify technical skills required for M&V
6. Identify funding sources for M&V
7. Initiate M&V at appropriate time

Standardized M&V Protocols

- The purpose of M&V is to measure current data for specific parameters that may change over time.
- Standardized protocols are developed for selected project types:
  - Energy CCMPs that displace grid-generated electricity
  - Energy CCMPs that displace off-grid electricity
  - Energy CCMPs that displace thermal energy generation
  - Methane recovery CCMPs

Step 2 – Update Project Boundary Definition

- Central question: has project boundary changed from the initial definition?
  - Plants added to or retired from the grid?
  - Have state grids been linked to national grid?
- New project boundary will require new baseline and project case calculations.

Step 3 – Identify the Appropriate Baseline Source

- As with the project boundary, M&V should determine whether the baseline generation sources have changed over time.

Step 4 – Calculate Baseline Carbon Emissions Rate

- After identifying the baseline sources to be displaced by the CCMP, calculate the carbon emission rate of these sources *using the measured data gathered in the M&V process.*
- Determine the weighted average marginal emissions rate, for CCMPs that displace…
  - Grid generated electricity – the baseline depends on the installed generation capacity and fuel mix for plants on the margin.
  - Off grid electricity and thermal energy generation – use the carbon content of the fuel combusted to calculate the baseline emission rate

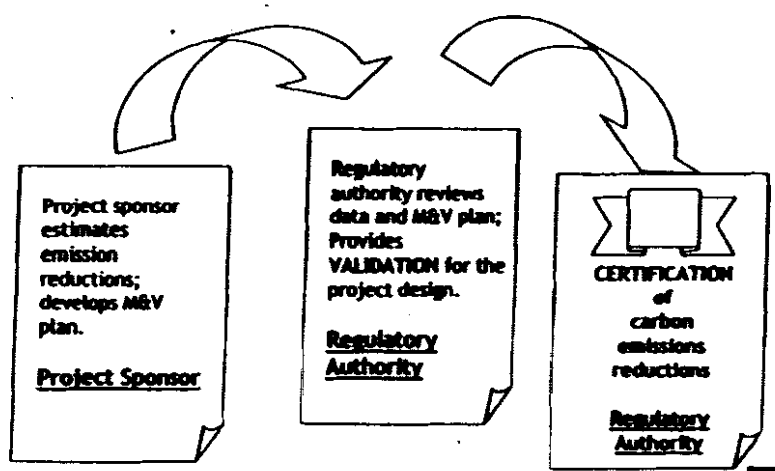
Step 5 – Calculate Emission Reductions

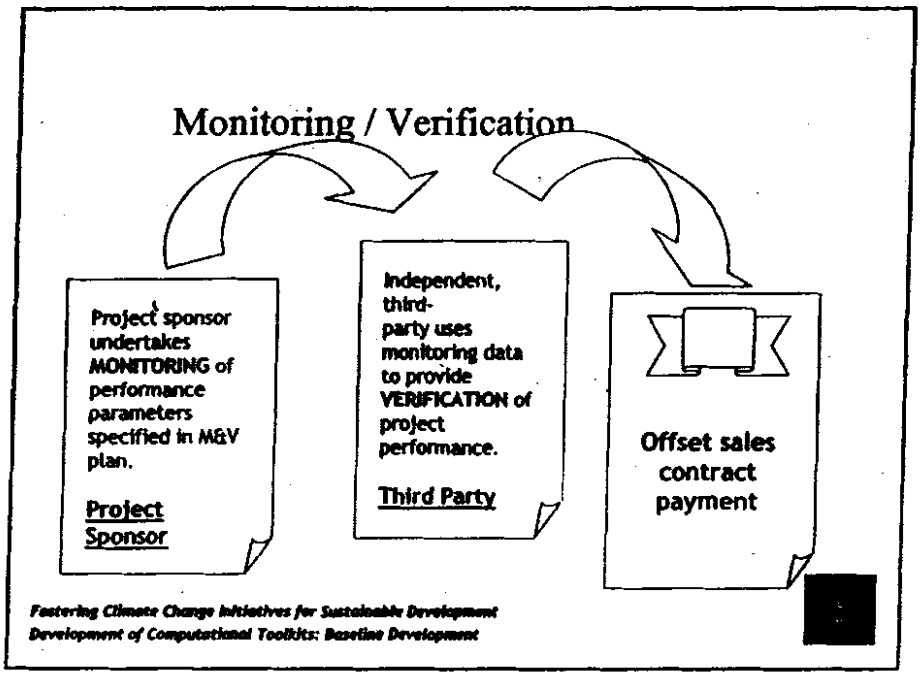
- Calculate emission reductions *with measured data from the M&V process.*

Application of Procedures to Non-energy CCMPs

- The toolkit addresses energy CCMPs.
- The M&V principles and procedures in this toolkit also apply to non-energy CCMPs.

Validation / Certification




Monitoring / Verification
Project sponsor undertakes MONITORING of performance parameters specified in M&V plan.
Project Sponsor
Independent, third-party uses monitoring data to provide VERIFICATION of project performance.
Third Party
Offset sales contract payment
Fostering Climate Change Initiatives for Sustainable Development
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Computational Tool Kit: Marketing & Funding

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DRAFT

United States Agency for International Development
Greenhouse Gas Pollution Prevention Project
Climate Change Supplement
(GEP-CCS)

Fostering Climate Change Initiatives for Sustainable Development

Task 1C
Computational Tool Kit: Marketing & Funding

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May 14, 2001

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Executive Summary

This toolkit is the last in the set of guides developed to assist project developers and sponsors through the process of planning and implementing Climate Change Mitigation Projects (CCMPs). The Marketing and Funding Toolkit is intended to provide Climate Change Centers (CCCs) and developers of CCMPs and clean energy projects, along with the Carbon Finance Toolkit, with information and assistance that will allow them to complete the process of procuring project funding and sell the resulting carbon credits.

The toolkit consists of five primary sections:

1. Introduction
2. Assessment Criteria
3. Implementation
4. Supporting Materials
5. Funding Sources for CCMP Projects

By the time the developer is ready to begin the process of approaching potential funders, they should have already completed the initial stages of development. Developers should have a very good understanding of all of the elements of their project and should be confident that their project will be successful based on an initial analyses.

When preparing to approach potential funders, the key information that must be provided at a minimum includes:

- Expected total project cost (in stages or phases if required);
- Projected revenues from the sale of goods or services (energy sales, consumer products, expected savings/avoided costs resulting from project);
- Assessment of market penetration and growth potential;
- Risks to project realization (technical, financial, regulatory);
- Local economic, social and environmental impacts of the project; and
- Preliminary pro-formas, if available.

These assessment criteria will assist the developer in planning to eventually approach funding sources as they move through the development process. By keeping these questions and criteria in mind, the developer will be better prepared and will know the appropriate time to consider various elements that are appropriate to the presentation of their project to funders.

In their simplest forms, there are three types of financing for any given project: (1) grant financing, (2) debt financing, and (3) equity financing. While knowledge of specifics of these types of financing instruments is not necessary for the purpose of approaching funders, it is helpful to know and understand how each of these types of financing instruments will impact the project.

The importance of risk evaluation in the development and financing of CCMPs cannot be understated. The level of risk in the project will have a substantial impact on the availability and cost of financing and therefore it is important for CCMP developers to carefully consider all of the potential risks that their project may encounter in conjunction with the level of risk that the targeted lenders will accept and must develop satisfactory mitigation plans accordingly and as appropriate.

A fair and honest exploration of the risks inherent in the development process is critical to attracting investor interest. Project presentations should include identification of the main risks to the project (technical, commercial, and regulatory). As explained in the carbon financing toolkit, there is a fundamental relationship between perceived risk and expected return that drives the cost and availability of funding.

During the period from six to twenty-four months in the project development cycle, a full-scale technical and financial feasibility study of the project should be completed, including initial financial pro formas. An objective feasibility analysis will help the developer to address perceived risks and establish the conditions that will contribute to the project's success. The feasibility study will feed into the project presentation document and demonstrate to potential funders the commercial viability of the project. Project developers should also begin the process of securing revenue streams from power or other product sales as well as host country approval for any anticipated carbon offsets as soon as the technical viability of the project is clear.

Once the project's technical and financial viability have been established, the developer must begin to prepare a project presentation document that will be offered to funders. Essentially a business plan, this document is a concise description of the project concept, goals and objectives; the market; preliminary financial analysis; and technical and legal justifications for pursuing the project path. The credibility and presentation of this document is very important to successfully funding the project. When a sound business plan has been constructed, the developers should contact potential funders and send the business plan out for review prior to scheduling interviews.

While it may be possible for developers to market their business plan to funders whose investment criteria include the rights to the carbon credits that result from the project, this may not always be the case. In many cases, it will not be possible for developers to obtain project financing tied to carbon credits and the process of presenting the project may have to be repeated with potential carbon buyers.

There are many potential sources of funding for CCMP and clean production projects. Section four provides a catalog of potential funding sources that offer project financing and investments on commercial terms as well as those offering grant funding and various forms of investments for projects that may involve higher-risk or lower return but that meet environmentally-focused objectives. In addition, the catalog provides information

on several financial intermediaries and brokerage firms that offer support in the development of financial structures and transactions that incorporate carbon credits.

1. Introduction

This toolkit is the last in the set of guides developed to assist project developers and sponsors through the process of planning and implementing Climate Change Mitigation Projects (CCMPs). The Marketing and Funding Toolkit is intended to provide developers of CCMPs and clean energy projects, along with the Carbon Finance Toolkit, with information and assistance that will allow them to complete the process of procuring project funding and sell the resulting carbon credits. The objective of the marketing and funding toolkit is two-fold: to help Climate Change Centers (CCCs) and project developers develop the ability to market their projects to investors, lenders and potential buyers of carbon credits; and to identify sources of debt and equity financing for projects as well as potential carbon buyers.

As with the other topics covered in this series of toolkits, the Marketing and Funding aspect of CCMP development is key to securing adequate funds to complete the development of the project – without funding, the project cannot be implemented – and to realizing the additional revenue streams that may be obtained from carbon sales. Because CCMPs have a different risk profile compared with other, more conventional power projects, it is essential that developers have a clear understanding of the special considerations involved in procuring funding for their projects as well as the specific range of funding sources that are available and their requirements. This toolkit is designed to help developers identify the funding available to CCMPs and Clean Energy projects and target the presentation of their project specifically to these sources, matching their project presentation to the specific interests and objectives of funding sources.

Targeted investors in energy sector project development include both conventional, commercially-oriented investors and unconventional, environmentally-oriented investors. Investment opportunities for CCMP projects may take many forms. Equity or debt funding may be targeted specifically to sustainable development (SD) activities and may or may not require a stake in the carbon offsets that are generated. Marketing projects to investors requires the ability to package and present projects – to sell projects – in a way that meets the investors' expectations and needs. Developers need to understand that funding scenarios for CCMPs can cover a range of financial structures and be flexible in designing a funding agreement that meets both the needs of the project and covers the objectives of the investor.

Eligibility criteria may vary among potential funding sources, but they all use some form of risk-versus-return assessment of projects. In addition, funds that are specifically targeted to SD activities often require that projects meet specific targets for environmental, social and economic sustainability. It is strongly recommended that project developers research the eligibility criteria of individual investors and address these specifically in the project presentation. The strengths and weaknesses of the project

as presented by the project developer, should represent risk and return decisions for the investor based on their own particular interests and goals in investing.

Funding sources are not all alike. Private investors with solely commercial interests will review projects with a focus on the risks to cash flow that may jeopardize retained earnings and in turn, degrade internal rates of return. Specialized funds, such as those which include environmental objectives, may accept some level of higher risk to cash flows in exchange for a stronger likelihood of meeting those non-commercial goals.

The term "marketing" as it is used in this toolkit, refers to a process of analyzing, packaging and presenting projects to potential investors and funding agencies. Successful marketing of a project requires in-depth knowledge of its strengths and weaknesses from a number of perspectives (i.e. technical, financial, economic), and an ability to communicate those strengths and weaknesses to investors in terms they can understand.

This toolkit combines (1) an explication of the fundamental requirements of project presentation (financials, commercial, regulatory and economic risks and mitigating securities, etc.), (2) examples of project presentations, and (3) critical information on sources of public and private financing for projects. The following summarizes the information contained within this document by section.

- Section 2: *Assessment Criteria* outlines the basic parameters for evaluating a CCMP in terms that are relevant and understandable to potential financiers and includes a critical path diagram showing the steps relative to generating an appropriate project presentation for funders.

- Section 3: *Implementation* outlines the relationships between project development phases and project risks and identifies steps that a project developer must take to preparation for approaching funding sources. Specifically within this section:
  - *Investment and Risk* describes the importance of risk and identifies different types of risk associated with the project development cycle.
  - *Sharing the risk* describes how to use financial risk analysis to generate a risk-return profile for different types of funding sources. The Carbon Finance Toolkit provides detailed information on the types and sources of project, market and financial risk with quantification and mitigation techniques and should be used as a reference in reporting potential risks and mitigation techniques to investors.
  - *Feasibility Study Analysis* outlines the purpose and importance of generating a sound, objective feasibility analysis to address perceived risks and establish the conditions that will contribute to the project's success. The feasibility study will feed into the project presentation document and demonstrate to potential funders the commercial viability of the project.

- *The Business Plan* section provides a template for presenting projects to potential funders that can be customized to a given project developer's needs and goals. This section outlines the basic distinctions between project financing and carbon credit sales and explains how CCMP developers can structure project financing that includes the rights to carbon credits, or treats the two as distinct transactions.
- *Marketing Carbon Credits* demonstrates how to identify and approach interested carbon buyers and provides a template "Project Brief" which may be customized to meet individual carbon buyer's requirements.
- *Financial Additionality* describes this issue and its importance in utilizing carbon credits to support project financing and acquiring approval of and buyers for carbon credits.

- Section 3: provides a detailed case study of a successful energy efficiency project, which demonstrates an innovative financial structure that includes carbon offset revenues to support the project.

- Section 4: provides a catalogue of available sources of funding for CCMP project development in India as well as other resources that may be of use.

2. Assessment Criteria

Before approaching sources of private and public financial support, project developers must first review and assess their own project in terms that are relevant and understandable to potential financiers. By the time the developer is ready to begin the process of approaching potential funders, they should have already completed the initial stages of development. They will have identified a site and have generally chosen the technologies they intend to use. They have completed an in-depth feasibility study (described in section 3), including at least preliminary financial projections for their project and will have measured the potential of generating carbon offsets from the project. Developers should have a very good understanding of all of these elements of their project and should be confident that their project will be successful based on these initial analyses.

When preparing to approach potential funders, the key information that must be provided at a minimum includes:

- Expected total project cost (in stages or phases if required);
- Projected revenues from the sale of goods or services (energy sales, consumer products, expected savings/avoided costs resulting from project);
- Assessment of market penetration and growth potential;
- Risks to project realization (technical, financial, regulatory);
- Local economic, social and environmental impacts of the project; and
- Preliminary pro-formas, if available.

Checklist

These assessment criteria will assist the developer in planning to eventually approach funding sources as they move through the development process. By keeping these questions and criteria in mind, the developer will be better prepared and will know the appropriate time to consider various elements that are appropriate to the presentation of their project to funders. Later stages of the development process such as risk assessment

and feasibility study will be more transparent and the project proposal will be more complete.

The critical path diagram below illustrates the cognitive process for preparing a project presentation from initial project identification through approaching funding sources.

Figure 1: Critical Path Diagram

Project Identification

CCMP Developer Assessment and Review of own project in terms Relevant to Potential Funders

Assessment Criteria

Key Information:

- Expected total project cost
- Projected revenues from sale of goods or services
- Risks to project realization
- Local economic, social and environmental impact of the project
- Preliminary pro-formas, if available

Key Questions to Ask Yourself Before Seeking Funding:

- At what point in the project development cycle is the project, with regard to: development, financing needs and risks?
- What are the next steps in the project development process (equity investment, bridge loan, technical support, grant funding)?
- What do individual financiers want to know most about the project (what are the financier's criteria)?

Risk Assessment

Feasibility Study
May require early stage funding

Project Proposal

Assessment of type of funding required

Approach Funding Sources

DEBT | **GRANT** | **EQUITY**

Secure revenue streams from power or other product (steam, hot water) sales as soon as technical viability of the project is clear.
When possible potential buyers should submit letters of interest to potential investors as a reassurance of the developer's ability to pay debt servicing.

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It is important to note, as is the case in the carbon finance toolkit, project developers and sponsors must have a clear understanding of where they are in the project development and financing cycle and how each phase in the development process relates to perceived risk on the part of financiers before they approach funding sources (see Figure 33). Furthermore, project developers must have a sound understanding of their project in terms of both its "bankability", in other words where the project would fall in a spectrum of risk versus projected return, and in terms of what funding sources would be available to the sponsor given its position within the spectrum and given the objectives and goals of specific funding sources.

The following checklist provides a tool for CCMP developers for use in evaluating whether their project is ready for presentation to potential funders. Evaluated in terms of the number of "yes" versus "no" answers, the checklist provides an overview of the project's readiness for presentation. Please note that the checklist contains items that are not specifically targeted to CCMPs but rather to project development in general, some of which may not have been covered specifically in the toolkits. These items are no less important to securing project funding and must be performed as a matter of course in any project development activity.

CCMP Presentation Readiness Checklist
1. A satisfactory feasibility study and financial plan have been prepared
2. The cost and availability of the fuel or other raw materials that will feed the project has been assured
3. A market exists for the product or service to be produced
4. The project partners/sponsors are experienced and reliable
5. The operator is experienced and reliable
6. The intended technology is proven and reliable
7. Contractual agreements are in place and satisfactory
8. A stable and friendly political environment exists, licenses and permits are available, contracts can be enforced, legal remedies exist
9. All potential political, financial, technical, development and economic risks have been adequately assessed and mitigation plans are in place
10. The key stakeholders have made an adequate equity contribution
11. Satisfactory appraisals of resources and assets have been obtained
12. Adequate insurance coverage is contemplated
13. All financial calculations have been completed and adequately documented, including carbon revenue streams
14. The project has adequate ROE and ROI for the investor

3. Implementation

Types of funding available and their relationship to project risks and project development

This section outlines the relationships between project development phases and project risks and identifies steps that a project developer must take to prepare to approach funding sources.

In their simplest forms, there are three types of financing for any given project: (1) grant financing, (2) debt financing, and (3) equity financing. Grant financing is provided by organizations and entities that are not expecting financial returns, but may have very strict expectations and requirements regarding the use of the funds. They are likely to require reporting or monitoring on the use of funds and accounting of all costs in assessing the value of the grant.

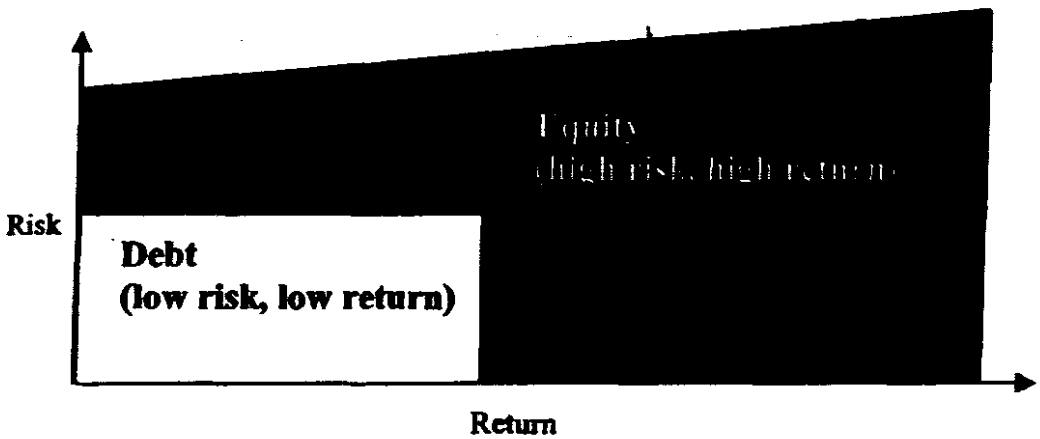
Debt financing refers to any kind of loan to the project, based on contractually defined terms regarding maturity and interest rate. Loans do not represent ownership in the project; on the contrary, debt financing seeks as little risk exposure as possible, and ownership in the project would constitute shared risk. Lenders will seek collateral for their loans in the form of physical property (assets), which may be appropriated by the lender in the case of default.

Equity financing provides funds in exchange for direct, proportional ownership in the project. Equity owners realize their value through distribution of profits (dividends distributed after taxes, debt-service) and through the eventual sale of their ownership stake at higher valuations. Equity owners bear more risk than lenders because if the project fails, they have no claim on other assets and are likely to lose their investment in the project.

Among these three, further differentiation reveals different types of grants, debt and equity. Different types of financing instruments, such as subordinated debt and working capital loans, are available for projects depending on the project needs and the best-suited overall financing package. Knowledge of specific types of financing instruments beyond debt, equity and grant financing is not necessary for the purpose of approaching funders. However it is helpful to know and understand how each of these types of financing instruments will impact the project.

Figure 2 below shows the relationship between equity and debt versus general project risk.

Figure 2: Debt/Equity vs. Risk Relationship



As mentioned above, firms raise investment capital in a number of ways. They can receive grant financing, borrow from banks and other financial institutions or they can issue various kinds of debt, stock, or other forms of equity. The combination of these types of funding is called a project's *capital structure*. Projects that have high levels of debt are said to be highly leveraged. Being highly leveraged in some cases can be very beneficial because a small positive percentage change in a firm's earnings (before interest and tax, EBIT) can translate into a large positive change in the project's net income (smaller share of earnings are paid out to equity investors). The methodology to measure the impact of your project's capital structure on the project earnings is described in the Carbon Finance Toolkit (Step 15).

Taxes play an important role in the impact of grant, debt, and equity financing on a project's earnings. Interest on debt is tax deductible in most countries, meaning that your income is lower because your project has taken on debt. Thus, by taking on debt as the income level increases, less of the project's earnings are required to go to the government in the form of taxes. To understand what value debt has to a company you can simply multiply the amount of debt by the tax rate. This will give you an additional amount of revenue annually that counts toward the value of the project. This will improve the value of the investment made by equity holders.

After reading the above section, a project developer might think that debt financing offers a substantial advantage over equity. It should be noted that project developers with substantial amounts of other *'tax shields'* may not want to pursue this strategy because these shields may push down earning to an artificially low level. In addition, equity investors may not be interested in a project with large amounts of debt. Projects that are perceived as overly leveraged will find it difficult to attract other funding, and in some

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cases may be considered in financial distress (or simply, bad investments). Each project developer should decide on a reasonable debt-equity level that takes profile maximization into account, as well as the interests of the equity holders. Few projects can be completely financed with debt, making the interests of equity holders of paramount importance.

Project Sponsors

Equity investors and lenders are not likely to give sponsors more than a non-committal "interest" in a project that is still in the conceptual stage, unless it is accompanied by strong, credit-worthy sponsors or some form of guarantee. In the absence of strong corporate backing or early guarantee, potential lenders and investors will need to know more specifics about the technical, commercial and regulatory risks inherent in the project, issues which can only be addressed through pre-feasibility and feasibility studies (discussed later in this document).

It is important to note that either debt or equity arrangements can include elements of carbon financing depending on the funder and the goals of the investment vehicle. It is up to the developer to understand the ways that carbon finance can be shaped and used with a project and to be flexible when presenting his project to potential funders. It would be wise for the project developers to create presentations tailored to several types of potential investors and funders and be sensitive to the specific requirements of the investor.

Investment and Risk

The importance of risk evaluation in the development and financing of CCMPs cannot be understated. The level of risk in the project will have a substantial impact on the availability and cost of financing and therefore it is important for CCMP developers to carefully consider all of the potential risks that their project may encounter in conjunction with the level of risk that the targeted lenders will accept and must develop satisfactory mitigation plans accordingly and as appropriate. This will be discussed in greater detail in the *Sharing the Risk* section below.

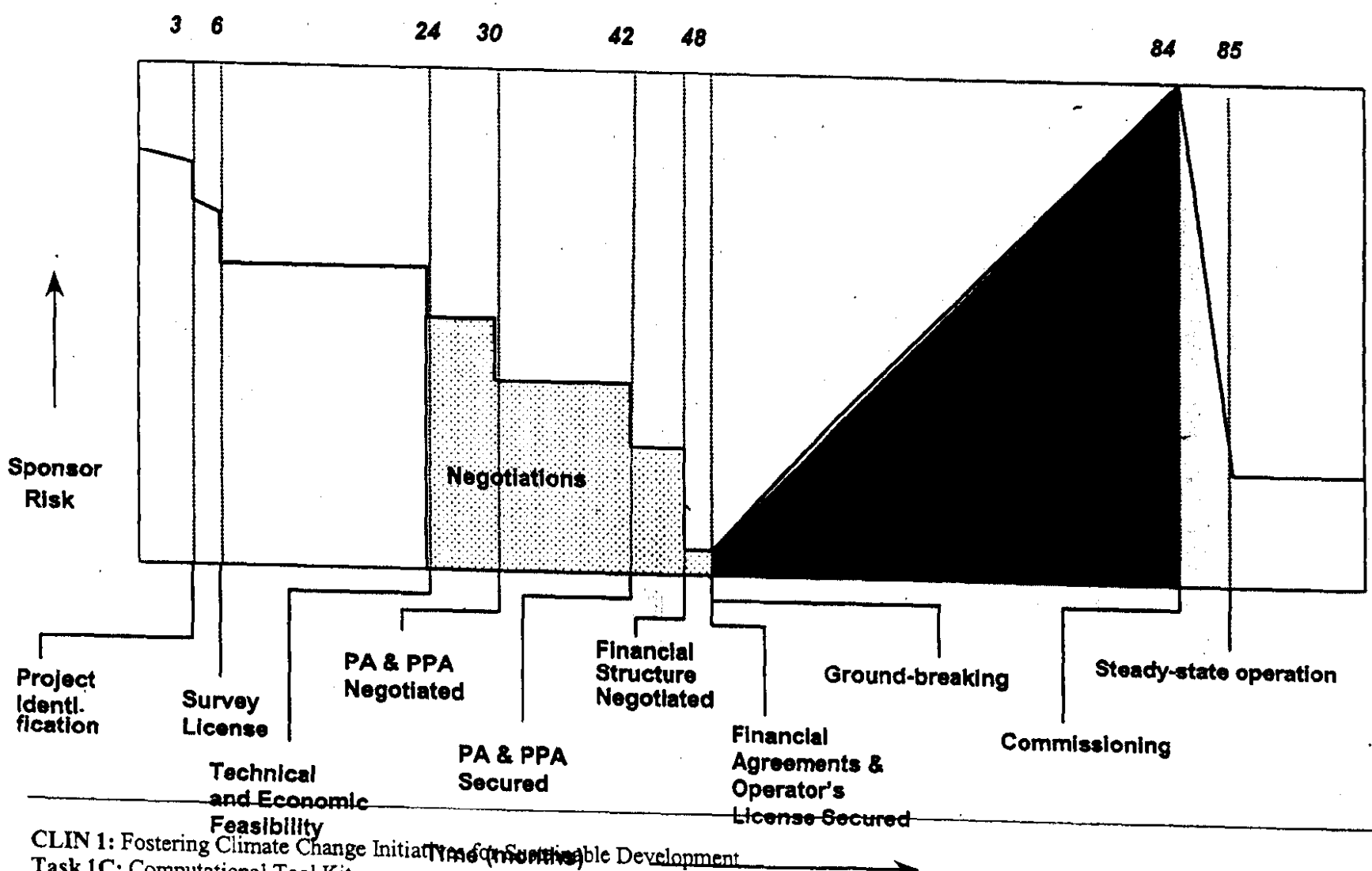
After assessing where they are in the project development path, developers can best understand the needs and concerns of funders by trying to understand their own project risks (see Carbon Finance Toolkit for a detailed list of project risks). Debt and equity investors are primarily concerned with any risk that could impact the timely repayment of their investment and return. For equity investors, this means concerns about the ability to complete the project and build value through successful operation and positive cash flows. The creation of value from their investment ensures their ability to realize gains from the future sale of their equity stake in the project. For lenders, the project must have "securities" such as enforceable sales contracts, other fixed assets, or corporate

sponsorship, as reassurance that their loan will be repaid in a timely fashion. In addition, lenders generally require that the project stakeholders have made a substantial investment in the project. Unless guarantees are available from very creditworthy guarantors, lenders will always require a substantial equity investment in a project as an assurance that sponsors will not walk away from the project.

Precisely how much risk mitigation and security has to be provided varies from funding source to source. Not surprisingly, lenders and equity investors will require more information on risks and risk mitigation plans the closer they are to making an investment decision. The amount of work put into providing this information is in large part the project developer's subjective decision, based on his/her discussions with potential funders.

Figure 3 on the following page shows a typical time/risk relationship for a medium-sized (60MW to 100MW) run-of-the-river hydro facility requiring high upfront capital costs and a relatively long period for construction. The periods used are therefore for reference only, and developers should sketch out their own development periods and schedule reflecting the relative costs and construction requirements of their technology (i.e. biomass-fired cogeneration typically requires two years from concept to completion).

Figure 3: Project Development and Risk Relationship for Run-of-the-River Hydro



As illustrated in Figure 3, the earliest stages of project development represent some of the highest risk to the participants. The sponsor, for example, must consider the opportunity cost of capital resources committed, including resources for project identification, country and project risk assessment (if an international project development), and initial cost estimations. In fact, resources committed at this *pre-investment* stage (sweat equity[1], internal funds, among others) must show a higher rate of return on a discounted basis than what the project will eventually show at the time of closing.

As development of the project proceeds, confidence may grow and the assessed risk may begin to fall. At the same time, more resources are committed and at risk, while unexpected costs are incurred and the discounted rate of return on the project begins to fall. This process of *pro forma degradation*, in which the expected return on the final project investment erodes in the pre-investment stage, continues until the estimated rate of return converges with the required rate of return for equity investment in the entire project, as identified by the sponsors (the real opportunity cost of capital plus risk premium). If the discounted rate of return falls too fast, the sponsor may withdraw from the project.

The risk profile in Figure 3 therefore, continues to decline from the perspective of the sponsor as confidence in the value of the project grows. Assessed risk reaches its lowest point when all of the legal and financial documents are secured. The proposed project now has an independent value that mitigates much of the sponsor's perceived risk based on its estimation of the opportunity cost of capital.

When key legal and financial documents have been secured, conventional risk analysis takes hold, based on the amount of funds committed. In a renewable energy or energy efficiency project with clearly defined contractual parameters, for example, the debt and equity that have been secured for the project are now dispensed to meet cash flow requirements during construction. The risk during this phase rises quickly because interest accumulates on debt funds without any offsetting revenue streams. For the same reason, risk at this time is also particularly sensitive to any cost or scheduling overruns. The financing of this phase is usually a mix of equity, subordinated debt, senior debt, and guarantees.

Referring to Figure 3, only after approximately three to six months of work on refining the project concept and researching risks and obstacles (permitting and licensing, for example) would it be reasonable to expect more than a non-committal interest from potential funders. At this stage, the developer should have a refined project proposal and a good understanding of the financing needs, regulatory hurdles (permits and licenses), and should be beginning discussions with potential project partners. With this

[1] "Sweat equity" includes materials and services provided at no or below cost in exchange for shares (ownership) in the project.

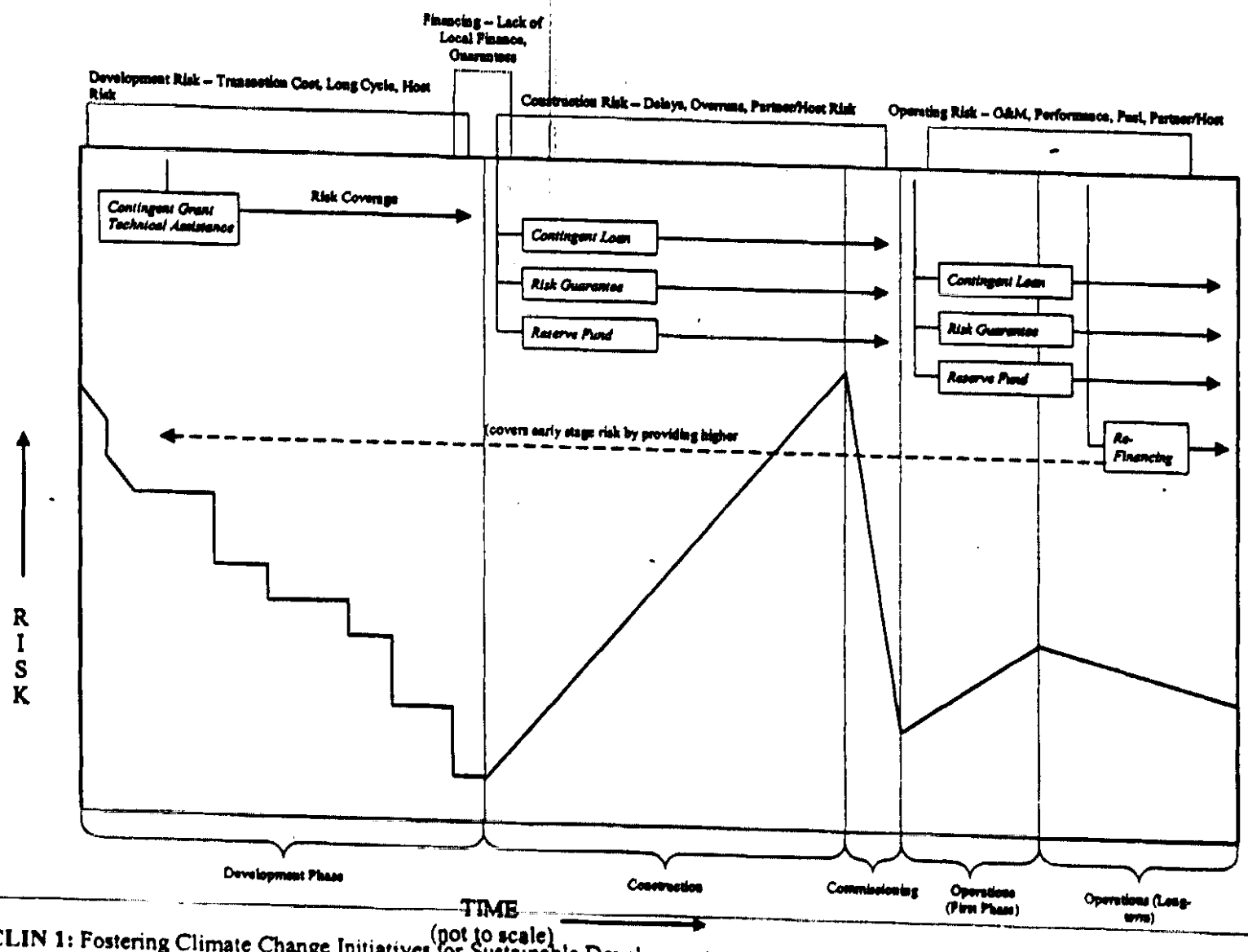
information clearly presented in an initial project document, developers should then research any available information on the criteria of a given funding source.

Sharing the risk

Steady-state operation of the project means it is generating revenues that are adequate to meet the cash flow requirements (O&M, debt servicing and return on equity requirements identified when the financial and legal documents were secured). Refinancing of the project is now possible. With the project risks greatly reduced, the required (forward-looking) rate of return is significantly lower, making it possible to reduce the cost of financing the operational phase of the project, thus improving the position of equity investors.

Figure 4 below superimposes the funding mechanisms of the Global Environment Facility (GEF) on the project risk and development diagram. This is useful for thinking about where you are in the project phases and what kind of funding instruments may be appropriate and available. GEF grant and non-grant funding sources correspond with the project development cycle and its three phases: (1) pre-construction, (2) the construction phase and (3) the operational phase. There are two areas of the project development cycle where GEF non-grant measures, such as concessional lending and loan guarantees are relevant: (1) pre-construction and (3) operation. The construction phase (2) is not appropriate for GEF support because risk is mitigated primarily through contractual obligations between the sponsor and the contractor.

Figure 4: Risk through the Project Cycle with Financing Modalities



A fair and honest exploration of the risks inherent in the development process (see Carbon Finance toolkit for a comprehensive list) is critical to attracting investor interest. Project presentations should include identification of the main risks to the project (technical, commercial, and regulatory). As explained in the carbon financing toolkit, there is a fundamental relationship between perceived risk and expected return that drives the cost and availability of funding.

Referring to Figure 4, during the (1) pre-construction phase, project developers take on greater risk that the project will not come to fruition and they will not be able to recuperate paid-in or "sweat" equity from successful closure of the project. This risk-sharing element of the development stage is important to maintain, because it helps to assure potential lenders that the developer has enough at stake to see the project through to completion.

However, the pre-construction phase of a CCMP, such as a renewable energy or energy efficiency project is likely to last longer and require more costly transactions relative to the total investment value than conventional project development. The lengthy period and high transaction costs associated with CCMP development therefore constitute barriers that can be addressed by existing concessional or dedicated funding sources. Because these costs occur at the pre-investment stage and put the entire project at risk, their relative importance is magnified in small projects, even though they may not represent a large fraction of the final investment.

Insurance can often offer a strong risk hedging strategy, particularly where the project involves international project stakeholders and equipment imports. Insurance programs designed to protect renewable energy firms against commercial and political risk can substantially strengthen the project presentation, enhancing the chances that lenders will make loans and investors will make investments. The Overseas Private Investment Corporation for example, offers a wide range of insurance programs to cover losses from political violence, currency convertibility and expropriation.

GEF contingent grants convert into loans if a project proves successful, addressing certain pre-investment costs, particularly early-stage development costs that require smaller, incremental funds. In other words, a contingent grant is capitalized as an overall project cost as the project moves to financial closure. For projects that enter commercial operation, a grant of this kind would be recovered when it is converted to part of the loan financing. If the project does not reach commercial operation, the grant is not recovered.

Concessional lending, grants and dedicated equity funding is often predicated upon addressing the high-transaction costs of the pre-construction phase of CCMP development. High transaction costs during the pre-construction phase can contribute to the higher total capital requirements of CCMPs. As a result, concessional lenders and/or risk-friendly environmental investors often want to know in some detail how they may

address higher transaction costs during the pre-construction phase to leverage commercial debt and equity participation later in the development cycle.

Because the risks of CCMP project development lead to higher return requirements and stricter lending terms, other forms of financing can be committed early and formalized later upon financial closure. Early, non-contractual commitments of financing instruments such as partial credit and risk guarantees or other concessional debt or equity can be very valuable in moving the project forward.

As for the operational phase, this is when the risks of financial or technical non-performance begin to decline. In some cases, however, the construction phase of the CCMP may be completed and guarantees and/or co-financing may be required at that time to secure take-off or long-term refinancing for steady-state operation. This can only be determined on a case-by-case basis.

Funders will want to know what measures the owners, investors and service providers are taking to share risk and allocate risk mitigation in the project. It is very important for CCMP developers and sponsors to be able to explain not only how they have identified the financing needs and overall risks in the project, but also that they are willing to share in the risks in the project outcomes. Banks expect the project sponsors to have some kind of equity position in the project, for example, so that they know they are not carrying all of the risk. This may be as simple as a debt-equity requirement by the lender, or more complicated in the form of additional security provided by the sponsor. CCMP developers without strong corporate backing should not be surprised by the need in some cases to provide additional personal securities to lenders, beyond what is available from the project (i.e. physical assets).

Finally, the risks of the operational phase, while significant, are comparatively low. This is a question of degree in that the failure of operation may only create short-term underperformance and can be corrected, whereas cost overruns during the development and/or construction phases may undermine the entire project.

Feasibility Study Analysis

During the period from six to twenty-four months in the two diagrams above (or, for comparison, three to twelve months for bagasse-fired cogeneration, for example), a full-scale technical and financial feasibility study of the project should be completed, including initial financial Proforma. If the developer does not have his/her own resources to complete the feasibility, a preliminary project report or pre-feasibility should be completed to support applications for additional early stage funding. A pre-feasibility study provides a summary of the project and is also the basis for determining whether the project is worthy of further investment and analysis in a full-scale feasibility study. The objectives of a pre-feasibility study are to 1) establish the parameters and characteristics of the project, 2) assess the regional resources to establish fuel supply and technology options, 3) determine candidate project sites, and 4) identify potential project sponsors or

partners. A formal pre-feasibility study may not be necessary depending on the type of project, if much of this information is already known or if the project developer has conducted these assessments in a less formal manner. However, for project developers that are seeking early stage funding for a more detailed full-scale feasibility study, a preliminary feasibility study or more formal project concept document that outlines these key criteria will help in making a case to lenders.

Several sources of early stage funding, i.e. pre-feasibility or feasibility study funding exist in association with funds that are oriented towards environmentally-friendly or sustainable development. For example, the Small- and Medium-Sized Enterprise Fund of the International Finance Corporation, which invests in small, environmentally friendly projects of various kinds, can sometimes provide grants for feasibility studies during the loan review process. A full-scale feasibility study, which establishes the technical and financial credibility of the CCMP and projects cost and revenue streams for several ongoing years, is a necessary element of the financing proposal and will be required by lenders. A strong feasibility study conducted by credible analysts will improve the developer's presentation of his project and will reassure lenders that the project has a credible developer leading the effort.

A full-scale feasibility study looks at the project in greater detail and should predict the project's ability to achieve commercial success, based on an objective assessment of market penetration and growth potential. It should provide a clear picture of the project from a technical as well as financial standpoint, its market, the costs of operation and a projection of the potential sales and profits based on the size of the market, the existing competitors and the room for growth in the market. The feasibility study is the project sponsor's primary argument for selling the project to potential financiers and the primary determinant of future success. Therefore, it is very important that the feasibility study be carried out objectively and accurately. If the sales volume predicted by the feasibility study is not adequate to support the project, then the developer should not pursue the project. Developers gain nothing by altering the projections so that they seem more attractive to potential funders – if the sales are not really there, the project will fail.

The feasibility study includes both an analysis of projected sales volume and the costs and expenses that the project will incur – this can be estimated based on similar projects in the same industry and adjusted for any differences in your project. By comparing these projected costs with the projected sales volume you can calculate whether the project will be able to generate adequate profits.

Project developers must begin the process of securing revenue streams from power or other product (steam, hot water) sales as soon as the technical viability of the project is clear. Power purchase or other sales contracts for the project's output are ultimately going to be a major part of the security package that reassures lenders of the developer's ability to pay debt servicing. If possible, project developers should provide potential investors with expressions of interest in the project output from buyers, along with information on the credit worthiness of those buyers and an outline of the intended

commercial arrangements and likely contract structure. Early indications of secure sources of revenue to the project can go a long way to reassuring investors that the project is a good candidate for financing.

In addition, project developers should also begin seeking host-county approval for the carbon credits that they expect to generate from the project as part of the post-feasibility development process. Obtaining host-country approval is critical to having the carbon credits recognized as legitimate within the national policy framework and as having value in the international carbon market. Without host country approval, most carbon buyers will not even consider the carbon credits as viable. Obtaining host-country approval is different in every country, however in general terms a Ministry or Secretary of Environment will house an office that is capable of reviewing and signing off on carbon credits. Generally a simple approval letter is sufficient evidence of host-country approval. It should be noted here that in India, while the government has yet to approve any project for its carbon emissions reductions, the general trend in the country is pointing to greater involvement in and support of international activities to curtail greenhouse gases.

Marketing and Funding

As a first step in locating lenders or investors, the developer should compile a list of potentially interested funding sources and conduct research on the specific investment criteria of each lender in order to narrow the list to those with strategic and operational goals that are most conducive to the specific CCMP. This may involve contacting funders directly to discuss the focus of the project and determine whether the financier has an interest in pursuing the project. Different funders will require different levels of information and different criteria in terms of return, social/environmental goals and/or carbon rights in order to move to the next step and this process may involve several telephone calls in order to obtain approval to provide a formal project presentation.

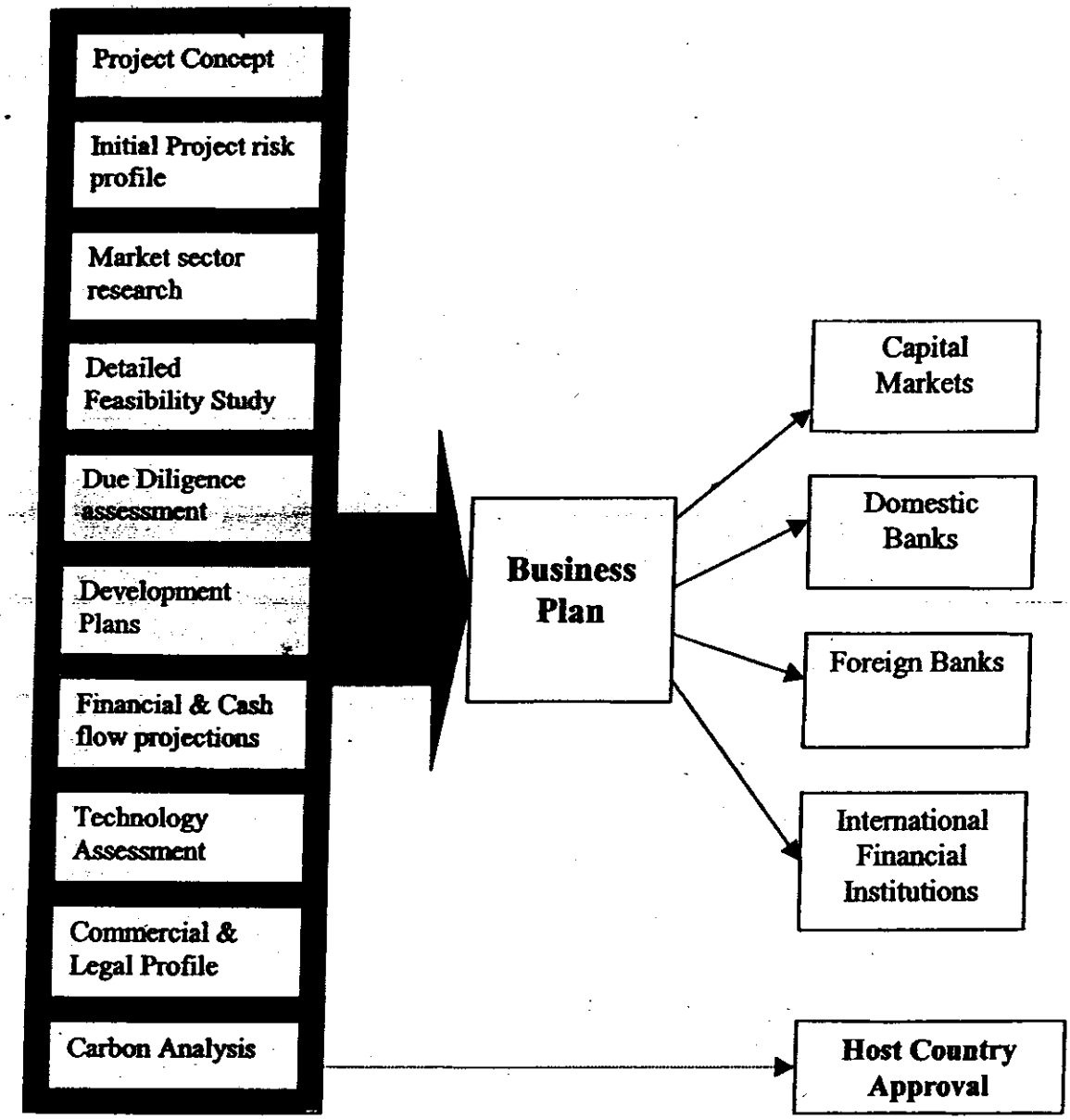
The Business Plan

At this stage, the developer will have already completed a series of discrete steps in the project development process, many of which feed directly into the project presentation document that will be offered to funders. This document is essentially a business plan or sometimes called a financing proposal or financing plan. It is a concise description of the project concept, goals and objectives; the market; preliminary financial analysis; and technical and legal justifications for pursuing the project path. The credibility and presentation of this document is very important to successfully funding the project. While a poorly written business plan may not kill the opportunity for funding, keep in mind that most funders review several business opportunities per week, and a strong, professional document will give developers an advantage over much of the competition. The business plan should be clear and understandable to a person who has no experience with your project or the technology. It should be free of jargon and should lay a proper foundation so that a layman can understand the concepts it outlines. The technical

specifications and financial projections must be based on objective, accurate analyses and grounded with complete documentation.

While the business plan does not draw on every step in the project development process directly or expansively, it does provide summary information and the results of many of these steps. Figure 5 below represents the steps in the development process, which will feed, either directly or indirectly, into the business plan.

Figure 5: Business Plan Inputs



When developers have received an invitation to provide a formal presentation of their project to a funder, they should send a completed business plan with an introductory cover letter. An investor who is serious about the project will want to review the business plan in detail before setting up a formal meeting with the developer. Do not plan to drop off the business plan in person and expect the investor to examine it while you wait. Also, do not wait until you get a response from one funder to send the business plan package to others, as many will decline the project. Developers should plan to send the package to several investors simultaneously, being certain to keep detailed notes of all telephone calls, to whom the package was sent and the dates for follow up. If an investor is interested in a project, the developer must be able to speak intelligently about any previous contact they may have had.

In preparing a presentation to potential investors and funders, it is important to present a complete picture of the project, the project sponsors and partners and the market in which the project will operate. Whether seeking debt or equity contributions from commercial or development banks or other financial institutions, and whether the financing request includes carbon offset sales or not, funders want to see hard facts as well as personal attributes such as track record, qualifications and dedication to the project in terms of sweat or other equity invested. It is important to package the project brief in the most professional way possible; getting funding is essentially a sales job and having a professional look goes a long way to capturing potential investor's interest and showing them that the developer is a serious business person with a well thought-out, commercially strong project. The following outline contains the main elements of a business plan.

Business Plan Outline

Executive Summary (~2 pages)

- Company Overview
- Product or Service Description
- Industry and Marketplace Analysis
- Marketing Strategy
- Operations
- Development
- Management
- Summary of Financials
- Offering

Company Overview (~1 page)

- Mission Statement
- History and Current Status
- Market and Products
- Objectives
- Company Financials

Product or Service Description (~2 page)
- Description of service offering
- Detailed financial projections

Industry and Marketplace Analysis (~3 pages)
- Industry Analysis
- Marketplace Analysis
- Customer Analysis
- Competitor Analysis

Marketing Strategy (~4 pages)
- Target Market Strategy
- Product/Service Strategy
- Pricing Strategy
- Distribution Strategy
- Advertising and Promotion Strategy
- Sales Strategy
- Marketing and Sales Forecasts

Operations (~2 pages)
- Operations Strategy
- Scope of Operations
- Ongoing Operations
- Operations Expenses

Management (~2 pages)
- Company Organization
- Management Team

The Business Plan outlined above will have to be customized for the given project, but this format can serve as a template that includes key information.

If the business plan is well-received and the project shows strong financials, then several potential funders will likely call to schedule an interview to discuss the project in detail. They will want to see who is requesting the money and developers will also want to get a feel for the investors. Prepare a brief presentation with visual aids ahead of time. Anticipate questions and plan concise, informative answers. Above all, be relaxed; try to gauge the funders' business objectives and determine how to conduct yourself to best make it easy for them to say "yes."

If investors and funders all had the same capabilities and funding criteria, the process of securing funding would be a simple matter. This is not the case, however. Every funder

will have different criteria, emphases and political agendas. Every bank and international lending institution stresses a different portfolio mix of working capital loans and investments. Thus, it is very important that the project developer conduct enough preliminary research to 1) identify appropriate lenders and avoid wasting time with those that would not be likely to invest in the project and 2) target the business plan to the specific eligibility criteria and funding goals of those that are the most likely to invest in the project. The developer's analysis of risk is important here, as the level of risk that is inherent in the CCMP will play an important role in the type of funder or investor that the project developer should approach and the type of financial instruments that will be available.

- There are additional measures that the project developer can take to give him an edge with potential lenders. These measures are by no means a guarantee of success, however, many business professionals have found that the following ten rules have helped them to be better prepared to present their projects and deal with the potential pitfalls of securing funding.

Ten Rules for Presenting Projects to Funders

It is important to note that it may be possible for developers to market their business plan to funders whose investment criteria include the rights to the carbon credits that result from the project and, in this case, your business plan should include a proposed financial structure to accommodate the purchase of carbon credits as well as the a summary of the

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results from your other toolkit analyses. However, this may not be the case. In many cases, it will not be possible for developers to obtain project financing tied to carbon credits and the process of presenting the project may have to be repeated with potential carbon buyers. While this process is less onerous than obtaining initial seed funding for project development, it still requires a rigorous research and preparation process, which will be discussed in the Marketing Carbon Credits section below.

Marketing Carbon Credits

As noted previously, funders and investors will have different objectives and criteria for selecting project investments. It may be in the best interest of the project, depending on the individual investor, to bundle the project financing with the rights to the resulting carbon credits, or it may be more advantageous to conduct a separate transaction for the sale of carbon credits. Flexibility is paramount – be prepared to structure a transaction with or without bundling the carbon credits depending on the funder's offer.

As international markets for carbon credits mature, transactions involving carbon as a commodity are becoming more common. Entities ranging from development banks and multinational corporations to industry groups and individual investors are entering this market, helping to solidify carbon as a legitimate commodity and stabilize pricing indicators. Interested buyers have taken various approaches to identifying projects eligible for investment, and the CCMP developer can enter this market with a little market research and foresight. Several large corporations and climate change specific development funds have issued requests for proposals for carbon offset purchases. These may be published on the Internet or coordinated through a financial intermediary such as a brokerage house. CCMP developers may wish to contact a firm with specialized services focused on brokering environmental commodities or conduct their own research. Generally, brokerage firms will require a small commission based on the quantity and price of offsets sold, plus may charge some analysis fees, depending on the level and quality of carbon baseline and project case analysis that has been completed prior to this phase of the project process.

In responding to a carbon request for proposal, the developer will generally need to prepare a separate presentation document for his project similar to the "Project Brief" shown below. This sample is based on the format used by the World Bank's Prototype Carbon Fund, a well-respected and substantial fund, focused on supporting climate change mitigation projects through the purchase of carbon offset credits. The information contained in the World Bank's project brief will probably be similar in nature to that which any interested carbon credit buyer would require. All of the information contained from the Project Brief can be taken from the Business Plan and from the carbon analyses that have been completed through each of the other toolkits.

PROJECT BRIEF
Name &Location of Project

Date

Project Identification: Reference name for project for all documents

Project Goal: Provide a statement of the project goal, e.g. "development of a high-efficiency cogeneration power system and an integrated materials production system at XXX sugar mills"; "sustainable manufacturing of packaging materials with commensurate reductions in harmful emissions, including GHG emissions"

Background: Answer the question "if I am investing in clean energy projects, why should I be interested in this particular project?" include history of the project; history, financial status and qualifications of project sponsor (especially track record of similar projects); main business and other relevant experience; short description of the project specifications (product, scale, etc.); and any information on financing to date

Market Assessment: Answer the question "will I be able to operate in the existing market for my product?" or "Is there sufficient market demand for my product?" Include a discussion of the market generally, (electricity sales volume, product sales volume, growth potential and anticipated company share) and base estimates on factual statistics as much as possible; discuss relevant regulations; overall supply and demand; pricing; identify any potential competition)

Project Description: "What will your project do?" include technology options (but avoid detailed technical specifications), and characteristics that make it unique, or at least more attractive than comparable investments

Preliminary Technical Assessment: Summarize technical information from the carbon baseline and M&V toolkits; include output parameters (units over time), fuel consumption, etc.

Preliminary Financial Assessment: Enter data from Carbon Finance Toolkit

Preliminary Legal and Institutional Assessment: [include all information available to date on taxation, permitting and licensing requirements for the project, and the associated costs and timetable for securing and identifying outstanding legal and

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4. Supporting Material

The section provides a real world example of a CCMP project that has successfully securing funding that utilizes revenues from the sale of carbon emission reductions as a supplement to the toolkit.

Case Study – CCM Breweries

Overview of Project

In March 1998, after presenting his business plan to several potential funders, the proprietor of Empresas ESM S.A. de C.V. (EESM), a start-up Mexican Energy Services Company, was invited to present a potential investment opportunity to the Environmental Enterprises Assistance Fund (EEAF). EEAF is a non-profit organization that operates as a venture capital fund, providing long-term risk capital to renewable energy, energy efficiency and environmentally beneficial projects and businesses in developing countries. The project involved energy efficiency measures at two brewing facilities (located in Sonora and Baja California) operated by one of Mexico's largest beer companies, Cerveceria Cuauhtemoc Moctezuma (CCM), part of the publicly traded FEMSA Group (NYSE:FEMSA). The energy retrofit project would be implemented using a performance contract, a contracting vehicle that was completely new to the Mexican efficiency market.

EEAF, interested in the project but unfamiliar with the ESCO and Mexican ESCO market, contacted Econergy International Corporation (EIC) to conduct a due diligence analysis of the project and developer and to make recommendations on the advisability of the investment.

The objective of the efficiency project was to reduce the two plants' energy needs (both consumption (kWh) and demand (kW)) with two complementary approaches. Mexico's state utility, the Federal Electricity Commission (CFE) supplies both plants' energy needs. First energy efficiency measures were installed to better manage electricity load during peak hours and second, control measures were installed to monitor and improve the efficiency of the brewing processes.

The project essentially involves better regulation of the electric load during daily peak consumption periods. Using electrical equipment for process cooling on a sequential or staggered schedule, rather than simultaneously and continuously, reduces the total peak demand. Refrigeration needs during summer months increase as much as six times that of winter months, so this approach can yield significant savings. In addition, EESM installed efficiency measures in the brewing processes, including controls on motors, fans, pumps and other electric devices, and improved the efficiency of back-up cooling

systems. As part of the load management project, many of these motors can be turned off temporarily without disrupting production.

The project is structured on the basis of a performance contract, under which EESM's compensation, in the form of quarterly lease payments, is dependent on the realization of energy savings by the breweries. EESM provided the necessary energy audits, engineering, analysis, and design for the project and oversaw the installation of new equipment. As a result of the project, the breweries are expected to reduce energy consumption by 7% (3.7 million kWh) annually.

By tracing the energy savings upstream to the power plants operated by CFE, it is possible to determine the amount of fossil fuel consumption that is offset by this project and to determine the magnitude of the carbon savings. These calculations indicate that the project will reduce carbon emissions by 986 metric tons annually over the five-year lifetime of the project for a total of 4,930 metric tons of recorded emissions reductions.

Financing

EIC evaluated the opportunities in the Mexican market and the viability of the projects and determined that their small size and low rates of return due to risks associated with investing in Mexico made the projects unacceptable. Risks included Mexico's unsteady financial environment and the fluctuating regulatory structures in the energy sector. However, the opportunity to acquire carbon offsets and to demonstrate the viability of incorporating such offsets into a project finance package, improved the attractiveness of the project for EIC. Likewise, the other financing institutions would have been unlikely to help underwrite the project without EIC's efforts to package the transaction in a manner that quantifies and monetizes the carbon reductions associated with the project.

Given the existence of USIJI and the value associated with their certification of carbon mitigation projects, EIC concluded that it was willing to accept the commercial and political risk associated with the project in order to acquire the carbon offsets and the expertise in designing transactions that result in an international transfer of such offsets. Under these circumstances, for example, EIC was willing to issue a loan to EESM at a rate of 12 percent per annum for the CCM Brewery Project, approximately ten points lower than the prevailing commercial rate for similar transactions in Mexico. In exchange for offering this concessionary financing for subordinated debt, EIC included a stipulation that assigns it itself the rights to all carbon offsets generated by the project. EIC has also continued to offer its services to develop and secure financing for other projects to be included in the Mexico Carbon Portfolio in exchange for the rights to the carbon offsets generated by the projects.

The potential revenues from carbon offsets enabled EESM to obtain better financing terms for the subordinated debt. Econergy and EESM contracted with Carbontrade, Inc., a special purpose corporation focused on brokering carbon credits, to aggregate the carbon credits associated with the project, along with two others that EESM was developing. This pool of carbon credits is then available to any emitters seeking to register offsets through flexibility mechanisms developed under the Framework Convention on Climate Change. In August 1999, EIC and EESM submitted the ESCO/Brewery project information to the Mexican and U.S. governments for acceptance simultaneously. The relevant Mexican Government authorities at INE have favorably reviewed the project and are now seeking concurrence from the other responsible Ministries. Total carbon credits expected over the five-year life of the CCM Brewery project are 4,930 mt.

EIC, the primary U.S. participant, entered into the development and financing of the EESM projects with the assumption that ownership of the carbon credits will have a future value. EIC provided concessional subordinated debt financing for the CCM Brewery Project and project development and financial advisory services for other projects as "in kind" services under the assumption that these investments and concessions will have a financial return in the future carbon market.

Under the terms of the contract between EESM and EIC, EIC is awarded ownership of the carbon credits, which may be traded or sold in the future. The carbon purchases will also be executed under a performance based contract to help minimize the risk that the offsets are not delivered on time or in the agreed amounts. EIC invested in the project based on an estimated future value of carbon credits generated by the project. Delivery and payment of the carbon credits will occur annually to reduce transaction costs. Payment occurs only after the savings calculations and the corresponding emissions reductions are validated by a third party validation service. Financial closure was, therefore, accelerated for a project that would otherwise have been difficult to complete.

A diagram on the following page shows the structure of the financial arrangement applied to the Breweries project.

- Channels selective GEF concessional support only to projects that require assistance
- Status -- Equity fund first closing achieved at US$65 million in March 2000; debt facility and GEF co-financing in place; looking for projects!

Small and Medium Scale Enterprise (SME) Program

- US$21 million program to provide contingent, concessional loans to financial intermediaries (FIs), which then on-lend to or invest in SMEs
- FIs include both NGOs and commercial enterprises
- Incentives for FIs to seek repayment from SMEs
- 10 FIs selected to date - US$6.3 M approved

Solar Development Group

- Exclusive focus on Rural PV Solar Homes Systems (SHS) in Emerging Markets
- $50 million Target Initial Capitalization
- Private, Stand-alone Entity with Finance Window ($32 million) and Business Development Services ($18 million) to local PV companies.
- Initiative launched by World Bank, IFC, GEF and U.S. Charitable Foundations as Potential Founding Investors
- Status: Active fundraising continues; business advisory work underway

Efficient Lighting Initiative (ELI)

- ELI aims to overcome the barriers to efficient lighting technologies in seven countries
- ELI's resources: US$15 in GEF funds
- ELI's market interventions:
  - Product quality standards & labeling
  - Financing
  - Public education
  - Transaction support
  - Market aggregation

Contacts:

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  International Finance Corporation
  2121 Pennsylvania Avenue, N.W.
  Washington, DC 20433
  USA

  Telephone: (202) 473-0400
  Fax: (202) 974-4340

  The Director of the East Asia & Pacific Department

is Mr. Javed Hamid.

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  Chanakyapuri
  New Delhi 110 021
  India

  Telephone: (91-11) 611-1306
  Facsimile: (91-11) 611-1278
  (91-11) 611-1281

  The Director of the South & Southeast Asia Department is Mr. Bernard Pasquier.

  Website: http://www.ifc.org/

World Bank

Prototype Carbon Fund

The PCF is endeavoring to achieve a balanced portfolio both geographically and technologically. Approximately half of the investments will be made in Economies-in-Transition demonstrating JI, and half will be made in developing countries facilitating the CDM. The major emphasis will be placed on renewable energy and energy efficiency projects, which have a great potential for replication and for reducing climate change at a reasonable cost.

Normally, the PCF will purchase emission reductions from projects directly, and not through intermediaries. However, PCF will also work through established intermediaries, such as local or regional energy investment funds, energy service companies, commercial banks, and others to aggregate smaller projects efficiently and build capacity for smaller economies to supply high quality, attractively priced emission reductions.

Objectives:

- To demonstrate how JI/CDM projects can promote SD
- To provide the Parties to the UNFCCC an opportunity to "learn-by-doing"
- To partner with public and private sectors to mobilize new resources for climate change mitigation and build confidence in trade dominated by private capital and intermediaries

Website: http://www.prototypecarbonfund.org/

Overseas Private Investment Corporation (OPIC)

The Overseas Private Investment Corporation is an independent U.S. Government agency that encourages mutually beneficial direct U.S. investment in developing countries.

OPIC assists U.S. investors in renewable energy projects through three programs: financing investments through direct loans and loan guarantees; insuring investments against a broad range of political risks; providing a variety of investor services, including advisory services, investment missions and outreach.

OPIC's loans and loan guarantees are extended in the form of project financing up to a maximum amount of $200 Million USD. Project evaluations are based on the viability of the project. The project must have adequate cash flow to pay all operational costs, to service all debt and to provide the investment owners an adequate return.

OPIC can provide a major portion of medium- and long-term funds for financing in countries where conventional financial institutions are often hesitant or unable to lend. OPIC programs support private sector investments in financially viable projects. They do not offer concessional terms often associated with inter-government lending, nor do they finance export sales unrelated to direct investment.

Under certain circumstances, OPIC may purchase equity in a project, including convertible notes and other debt instruments with equity participating features. The terms and conditions are decided on a case-by-case basis.

The amount of OPIC's commitment varies, taking into consideration the contribution of the project to the development of the host country, the financial requirements, and the distribution of the financial risks and benefits among the investors and lenders.

Potential project developers that wish to obtain financing should provide a copy of the business plan of the proposed project to OPIC. This business plan should serve as the basis for general eligibility. It should also provide the terms and amount of the requested financing. The following information should be given to OPIC, including:

- A general description of the project
- Identity, background and audited financial statements of the project's proposed principal owners and management
- Planned sources of supply, anticipated output and markets, distribution channels, competition and the basis for projecting market share
- Summary of project costs and sources of procurement of capital goods and services
- Proposed financing plan, including the proposed amount of OPIC participation
- Brief statement on how the proposed business will contribute to local economic and social development.

Contact:
Overseas Private Investment Corporation
1100 New York Avenue, NW
Washington, D.C. 20527
Tel: 202-336-8663
Fax: 202-408-5145
Asia/Middle East
Tel: 202-336-8589

U.S. Trade and Development Agency (TDA)

It should be noted that TDA only provides funding if there is a significant potential for U.S. Exports to the project.

The TDA supports feasibility studies for the development of public-sector projects in developing countries, which present significant opportunities for trade with U.S. Suppliers. The support of the TDA enables the host government to determine the economic and technical viability of a project with the application of U.S. technology. Feasibility study contracts are awarded to United States companies which submit bids in response to these solicitations; the host government is responsible for selecting the winning firm. Feasibility studies for public-sector projects approved by the host government will be funded 100 percent by the TDA. Typical grants range in size from $30,000 to $2 million.

The TDA also has what is known as the "Evergreen Fund" in place at several Multilateral Development Banks. These funds, are available at the Inter American Development Bank, the World Bank (IBRD), The International Finance Corporation, the European Bank for Reconstruction and Development, and the African Development Bank. U.S. Companies that have won feasibility study contracts for projects that are to be funded by the MDB are eligible for this assistance.

Contact:
U.S. Trade and Development Agency
1621 North Kent Street
Suite 309
Rosslyn, VA 22209
Tel: 703-875-4357
Fax: 703-875-4009

Renewable Energy Project Support Offices (REPSOs)
The Renewable Energy Project Support Offices are a global network of non-governmental organizations that provide technical and financial support services to assist firms in identifying opportunities for renewable energy projects. REPSOs bring about the use of renewable energy technologies for rural energy supply in developing countries. REPSOs are funded by USAID and local offices managed by Winrock International.

REPSOs can provide resource and market assessments and identify potential sources of project financing. REPSOs also offer private project developers cost-share funding of up to 50 percent of the cost of a pre-investment study.

Contact:
REPSO – India
P.O. Box 8808
7, Poorvi Marg, Vastant Vihr
New Dehli – 110 057, India
Tel: 91-11-687-1927
Fax: 91-11-687-6004

Asian Development Bank (ABD)

The Asian Development Bank (ADB) is a major lender for infrastructure projects and environmental development in Asian countries.

The ADB follows strict International Competitive Bid (ICB) guidelines for public sector projects. ADB has also had experience in private sector projects such as those involving small regional entrepreneurs, where ADB's participation has not been greater than $5 Million. To fit the ADB's criteria, projects must be targeted to member countries and must be approved by the planning and financial authorities of the host government. This approval will be confirmed through consistent discussions between the ADB and the host government.

The borrower is usually only permitted to draw on the loan in order to meet expenditures associated with the project as they are incurred. In the interest of economy the ADB requires that borrowers seek competitive bids from potential suppliers in member countries, engineering plans be drawn up independently of the suppliers and, if appropriate, independent consulting engineers be retained by the borrowers.

Except in special circumstances, the ADB requires that the proceeds from loans or other ADB financing be used for only the procurement of goods and services produced in member countries. ADB adjusts its variable lending rate each year in January and July.

ADB lends to both public and private entities. ADB will take equity interests to encourage the financing of private sector sources in developing countries. The ADB will also participate in sector and cross-country loans and equity financing.

The ADB has a $150 million loan in the final stages of negotiation with the Indian Renewable Energy Development Agency Ltd. (IREDA). The IREDA loan will target wind, co-generation, biofuels, and solar projects, although all renewable energy projects will most likely qualify.

In order to apply for project financing the following should be submitted:

- The proposed borrowers business history
- Project description and operation plans
- Feasibility studies, pre-investment surveys and any other technical and financial feasibility information
- Amount of loan requested and the project cost estimates
- Financial performance estimates and cash flow projections
- Value and volume of annual sales

The ADB maintains field offices in Bangladesh, India, Indonesia, Nepal and the South Pacific.

Contact:
Asian Development Bank
37 Golf Links
P.O. Box 3019, Lodi Road HPO
New Delhi 110 003, India
Tel: 91-11-469-2578
Fax: 91-11-463-6175

Photovoltaic Market Transformation Initiative (PVMTI)

Photovoltaic Market Transformation Initiative (PVMTI) is a $25 million GEF-capitalized fund developed by the International Finance Corporation (IFC) to finance and provide technical assistance to solar photovoltaic enterprises in developing countries, initially India, Kenya, and Morocco. So far, the fund has commitments of $9 million in India and $3 million in Kenya. The Morocco program is expected to start up soon now that the national electric utility, ONE, has approved its own participation. The PVMTI fund manager is Impax Capital, along with IT Power.

Contact: Ian Simm, Impax Capital Corporation Ltd.,
Broughton House, 6-8 Sackville Street,
London W1X 1DD, UK;
Tel: +44 (207) 434 1122; Fax:+44 (207) 434 1123;
email: info@impax.co.uk
website: http://www.impax.co.uk

The Industrialization Fund for Developing Countries (IFU) and Investment Fund for Emerging Markets

The Industrialization Fund for Developing Countries (IFU), Investment Fund for Central and Eastern Europe (IØ), and Investment Fund for Emerging Markets (IFV) are the Danish government's international investment funds. The three funds share the same

boards of directors and management. IFU, the oldest and largest of the three, provides equity, debt, and guarantees, and assists in mobilizing supplementary financing from other sources for projects in all but the poorest developing countries. It generally participates as an equity partner, providing up to 30% of the equity. It can also provide loans up to 25% of total project cost including working capital. It invests in both large and small projects, including pilot projects, and offers advisory services in the preparatory and initial phases of investment projects.

IØ works along the same lines as IFU but only in Central and Eastern Europe. It is among the biggest foreign investors in Poland and has an office in Warsaw. IØ administers a special Environmental Investment Facility (MIØ) in cooperation with the Danish Ministry of Environment and Energy. IFV operates in the poorest developing countries, which are not eligible for IFU or IØ financing. It co-finances start-ups as well as expansions and privatizations, provided that Danish companies participate with financing and management. IFU has regional offices in India, China, Zimbabwe, and Mexico.

Contact:
IFU at Bremerholm 4,
DK 1069 Copenhagen K, Denmark;
Tel: +45 (33) 63 7500; Fax: +45 (33) 32 2524;
emails: ifu-cph@inet.uni2.dk
io-cph@inet.uni2.dk
ifv-cph@inet.uni2.dk
website:http://www.ifu.dk

Export-Import Bank of the United States (Ex-Im Bank)

Export-Import Bank of the United States (Ex-Im Bank) is the U.S. Government export credit agency. The Bank facilitates short-, medium- and long-term financing to creditworthy international customers to purchase U.S. goods and services, and short- and medium-term export credit insurance to enable U.S. firms to extend credit directly to international customers. There is no minimum project size.

The Bank is interested in, and has actively supported, clean energy projects, including the establishment of a $100 million sustainable energy window for China. In addition, it has a policy that allows it to provide concessional financing on a case-by-case basis to renewable energy exporters, among others, in order to match the concessional terms provided by other export credit agencies. Another U.S. agency, **Overseas Private Investment Corporation (OPIC)**, provides political risk insurance, loan guaranties, and direct loans for small businesses. Under its U.S.-Africa Sustainable Energy Program, cosponsored with the U.S. Department of Energy to advance clean energy, OPIC has given the region priority in its programs, including a small grant fund for small businesses and non-governmental organizations.

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Contact:
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Environmental Liaison Officer,
Ex-Im Bank,
811 Vermont Ave. NW,
Washington DC 20571 USA
Tel: +1 (202) 565-3946;
Fax: +1 (202) 565-3380.

OPIC,
contact Sam Smoots,
Tel: +1 (202) 336-8645;
email:ssmoo@opic.gov
website: http://www.opic.gov/

Netherlands Development Finance Company (FMO)

Netherlands Development Finance Company (FMO) is the Dutch development bank specializing in providing finance to the private sector in emerging markets. The FMO was founded in 1970 as a joint operation by the State and the private sector. The State owns 51% of the shares; the other shareholders are leading Dutch banks (42%), the two largest trade unions, and approximately 120 Dutch companies and individuals. Projects do not have to include a Dutch partner. In addition to providing both equity and debt, the FMO implements a number of special Dutch government programs: Small-scale Enterprise Fund; Seed Capital; Investment Promotion and Technical Assistance for Developing Countries; Investment Promotion and Technical Assistance for Central and Eastern Europe.

Contact:
FMO,
Koningskade 40,
2509 AB The Hague, The Netherlands;
Tel: +31 (70) 314-9696;
Fax: +31 (70) 324-6187;
e-mail: fmo@wxs.nl
website: http://www.fmo.nl

Commercial Funding Sources

Global Environment Fund
Global Environment Fund, not to be confused with the multilateral Global Environment Facility (GEF), is a venture capital fund manager with over $250 million under

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management in four funds and private asset accounts focused on public and private equity investments in emerging markets. Two of its funds, Emerging Markets Funds I and II, invest in renewable energy, among other environmentally oriented projects.

Contact:
Wendell Robinson,
1225 Eye Street NW, Suite 900,
Washington DC 20005; Tel: +1 (202) 789-4500;
Fax: +1 (202) 789-4508;
email: reception@globalenvironmentfund.com

Nuon

Nuon is the largest energy and water utility in the Netherlands and one of the largest clean energy providers in Europe. It has set an ambitious goal of generating 10 percent of domestic power sales from renewable energy sources by the year 2010. Nuon has expanded its domestic investment philosophy to overseas markets, where it is pursuing clean energy equity investments in both industrialized and developing countries, including a wind farm in China, a rural electrification and photovoltaic solar home system business in South Africa, and its recently-announced $53.5 million equity investment in the Green Mountain Energy Company in the United States.

Contact:
Dr. Annemarie Goedmakers, Director, NUON Renewable Energy Business Unit, Postbus 9039, 6800 EZ, Arnhem, Netherlands, Tel: +31 (26) 377 2143; Fax: +31 (26)377-2186

Triodos Bank

Triodos Bank is a Dutch bank that offers financing to businesses with social and environmental objectives. In 1996, it organized and capitalized (and now manages) the Solar Investment Fund (SIF) to provide loans and guarantees to intermediary institutions (e.g. credit unions, utilities, non-governmental organizations, and equipment distributors) which in turn sell or lend to buyers of photovoltaic solar home systems. Triodos is also a co-investor/manager in the Solar Development Group. In addition, it manages The Wind Fund, which invests in wind project in the U.K., and the Triodos Greenfunds, which finance wind projects in The Netherlands. The bank is preparing to launch Triodos Venture Capital to provide equity to renewable energy companies in Europe.

Contact:
Hans Schut, Project Manager, Triodos Bank,
Utrechtseweg 60, P.O. Box 55,
3700 AB Zeist The Netherlands;

Tel: +31 (30) 693-6500; Fax: +31 (30) 693-6566;
email: hans.schut@triodos.nl

MeesPierson

MeesPierson is a Dutch commercial bank providing general credit facilities as well as structuring and arranging complex financial transactions. It concentrates particularly on asset-backed and project finance. MeesPierson's Global Energy Finance Group provides a complete package of commercial and investment banking services, including structuring, arranging, underwriting, and participating in corporate transactions and project financing. The bank intends to be particularly active in the arranging and structuring of project financing for wind power projects.

Contact:
MeesPierson at P.O. Box 243, 1000 AE, Amsterdam; Tel: +31 205279111;
website:http://www.meespierson.com/

Dexia-FondElec Energy Efficiency and Emission Reduction Fund

Dexia-FondElec Energy Efficiency and Emission Reduction Fund is a 70 million euro equity fund established by the European Bank for Reconstruction and Development (EBRD) to improve energy efficiency and reduce greenhouse gas emissions in Central and Eastern Europe. The fund is capitalized by the EBRD, Dexia Group, and several Japanese firms; and is managed by FondElec, a private equity fund management firm. The fund is focusing on energy service companies (ESCOs), district-heating systems, and combined heat and power (CHP) projects.

Contact:
Lawrence McGrath or Francisco Hoyos at FondElecGroup, Inc.,
333 Ludlow Street, Stamford, CT 06902 USA;
Tel: +1 (203) 326-4570; Fax: +1 (203) 326-4578;
email:lmcgrath@fondelec.com

Draper International India Fund

This $40 million fund was created to provide Indian entrepreneurs with capital and access to U.S. technology and management. It is the first venture capital fund with a dual presence in the United States and India. The fund makes equity and equity-related investments in early stage opportunities, including a small number of start-up companies. They also invest in later stage companies that are two to three years away from being publicly quoted.

Contact:
Draper International India Fund
50 Fremont Street
Suite 3500

San Francisco, CA 94105
Tel: 415-284-8696
Fax: 415-284-8132

INDIAN FINANCIAL INSTITUTIONS

IDBI

The IDBI is one of the leading lending and financial institutions in India. It was established in 1975 as a wholly-owned subsidiary of the Reserve Bank of India and ownership was transferred to the government in 1976 after guidelines on the entrance of new private sector banks were issued. In 1982, IDBI transferred its International Finance Division to Export-Import Bank of India.

IDBI's objectives for growth include building on its project financing successes and entering other compatible business operations as well as positioning itself among top development financial institutions of the world.

Contact:
IDBI Ltd
IDBI Towers, Cuffe Parade
Mumbai – 400 005
Website: www.idbi.co.in/

ICICI

ICICI's main function in the Indian capital markets is to provide financing for industrial companies. This is typically in the form of corporate term loans and project finance. Project loans are typically 5 to 7 years in duration, and therefore may be somewhat difficult for CCMP developers to access as sources of debt. The bank usually only lends up to 60 percent debt on total project costs, requiring the rest as sponsor's equity. ICICI has been lending to energy sector projects for the past over 20 years. ICICI can provide financing in both rupee and foreign currency.

Contact:
ICICI Ltd.
ICICI Towers, Bandra-Kurla Complex
Bandra (East)
Mumbai 400 051
Website: http://www.icici.com/

IFCI

IFCI, which was created by the Indian government in 1946 as a development bank, has since evolved into a commercial bank, which provides term loans as well as project

finance structures. IFCI is publicly traded, with about 25 percent being owned by the public. IDBI owns approximately 30 percent of IFCI.

IFCI has about $4.2 billion in assets (loans). Lending in 1999-2000 was about $700 million, of which about 2.5%, or $17.5 million, was to the power sector. IFCI is not known as a lender to the renewable energy sector, preferring more conventional power projects.

Power Finance Corporation

The Power Finance Corporation Limited (PFC) is a public development financial institution, wholly owned by the government of India, dedicated to the power sector. Its main objectives include: providing financial support to power sector projects, acting as catalyst to bring about institutional improvements and overall development, and mobilizing resources at reasonable cost. The PFC has been operating at a profit since 1988.

The PFC typically provides term loans, concessional term loans, equipment leasing, and guarantees in support of projects under development by State Electricity Boards, State Generation Corporations, State Power Development Departments, Municipal Utilities, Central Sector Power Utilities and also Joint Sector Power Utilities and Private Sector Power Utilities.

In its role as a development financial institution, the PFC assists in the development and implementation of Operational and Financial Action Plans (OFAP) for each of its beneficiaries, in order to encourage institutional development. These plans have been particularly useful in outlining conditions for improving the performance of State Utilities.

Contacts:
Power Finance Corporation Ltd.
Chandralok Building
36, Janpath
New Delhi 110 001
India
Fax: 91-11-331 5822
Tel: 91-11-372 2301 to 372 2038
Website: www.

Indian Renewable Energy Development Agency Ltd. (IREDA)

Incorporated under the Ministry of Non-Conventional Energy Sources (MNES), Government of India in 1987, IREDA's Mission is to be a pioneering, participant-

friendly and competitive institution for SD, promoting and financing self-sustaining investment in renewable energy and energy efficiency.

Objectives:

- Extend financial support to manufacturers and users
- Promote renewable energy
- Act as a financial intermediary
- Assist in rapid commercialization

IREDA has some funding from the Government of India, but most of its activities are financed by loans from international lending agencies, including the Asian Development Bank, which provided IREDA's first major line of credit, at $100 million in the mid-90s. A $145 million line of credit from the World Bank is being supplemented by a further line of credit of $135 million. This latter line of credit is dedicated to investments in energy efficiency and hydro-power.

For wind energy, IREDA is focused on small-scale projects. IREDA's terms for loans to wind projects are shown in the table below:

Category	Interest Rate	Term	Grace Period	Maximum Promoter's Contribution %
Manufacturing of Equipment				
Manufacturers of Equipment	14.0 %	8	2	25
Equipment Financing				
Wind Electric Generators up to 1 MW capacity	14.5 %	10	1	20
Stand alone non-grid Wind Electric Generators up to 10 KW capacity	8.3 %	10	2	20

Contact:
Prof. Dr. V. Bakthavatsalam, Managing Director
Indian Renewable Energy Development Agency Ltd., Core 4A East Court, IHC Complex, Lodi Road, New Dehli, India 110 003, Tel: 91-11-460-1344, Fax: 91-11-460-2855

EQUITY INVESTORS IN THE CARBON MARKET

Several new equity funds have been started to generate investment in CO2 reduction projects. These funds offer investors an easy way to access reductions from projects from across the world.

EBRD fund
A new equity investment fund created by the European Bank for Reconstruction and Development (EBRD) and the Dexia Group that will work to reduce greenhouse gas emissions in central and eastern Europe. This fund will raise US$128 million to invest in energy savings projects.

To date, US$52 million has been raised. EBRD and Dexia have each contributed US$17 million, and the EBRD potentially could contribute an additional US$ 8.5 million once the fund achieves its goal. The remaining US$18 million was generated through ten-year limited partnerships with various firms. Investors would receive equity returns, and be initialed to emission reduction credits.

Contacts:
Headquarters
European Bank for Reconstruction and Development
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Switchboard/central contact:
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Requests for publications:
Tel: +44 20 7338 7553 ; Fax: +44 20 7338 6102 ; E-mail: Publications Desk

General enquiries about the EBRD:
Tel: +44 20 7338 6372 ; Fax: +44 20 7338 6690 ; E-mail: Beverley Harrison

Project enquiries/proposals:
Tel: +44 20 7338 6282 ; Fax: +44 20 7338 6102 ; E-mail: Project enquiries

Website: http://www.ebrd.com/

Eru-PT
Eru-PT provides financing for projects that generate emissions reduction units (ERUs), (1,000 kilograms of CO_2 or CO_2 - equivalent). Through Eru-PT and Senter International, the Ministry of Economic affairs of The Netherlands buys the reduction in GHG emissions, which certifiable projects generate in Central and Eastern Europe, thus creating an additional source of income to boost the feasibility of projects and accelerate

their implementation. Eru-PT is restricted to emission reductions achieved in the period from 2008 to 2012. Projects must therefore be in operation and generate ERUs during the period from 2008 to 2012.

Senter International is not using any formal price limit for ERUs. As it will be the first time ever for Claims on ERUs to be traded, market prices cannot easily be set. Senter International has estimated that the market price for a Claim on ERUs will come in the US$ 3.88 to US$ 8.37 per tCO_2 range. The size of an offer to Eru-PT should be at least 500,000 ERU. Delivery of the actual ERUs is deferred until the commitment period (2008-2012), but Senter International will proceed with prepayment on the date of contracting. Prepayment amounts can equal up to 80 percent of the project. Eru-PT looks at two criteria:

- Price
- Feasibility of the ERU (this is split into three sub-criteria).
    a) Capacity of project developer
    b) Technical feasibility of the project itself (included in this definition is the need for the project to last until at least 2008)
    c) Emission reduction potential (minimum $500,000 mt CO2e)

Other quality criteria are based on host country approval. Eru-PT is not really looking for any co-benefits when making a decision to buy ERUs, although they will not invest in nuclear and they are strongly adverse to large hydroelectric projects.

Finnish Fortum Fund

Fortum, as part of its "Climate Initiatives," has set up a The Climate Fund aimed at sponsoring projects to help companies in Russia and the Baltic's cut their CO2 emissions. Their goal is to achieve reductions in the order of 300,000 to 500,000 tCO2. The Fund will enable implementing of reductions in emissions created prior to the drafting of working international rules for emission reduction.

Fortum currently accounts for around 13 percent of the 70 million tons of CO2 released each year in Finland. Therefore, an annual cut of around 5.5 percent in Fortum's CO2 emissions would mean a 0.7 percent cut in nationwide emissions Under the Kyoto clean air protocol, Finland, like the rest of the EU, promised to cut greenhouse gas emissions to their 1990 levels by sometime between 2008 and 2012.

Climate Trust

This organization was founded in the State of Oregon, with the intention to hedge future regulatory risk for Oregon companies, but with socially beneficial externalities. They will buy any type of ERU worldwide except those associated with soil sequestration due to their political sensitivity. Renewable energy and energy efficiency projects are preferred, with a preference for projects that take place in Oregon.

The organization has a long list of criteria when selecting projects, but most significant to the Climate Trust is additionality, permanence, portfolio diversity and leakage. The

Climate Trust is willing to pay a premium for projects that adhere to these criteria. Any additional quality criteria would be noted, but would increase the prices paid for ERUs. These co-benefits are considered tiebreaker criteria. They are presently looking to buy ERUs in the price range of $1.00 - $5.00 per tCO_2.

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Mike Burnett, Executive Director
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Climate Trust Email: mburnett@climatetrust.org
516 SE Morrison Street, Suite 1200B
Portland, OR 97214-2390
Web: www.climatetrust.org

OTHER ENTITIES PARTICIPATING IN COMMERCIAL ER TRANSACTIONS

KEFI-exchange
The KEFI-exchange is a pilot private exchange sponsoring trades of ERUs from a small set of test projects. Its focus is to give a true clear price signal for ERUs. The exchange generates certificates for forward contracts out to 2012. The majority of trades have been energy-related between companies in Western Canada (KEFI facilitated the recent trade between TransAlta and Epcor Utilities). KEFI staff stated that prices for trades have fallen between US$1.00 - 1.50 per tCO2. They believe that any credit for early action could almost immediately increase the price up to a maximum of $10 per tCO_2. But this is unlikely to happen in Canada for at least 2 more years, with a slight chance of price increases earlier.

Quality has been identified as an important issue, due to encounters with companies that will not trade credits unless they have been accredited by a non-partisan accrediting institution like GERT or PERT (e.g. Ontario Power Generation).

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T2M 1E7
Phone: (403) 210-2144
Fax: (403) 282-3323
Website: http://www.kefi-exchange.com/

Environmental Resources Trust (ERT)
ERT helps to create markets for environmental resources regionally, nationally, and globally through value-added and environmentally beneficial transactions. ERT aims to reduce pollution and stimulate markets through projects that involve the acquisition of air pollution emission allowances. ERT also has facilitated emissions allowance

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transactions, such as the carbon dioxide (CO2) sulfur dioxide (SO2) swap between Niagara Mohawk Power Company and Arizona Public Service.

Canada has been identified by ERT as a higher priced market. These prices tend to be higher than those in America because of overt government backing (although there aren't any fixed laws). This can also be associated with higher willingness to pay in buyer behavior and is most likely to be associated with their perception of what the future political climate.

Greenhouse Gas Emission Reduction Trading (GERT)
The Canadian Greenhouse Gas Emission Reduction Trading (GERT) Pilot, to be completed Dec. 31, 2001, focuses on providing industry, government, and other participants with experience and training in the implementation of greenhouse gas emission (GHG) reduction trading schemes. This includes reviewing a wide variety of projects, trades, and developing the key elements of a trading system.

GHG emission trading projects currently being reviewed through GERT include small hydro, fuel switching, landfill gas utilization, forestry, and wind power projects across Canada, from B.C to Newfoundland. The GERT Pilot reviews both traded projects, where a buyer and a seller of emission reductions have been identified, and offers to sell, where a buyer has not yet been identified.

GERT has a set of mandatory review criteria that can be roughly summarized as the following:

- Additionality, although they are still developing the definition for additionality
- Leakage
- Measurable, pilot proponents are required to measure and report on the emission reductions from their projects on an annual basis
- Verifiable, calculation methodology must be acceptable, transparent and replicable and the raw data required to verify and audit the calculations must be made available upon request
- Surplus

Secondary GERT criteria:

- Sole ownership, to ensure against double counting of emission reductions
- Other environmental and socio-economic benefits

Contact:
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Greenhouse Gas Emission Reduction Trading Pilot
Saskatchewan Department of Energy & Mines
Energy Development Branch
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Regina, Saskatchewan
Canada S4P 3V7

phone: (306) 787-3379
fax: (306) 787-2333
e-mail: HLoseth@sem.gov.sk.ca
Website: http://www.gert.org/

Greenhouse Emissions Management Consortium (GEMCo)
GEMCo is a consortium of approximately 10 Canadian energy companies focusing on market-based ways of reducing GHG emissions. GEMCo does not discriminate between project types (sequestered or offset) as long as there is an agreement on protocol. GEMCo will not bear CER certification risks under CDM until guaranteed under the supposed Kyoto Protocol rules.

GEMCo identified the cause of price differentiations in this market as the cost associated with project initiation, reducing the stream of GHG credits (vintage of ERU and the year of project investment). The following is a list of how this can affect the price of these units (mainly due to regulatory uncertainty) from least expensive to most expensive:

- Reduction action takes place before implementation period (2008-2012) and reductions take place before that period, too.
- Reduction action takes place now. Reductions begin now and continue occurring through the implementation period.
- Reduction action takes place after the beginning of the implementation period with reduction stream occurring right after.

The best price, right now, for vintage 2008-2012, with the reduction stream occurring form 2008-2012 is around US$ 3 per tCO_2. This induces the GEMCo Team to look at deals holistically and weigh it towards later vintages by incorporating both the CDM and the JI reductions. This may result in GEMCo purchasing ERUs that are expensive and less risky due to the diversification.

GEMCo previously tried to develop a project in Costa Rica (1998), but decided to walk away due to poor deal structure. The original Costa Rican offering was only partially securitized. The project developers could not resolve the issue of compensation if the seller failed to deliver the credits. The seller needed to guarantee delivery and institute a penalty system forcing it to find alternative ERU on the market (or otherwise) to deliver to the buyer. The suggestion was made to get the Costa Ricans to put up a certain portion of ERUs as a firm commitment with the use of the below listed risk sharing structure:

<u>Risk Sharing Structure</u> (could result in various price schedules within a deal)

1. Those offsets with backing carry the highest price (seller committed to selling, buyer committed to buying).
2. Those tons that fall under a right of first refusal carry the second highest price. This is a right to deliver on the part of the seller, and the buyer must pay for the tons of CO2 if delivered at the agreed price.

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3. "Put" (i.e., sell) provision tons carry the lowest price. The seller has no obligation to offer these ERUs to the buyer, but under the Kyoto Protocol , the buyer has an obligation to pay for them.

Also in this deal structure is an M&V protocol bailout provision. If a government M&V protocol is suddenly introduced after the contract begins, there is a clause that will allow the buyer to bail if cost runs over say 10% of total cost of the deal. If the costs are under that margin, the buyer must pay the extra cost. If this clause is included, the buyer is then willing to pay more for ERU. Most contracts GEMCo currently has have full bailout clauses if Kyoto Protocol blows up. Otherwise it is not a "true deal."

ENVIRONMENTAL BROKERS AND OTHER RELATED ORGANIZATIONS

Canadian Voluntary Challenge & Registry
VCR Inc. is a stand-alone, not-for-profit corporation dedicated to encouraging private and public sector organizations to voluntarily limit their net greenhouse gas emissions. It will accommodate emerging Canadian registration needs such as baseline protection, credit for early action, voluntary emissions trading, and offset systems that are currently being studied or proposed.

Pilot Emission Reduction Trading (PERT)
Pilot Emissions Reduction Trading Project, PERT, is similar to GERT, but the former only operates in the Canadian province of Ontario. PERT is an industry-led, multi-stakeholder environmental initiative. PERT is evaluating emission reduction trading as a tool to assist in the reduction of smog and other air pollutants in the Windsor-Quebec corridor, and the effects of climate change. They are facilitating emission reduction trading between companies is to help shape future legislation and commitments on emissions.

PERT has reviewed 20 million tons of CO_2 reduction projects, 4 million is in process and 15 million tCO2 worth of projects are in the pipeline. The top buyer to go through PERT is Ontario Power Group. The current price for vintage 2000 is $0.67 per tCO_2. The five main criteria used to evaluate these ERUs are:

- real,
- surplus,
- quantifiable
- verifiable, and
- unique.

The five main sub-criteria would be ownership, leakage, additionality, and project risk in general. Through the use of these criteria, PERT is able to ensure more reliable and quantifiable credits.

Sydney Futures Exchange
The Sydney Futures exchange is developing an exchange-traded market for carbon sequestration credits. The carbon trading market is being developed initially by SFE in association with State Forests of New South Wales. This carbon trading market will be open to all interested participants.

The integrity of the market will be underpinned by transparent carbon accounting, an open carbon standard, as well as ongoing verification and independent certification processes. Tokyo Electric Power Company (TEPCO), a Japanese electric utility, has signed a deal with NSW State Forests
to plant 1,000 hectares of forest in year 2000.

International Emissions Trading Association
The International Emissions Trading Association (IETA) is an independent, non-profit organization working to establish a system for trading in greenhouse gas emissions. IETA is committed to securing the development of market-based trading systems that are demonstrably fair, open, efficient, accountable and consistent across national boundaries. One of their main activities is to compile a transaction database.

International Petroleum Exchange

The IPE is Europe's leading energy futures and options exchange. The IPE provides a highly regulated marketplace where industry participants use futures and options to minimise their price exposure in the physical energy market. Over $1billion daily in underlying value is traded on the IPE.

London-based IPE proposal for creating a carbon market are at a more embryonic stage. The exchange hopes to establish a market for CO_2, N2O, and CH4 (methane) emissions credits sometime in 2001.

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IPE
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1 St Katharine's Way
London E1W 1UY, U.K.
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Fax number: +44 (0) 20 7481 8485
Information: +44 (0) 20 7265 3636
Website: http://www.ipe.uk.com/index.html

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5. Bibliography

Fels, M. "Special Issue Devoted to Measuring Energy Savings, The Princeton Scorekeeping Method (PRISM)", *Energy and Buildings*, (ed.) 1986, Vol. 9, Nos. 1 and 2.

Jochem, E. and E. Gruber, "Obstacles to Rational Electricity Use and Measures to Alleviate Them," *Energy Policy*, pp. 340-350, June 1990.

Johansson, T.B.; Kelly, H.; Reddy, A.K.N. and Williams, R.H. *Renewable Energy Sources for Fuels and Electricity*, Island Press, Washington, DC, (eds.), 1993.

"Proceedings of the United States Initiative on Joint Implementation Program Conference", Arlington, VA; May 31-June 1, 1995.

Swisher, J.N. and Masters, G.M., "A Mechanism to Reconcile Equity and Efficiency in Global Climate Protection," *Ambio*, vol. 21, pp. 154-159, 1992.

Swisher, J.N., "Joint Implementation under the U.N. Framework Convention on Climate Change: Technical and Institutional Challenges", *Mitigation and Adaptation Strategies for Global Change*, vol. 2, pp. 57-80, 1997.

Swisher, J.N. and Renner, F.P., "Carbon Offsets from Biomass Energy Projects", *Proceedings of the Seventh National Bioenergy Conference*, Tennessee Valley Authority, Muscle Shoals AL, 1996.

Tuller, Lawrence W., *Financing the Small Business*, Prentice Hall, New York, NY, 1991.

Delphos, William A., *Power Money, The international business Executive's Guide to Government Resources*, Sponsored by the U.S. Export Council for Renewable Energy, Venture Publishing N.A., Washington DC, 1994.

Nevitt, Peter K., and Frank Fabozzi, *Project Financing – Sixth Edition*, Euromoney Publications, 1995

6. References on obstacles to financing CCMIPs

Hirst, E. and M. Brown, "Closing the Efficiency Gap: Barriers to the Efficient Use of Energy", *Resources, Conservation and Recycling*, 1990, 3(4), pp. 267-281.

Greenhouse Gas Pollution Prevention-Climate Change Supplement (GEP-CCS)

Fostering Climate Change Initiatives for Sustainable Development

Marketing and Funding Toolkit

The Louis Berger Group, Inc.

Toolkit Objectives

- Give project developers an ability to market their CCMPs to investors.
- Identify sources of debt and equity financing for CCMPs.

What is Marketing?

- Analyzing, packaging and presenting CCMPs to potential investors and funding agencies.
- Requires in-depth knowledge of:
  - Project's strengths and weaknesses
  - Investors' needs and expectations

Potential Investors

- Conventional, commercially-oriented
  - Will typically focus on risks to cash flow
- Non-conventional, environmentally-oriented
  - May accept higher risk in exchange for environmental benefits

Project Assessment Criteria

⇩ Key information to provide to investors:

- Expected total project cost;
- Projected revenues from sale of goods or services;
- Risks to project realization;
- Local economic, social and environmental impacts of the project; and
- Preliminary pro-formas, if available.

Project Assessment Criteria

⇩ Questions for developer to answer prior to seeking project funding:

- Where am I in the project cycle regarding stage of development, financing needs and risks?
- What do I need to get to the next step in my project development (equity investment, bridge loan, technical support, grant funding)?
- What does the funder want to know most about my project (what are the funder's criteria)?

Types of Project Funding

- Grant financing
  - Funder does not expect financial return
  - Funder may have strict requirements as to use of funds
- Debt financing (loans)
  - Contractually defined terms of maturity and interest rate
  - Lower risk: does not represent ownership in the project
  - Collateral required in the form of assets

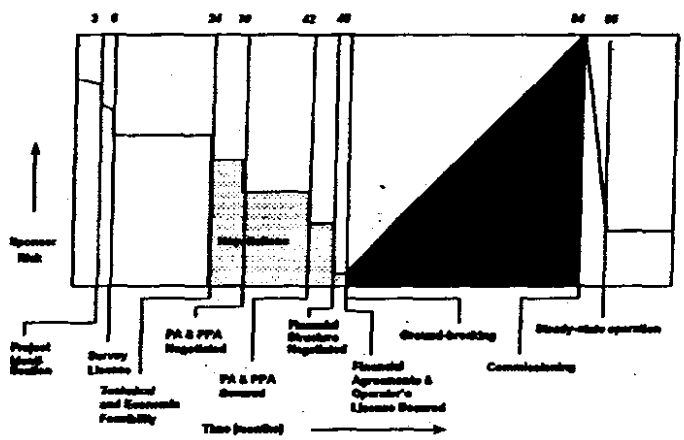
Types of Project Funding

- Equity financing (ownership)
  - Direct, proportional ownership in the project
  - Value through distribution of profits
  - Value through eventual sale of ownership at higher valuations
  - Higher risk: no claim to other assets, potential to lose entire investment

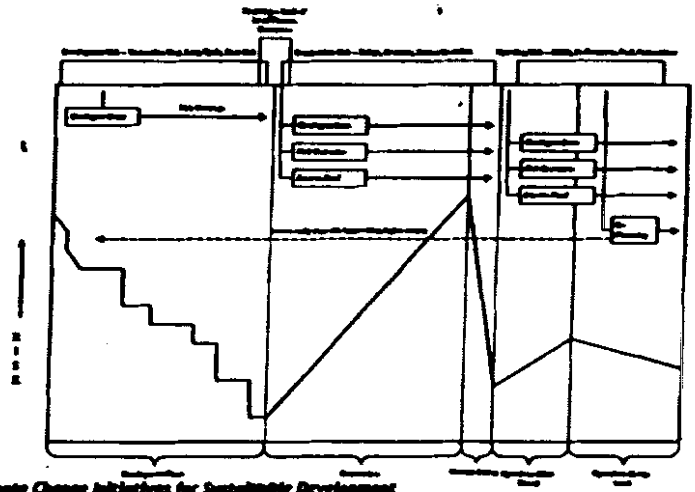
Investment and Risk

- A fair and honest exploration of the risks is critical to attracting investor interest.
- The level of risk varies through project development process.
- Various types of funding address these risks.
- CCMP developers must be willing to share in the project risks.

Project Development and Risk: Run-of-the-river Hydro CCMP



Project Development and Risk, with Financing Modalities



Fostering Climate Change Initiatives for Sustainable Development
Development of Computational Toolkits: Baseline Development

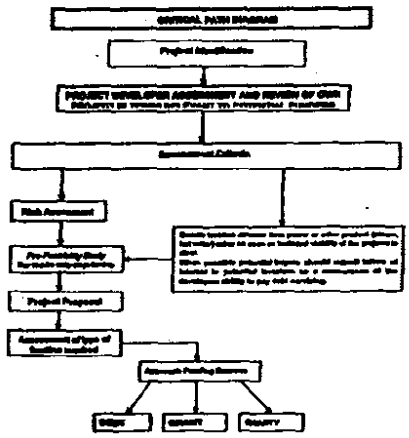
Project Presentation: Project Brief

⇩ **Main elements:**

- Project Identification
- Project Goal
- Background
- Market Assessment
- Project Description
- Preliminary Technical Assessment
- Preliminary Financial Assessment
- Preliminary Legal and Institutional Assessment

Fostering Climate Change Initiatives for Sustainable Development
Development of Computational Toolkits: Baseline Development

Project Presentation: Critical Path Diagram



Fostering Climate Change Initiatives for Sustainable Development
Development of Computational Toolkits: Baseline Development

Funding Sources for CCMPs

⇩ International Finance Corporation (IFC)

- IFC provides non-recourse project finance (debt, equity, and quasi-equity)
- Maximum 25% of project cost (up to 35% for smaller projects)
- Market pricing (but flexible on final maturity and grace period)
- No government guarantees
- Meet IFC and host country environmental guidelines

Fostering Climate Change Initiatives for Sustainable Development
Development of Computational Toolkits: Baseline Development

Funding Sources for CCMPs

⇩ Renewable Energy and Energy Efficiency Fund (REEF)

- US$ 65-100 million global private equity investment fund
- First fund focusing on RE/EE projects in emerging markets
- Mid-sized projects < 50 MW
- Parallel debt facility of $100 million
- Additional US$ 25-30 million in GEF funds for project co-financing
- Status -- looking for projects!

Funding Sources for CCMPs

⇩ World Bank Prototype Carbon Fund (PCF)

- Objectives:
  - » To demonstrate how CCMPs can promote sustainable development (what does this mean, how can it be measured);
  - » To provide the Parties to the UNFCCC an opportunity to "learn-by-doing";
  - » To partner with public and private sectors to mobilize new resources for climate change mitigation and build confidence in trade dominated by private capital and intermediaries

Funding Sources for CCMPs

⇩ Small and Medium Scale Enterprise Program

- US$ 21 million program to provide contingent, concessional loans to financial intermediaries (FIs) which then on-lend or invest in SMEs
- FIs include both NGOs and commercial enterprises
- Incentives for FIs to seek repayment from SMEs
- 10 FIs selected to date - US$ 6.3 M approved

Funding Sources for CCMPs

⇩ Solar Development Group

- Exclusive focus on Rural PV SHSs in Emerging Markets
- $50 million Target Initial Capitalization
- Private, Stand-alone Entity with Finance Window ($32 million) and Business Development Services ($18 million) to local PV companies.
- Initiative launched by World Bank, IFC, GEF and U.S. Charitable Foundations as Potential Founding Investors

Funding Sources for CCMPs

- Efficient Lighting Initiative (ELI)
  - ELI aims to overcome the barriers to efficient lighting technologies in seven countries
  - ELI's resources: US$15 in GEF funds (US$2m for Argentina; US$2.1 m for Peru)
  - ELI's market interventions:
    - » Product quality standards & labeling
    - » Financing
    - » Public education
    - » Transaction support
    - » Market aggregation

Funding Sources for CCMPs

- Indian Renewable Energy Development Agency Ltd. (IREDA)
  - Mission is to advance sustainable development by promoting and financing self-sustaining investment in renewable energy and energy efficiency
  - Funding primarily lines of credit from Asian Development Bank ($100 million), World Bank ($280 million), and others

Funding Sources for CCMPs

⇩ Nuon

- Largest energy and water utility in the Netherlands and one of the largest clean energy providers in Europe
- Pursuing clean energy equity investments in both industrialized and developing countries
  - » Wind farm in China
  - » Rural electrification and photovoltaic solar home system business in South Africa
  - » $53.5 million equity investment in the Green Mountain Energy Company in the United States

Funding Sources for CCMPs

⇩ Triodos Bank

- Dutch bank that offers financing to businesses with social and environmental objectives
- Manages the Solar Investment Fund (SIF) to provide loans and guarantees to intermediary institutions which in turn sell or lend to buyers of photovoltaic solar home systems
- Co-investor/manager in the Solar Development Group

Funding Sources for CCMPs

- MeesPierson
  - Dutch commercial bank whose Global Energy Finance Group provides a complete package of commercial and investment banking services, including structuring, arranging, underwriting, and participating in corporate transactions and project financing
  - Particularly active in financing wind projects

Funding Sources for CCMPs

- Global Environment Fund
  - Not to be confused with the multilateral Global Environment Facility (GEF)
  - Venture capital fund manager with over $250 million under management
  - Two of its funds invest in renewable energy, among other environmentally-oriented projects

Funding Sources for CCMPs

- Photovoltaic Market Transformation Initiative (PVMTI)
  - $25 million fund developed by the IFC to finance and provide technical assistance to solar photovoltaic enterprises in developing countries, initially India, Kenya, and Morocco

Funding Sources for CCMPs

- Finnish Fund For Industrial Cooperation Ltd.
  - FINNFUND's Private Energy Market Fund makes both equity and quasi-equity investments in energy projects and enterprises in developing countries
  - The investment targets are expected to be combined heat and power plants, power plants that use biofuels and other new fuels, and companies focused on improving energy efficiency.

Funding Sources for CCMPs

- Deutsche Investitions und Entwicklunggesellschaft mbH (DEG)
  - German government financial institution that finances the establishment, expansion, and modernization of private enterprises in developing countries
  - Tends to focus on joint ventures with German or European enterprises
  - DEG has supported wind projects in Brazil and Ghana, and a 36 megawatt run-of-river hydro project In Nepal

Funding Sources for CCMPs

- Industrialization Fund for Developing Countries (IFU)
  - One of the Danish government's international investment funds
  - Provides equity, debt, and guarantees, and assists in mobilizing supplementary financing from other sources for projects in all but the poorest developing countries
  - Generally participates as an equity partner, but can also provide loans

Funding Sources for CCMPs

- Export-Import Bank of the United States (Ex-Im Bank)
  - U.S. Government export credit agency
  - Facilitates short-, medium- and long-term financing to creditworthy international customers to purchase U.S. goods and services
  - Facilitates short- and medium-term export credit insurance to enable U.S. firms to extend credit directly to international customers
  - The Bank is interested in, and has actively supported, clean energy projects
  - Can provide concessional financing on a case-by-case basis to renewable energy exporters

Funding Sources for CCMPs

- Netherlands Development Finance Company (FMO)
  - Dutch development bank specializing in providing finance to the private sector in emerging markets
  - In addition to providing both equity and debt, the FMO implements a number of special Dutch government programs: Small-scale Enterprise Fund; Seed Capital; Investment Promotion and Technical Assistance for Developing Countries; Investment Promotion and Technical Assistance for Central and Eastern Europe.

Funding Sources for CCMPs

- Power Finance Corporation (PFC)
  - Public development financial institution, wholly owned by the government of India, dedicated to providing financial support to power sector projects

Funding Sources for CCMPs

- Indian Financial Institutions
  - IDBI
    - The IDBI bank is one of the leading lending and financial institutions in India
  - ICICI
    - ICICI's main function in the Indian capital markets is to provide financing for industrial companies, typically in the form of corporate term loans and project finance
  - IFCI
    - Commercial bank which provides term loans as well as project finance structures

Computational Tool Kit: Sustainable Development

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United States Agency for International Development
Greenhouse Gas Pollution Prevention Project
Climate Change Supplement
(GEP-CCS)

Fostering Climate Change Initiatives for Sustainable Development

Task 1C
Computational Tool Kit: Sustainable Development

By:

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May 14, 2001

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Executive Summary

Introduction

The objective of the sustainable development (SD) toolkit is to present a clear conceptual model of what SD means in general terms as well as in the context of climate change mitigation projects (CCMPs). The toolkit is designed to provide developers of projects to reduce emissions of greenhouse gases (GHGs) with the analytical methods and tools they need to assess the degree to which their projects incorporate SD principles, as well as to assist them in the process of incorporating SD principles. More specifically, the toolkit is designed to be used by Development Alternatives and organizations like it in their efforts to support project developers in India. Accordingly, the intended audience for this document includes businesspeople and practitioners of energy efficiency and renewable energy development – "project developers" in these areas – instead of theorists and academic specialists in the field. It is hoped, however, that both groups can benefit from, as well as apply, the ideas and materials contained here.

This document comprises the first of five toolkits, and covers SD in general terms. The four companion toolkits comprising documents on (1) carbon baseline preparation, (2) development of carbon emissions monitoring and verification protocols, (3) the carbon finance model and (4) the marketing and funding of climate change mitigation projects, are more narrowly focused. The purpose of this "SD Toolkit," therefore, is to assist project developers in the assessment of the SD attributes of their projects, and to seek ways to design more SD attributes into new projects. In addition, this document orients its readers on the linkages between SD principles in general and the narrow focus of carbon analysis and project development implicit in the other four toolkits, and it provides a framework for understanding the relationships between the other four as well as their individual uses.

This toolkit contains three major components. The first component (Section 2) provides a very brief summary of the intellectual underpinnings and origins of the concept of SD, while the following one (Section 3) articulates the concept of SD in greater detail. Although this presentation cannot be construed as being a definitive treatment, it is representative of current thinking on the subject. The last major component (Section 4) provides a set of SD indicators for use in establishing an initial (baseline) assessment of SD benefits from a given project or company, as well as for measuring increases in the generation of SD benefits. These indicators are intended to be adapted to the needs and characteristics of each project and company, and to be incorporated into regular reporting procedures, in the same way as financial reporting is performed.

Background on Sustainable Development

With the emergence of the modern environmentalist movement beginning in the 1960s, debate raged between the "technocentric cornucopians" (such as Julian Simon) and the "limits to growth" school of thought (such as the "steady state economics" articulated by Herman Daly), as well as even more uncompromising versions, such as the "deep ecology" espoused by various writers.[1] By the late 1980s, with the publication of the findings of the World Commission on Environment and Development (the "Brundtland Commission") in *Our Common Future*,[2] the bases for several different threads of argument over the definition had emerged. Since the publication of the Brundtland report, with its well-known formulation of SD as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" a great deal of further theoretical, and increasingly, empirical work has been done. Recent scholarship as well as practical experience indicate that SD encompasses three broad areas: environmental, economic and social sustainability. Sustainability in any single one of these areas depends on the degree to which it is achieved in the others.

The presentation of SD in this toolkit stresses that the implementation of SD principles is an evolutionary process that will take time, and that there are different "levels of sustainability" as well as different aspects of sustainability. At the same time, the view that SD requires limits to economic growth is rejected here. This assertion is based on two assessments: first, that there is increasing evidence that the search for greater environmental sustainability fosters a significant degree of technological innovation that permits companies to "do more with less" (a process that offers limitless potential for development and growth); and second, that in the emerging economies of the world, it is impossible for there to be any political support for development policies that limit growth, at least in the near term. In the end, the move toward SD must include the development of sustainable economic activity – sustainable businesses – for without them, economic activity would revert to unsustainable activities.

In its current mode, industrial development is essentially linear, based on the extraction of raw materials, processing these raw materials in an often large number of intermediate steps, and delivering a finished product to the end-user that embodies a small fraction of the total mass of the materials and energy extracted to produce it. The balance of materials and energy is accounted for as waste, some of which might be recycled, but the vast majority of which is not. Further, the level of extraction of certain "renewable" resources (forests, fisheries) exceeds the level at which those resources can regenerate themselves, while the volume of wastes produced exceeds the carrying capacity of the natural ecosystems where they are discharged.

Conceptual Framework for Understanding SD

[1] See Pearce, David and Turner, Kerry, *Economics of Natural Resources and the Environment*, (Johns Hopkins University Press, 1990): 12-15.
[2] Oxford University Press, 1987.

A large body of literature has been produced over the last 20 years detailing how the transformation of industrial activity cannot be achieved unless businesses and consumers have the correct incentives to move in that direction. In this respect, the analysis of sustainable development enters two broad areas: economic, or financial and commercial, sustainability, which describes how environmental sustainability flows from changes in the paradigms of business management; and social sustainability, which details how the transformation of business and industry toward SD helps strengthen linkages with surrounding communities, on the one hand, and how transformations of the communities themselves toward more sustainable modes of organization yield both local and broader benefits. These dynamics, in turn, generate strengthening political support for the continued evolution of business and communities toward SD.

In addition to environmental sustainability, therefore, it is necessary to address two other facets of sustainability: economic and social. It is important to note, however, that these two aspects of sustainability do not merely describe microeconomic and macroeconomic issues, although economic analysis at both levels is relevant. In both instances, and especially the social aspect, the implications of SD in terms of public, political and cultural developments are also important. Clearly, advances in technology play a central role in this process, with advances permitting the financially viable implementation of enhancements in efficiency and reuse of otherwise waste materials. Also, the linkages (environmental-economic, or "eco-efficiency", socio-environmental, and socio-economic) between these facets of sustainability are important.[3] Figure 1 summarizes the salient issues encompassed by these three facets of sustainability.

Technology is an important part of all three facets of sustainability – indeed it is a common thread uniting them.[4] "Technology" itself is a potentially sweeping concept in and of itself, since it may be understood to encompass *hardware* – equipment, tools, machines, etc. – as well as *software* – understood to include not just what is commonly thought of as software, computer programs, etc. but also organizational management techniques, analytical tools, etc. For the purpose of this conceptual presentation, "technology" is understood in its most sweeping definition.

Environmental Sustainability

There are different levels of environmental sustainability. World Bank economist Robert Goodland[5] describes these as "weak", "strong," and "restorative" (Goodland uses "absurdly strong") environmental sustainability.[6] The distinction between the three degrees is based on a classification of the types of capital necessary for all natural and

[3] See, for example, Ranganathan, Janet, "Sustainability rulers: measuring corporate environmental and social performance," *Sustainable Enterprise Perspectives* (Washington: World Resources Institute, May, 1998): 2-3.
[4] Personal communication, Janet Ranganathan, WRI, May 9, 2001.
[5] See Goodland (1995).
[6] The notion of environmental restoration as investment is implicit in Hawken, Paul, *The Ecology of Commerce* (HarperCollins: New York, 1993): 209 ff.

human production systems, and the types of flows or transformations that occur within and among them. The classification of capital involves natural capital (natural resources,

Figure 1: The Three Facets of Sustainability

Environmental	Economic	Social
Overall environmental impacts of economic activities, in terms of their rate of extraction (relative to rate of regeneration) as well as discharge levels (relative to carrying capacity) – with new technologies and management techniques, as well as social patterns, contributing to improvements	Potential for companies and projects engaged in environmentally sustainable activities to sustain themselves commercially and financially, creating jobs, wealth, and the basis for further gains and improvements – technological, managerial, and products	Social sustainability refers to social well-being and political stability that ensure the continuation and growth of social welfare, and the health of society, which in turn are vital to the propagation of innovations in technology, management practices, and advances in social organization the are crucial to economic sustainability
Linkages between the Three Facets[7]		
Environmental-Economic	Socio-Economic	Social-Environmental
The interface between environmental and economic sustainability has been referred to as "eco-efficiency" – materials use efficiency, energy efficiency, and economic value-added per unit of waste or pollutant discharge into the environment	The interface of social and economic sustainability covers the mutually reinforcing aspects of each – employment creation, equitable distribution of wealth, businesses serving social needs, investment in education and other social infrastructure, minority supplier access, and empowerment of women	The interface between social and environmental issues involves a range of concerns, from impacts of pollution on human health to human impacts on the environment, especially in rural areas, as well as issues of equity in access to natural resources, land tenure

both renewable and non-renewable, that produce a flow of materials and services, such as water purification, pollutant decomposition, etc.), human capital (labor), human-made capital (the traditional material conception of capital, both in its "liquid" – financial – and "illiquid" forms), and social capital (cultural, intellectual and technological knowledge that is maintained by successive generations of workers, engineers, managers and artisans who embody human capital).[8]

[7] See Ranganathan, op.cit.

[8] These definitions are not given by Goodland, but are consistent with his presentation of the concepts. Other writers present the categories of natural, financial, material (human-made), and human capital. This classification is equally defensible, but is not adopted here because the notion of money seems just as "artificial" as that of human artifacts, and because the distinction between human beings of a given time-period from the corpus of technological and cultural knowledge of that time is especially relevant. In the

Hence, the achievement of SD involves reducing the amount of material and energy required to create a unit of the final product, through *efficiency* enhancements, as well as finding ways to use what would otherwise be waste material as an input for other productive processes. This concept, which is complementary to efficiency and may be referred to as the identification of *process symbiosis*, is based on the assertion that only completely self-contained processes are truly sustainable. In a closed industrial production system, waste from one process is used as inputs for others. In short, these two concepts form the basis for attributes of environmental sustainability in industrial processes and/or projects.

Initially, enterprises or projects may begin with the implementation of actions that enhance the efficiency of resource or energy use in the overall production process without altogether eliminating the formation of wastes and effluents. The types of measures adopted range from actions that carry virtually no cost – implementation of good housekeeping procedures – to those that carry successively more significant costs and capital investment requirements – input substitution, process controls, equipment modification, and technology change. The end product might also be modified to reduce input requirements in manufacturing and/or fuels and material requirements when used as designed.

Subsequently, enterprises or projects can build on efficiency gains to identify and implement actions that actually reorganize processes, or link them to other, unrelated processes, to find productive uses for wastes and effluents in an effort to squeeze pollutant formation to zero. The goal of zero emissions comes about not just by reducing the generation of pollutants, but more importantly through the redefinition of pollutants as inputs for another process. This is referred to as symbiosis here, but has variously been labelled "biomimesis," "industrial ecology," "clean production," or "zero-emissions production." The key notion is that of imitating ecological systems – in the natural world, no material is wasted, energy is conserved, and balance is preferred to concentration, imbalance and inactivity. As Paul Hawken puts it, in nature, "waste equals food."[9]

The permanence of the environmental benefits obtained through the implementation of SD principles – or their "environmental integrity" – is enhanced as the types of actions proceed up the ladder from efficiency enhancements towards actions that close the loop and result in truly symbiotic processes. The importance of technology – both hardware and software – to this process is clear. Successive advances in production processes, management methods and equipment enable the same level of output to be obtained with reduced inputs and diminished waste generation. Meanwhile, product improvements enable consumers to obtain the same level of service or performance with lower energy consumption, materials use, and waste generation.

past, human beings have lost or even destroyed recorded or memorized knowledge with damaging consequences.

[9] See Hawken, Paul, *The Ecology of Commerce* (HarperCollins: New York, 1993).

In the last decade and half, many businesses throughout the world have begun to adopt environmental principles[10] and take the first steps toward SD. These actions may take the form of changes in management practices intended to result in alterations in productive processes, changes in the types of inputs used, development of new product lines, and changes in the business models employed. Complementing these actions, entrepreneurs and project developers have sought ways to provide services and equipment to enhance the efficiency of industrial processes, alter the environmental impacts of producing basic inputs, such as electricity and steam, reduce the pollution in different types of effluents and emissions, or even begin to close the loop and reuse or find productive uses for wastes.[11]

Economic Sustainability

For enterprises as well as policymakers, sustainability is an attribute consistent with commercial and economic realities, namely that a SD project must be economically sustainable – a viable venture grounded on a solid business concept – and must generate economic benefits to the community and broader social and economic context in which it is implemented. Over the longer-term the move toward reduced emissions and waste yields what some analysts have dubbed the "sustainable-development premium," the financial payoff to businesses, especially existing businesses, from the implementation of SD principles.[12]

In the long run, economic sustainability is essential to the proliferation of SD principles. This must be so, for in the absence of economic sustainability, activities that provide benefits in terms of environmental sustainability would depend always on government funding or donations – this would limit the extent to which they were implemented, on the one hand, and would subject them to the vagueries of political and public preferences. In contrast, economic sustainability implies that there is a financial or commercial incentive to undertake environmentally sustainable activities, thereby creating the potential for a virtually automatic process of expansion and economic transformation.

Social Sustainability

As companies undertake the longer-term move toward achieving the goal of zero-emissions and waste, other transformations occur that begin to extend the commercial benefits deriving from implementing SD principles to broader indicators of social sustainability at a macro-economic level. A venture based on SD principles benefits the community and country where it is located through job creation, local environmental benefits and resource recovery, enhanced standard of living, and creation of new educational opportunities. All of these benefits contribute to long-term social welfare,

[10] Such as the CERES Principles, the Business Charter for Sustainable Development, as well as others.
[11] Alan Hecht provides some examples of this process in "The triad of sustainable development: promoting sustainable development in developing countries," *The Journal of Environment and Development* 8 number 2 (June, 1999): 123-126.
[12] See Hedstrom, Gilbert; Shopley, Jonathan; and LeDuc, Colin, "Realizing the Sustainable-Development Premium," *Prism* Q1/2000 (Arthur D. Little): 12-17.

improved health for the human (as well as flora and fauna) in the community, political stability, and reinforcement of the trend toward SD.

The broader, community-based economic and environmental benefits and longer-term prospects flowing from a project may be characterized as attributes of social sustainability. This is critical, for in emerging economies, such as India, people cannot and will not allow environmental protections and other regulations to stand in the way of improving standards of living and opening up economic opportunities for their children. Therefore, any truly useful notion of SD has to be grounded in the need for *equity* between generations as well as among groups in the current generation (within countries as well as among countries). This notion of equity is not simply an environmental consideration – it is a social, economic and above all, a political one – and is vital to the socio-economic sustainability of a project or business.

Implementing and Measuring SD

The indicators suggested in this section are of a sufficient level of generality to accommodate their application as appropriate to any industrial process. Others not mentioned here may obviously be included by individual companies. The main objective is to develop a set of indicators to begin taking measurements and to record progress in increasing resource utilization efficiency. Experience in many industrial facilities suggests that over time, this process will lead to the elimination of whole areas of waste that were otherwise considered unavoidable.

The process of implementing measures to enhance environmental sustainability begins with the enhancement of resource-use efficiency (energy efficiency, waste minimization, water use reduction), followed by the implementation of measures intended to slowly squeeze the volume of waste material generated by industrial facilities. Although opportunities to exploit symbioses between industrial processes may sometimes be available at the same time as opportunities to invest in efficiency, it is likely that opportunities to exploit input-output symbiosis will emerge only in the context of close coordination and communication between companies from different sectors and access to information that might otherwise be considered confidential.

Environmental sustainability

- Development of mass/energy balances
- Measurements of resource utilization
- Resource consumption of end product
- Measuring recyclability/recycling

The financial measures typically used to evaluate any investment opportunity are relevant in the assessment of economic sustainability. All of the same issues regarding the evaluation of risk apply in CCMPs – as is made clear in the toolkit on the carbon finance model. However, there are also additional measures involving the provision of carbon osffset (Offsets) by CCMPs that require additional analysis. These are likely to be quantifiable, but they may also be qualitative in nature. Beyond the more traditional measures, there are also specific ones that will require more qualitative assessment, reflecting the fact that they have a great deal to do with the company management issues as much as engineering concerns.

Economic sustainability

- Measures of financial sustainability
- Rethinking business models
- Rethinking productive processes

The indicators suggested under this heading are as much qualitative as they are quantitative. To the extent that data are available to provide some quantitative points of reference for the items identified here, the evidence of how a given project or corporate initiative contributes to socio-economic sustainability will be strengthened. Nevertheless, managers should bear in mind that the qualitative indicators may well provide strong evidence of sustainability as well.

Social sustainability

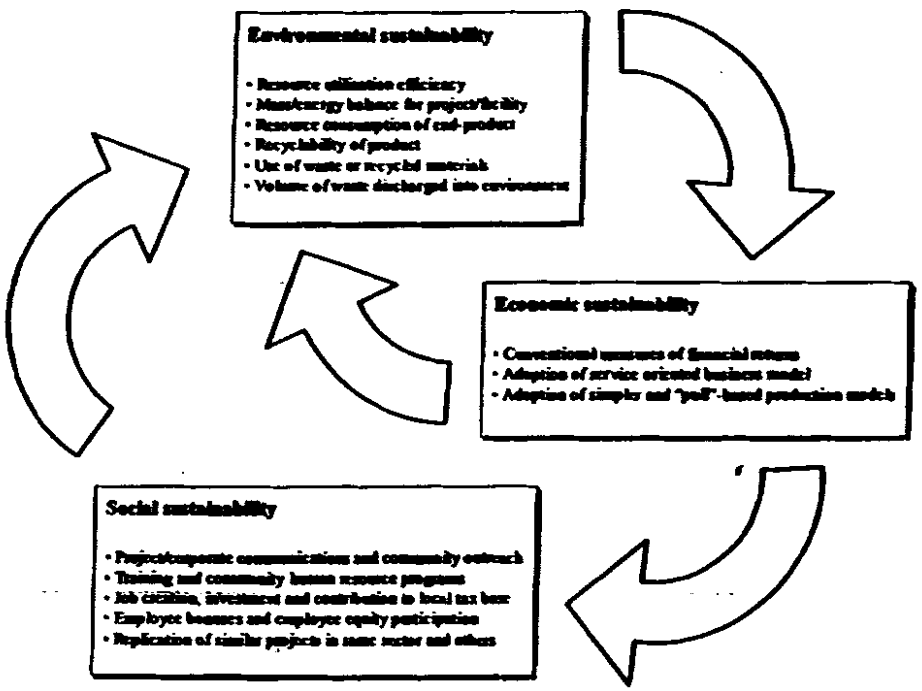
- Formation of human and social capital
- Creating constituencies for SD
- Generating project replication

The path to integrating SD principles into projects and corporate initiatives is necessarily a circular one, since that actions taken at the outset lead to conclusions that suggest new actions, and so forth. The process is iterative, and based on the basic total quality

environmental management cycle of "plan – do – check – act, and repeat." The relationship between the three facets of SD, in terms of where they fit in the critical path of SD implementation, is summarized in Figure 2.

The following checklist can be used as a questionnaire and self-assessment tool to identify the extent to which a project or corporate initiative integrates SD principles, and the list of SD indicators provides a representative selection of possible indicators that might be used.

Figure 2: Critical Path for Implementation of SD Principles



- Does the initiative to incorporate SD principles have the backing of senior management in the company, project developer or project company?
- Does senior management support public reporting of the scope and results of the initiative?
- Are sufficient human and material resources being allocated to this effort? Will the staff assigned to the task have sufficient time to work on it?
- Does the team assigned with this task comprise individuals familiar with the production (engineering), regulatory (including environmental compliance), marketing/sales, human resources and financial aspects of the company's business?
- Are adequate records kept of all aspects of the company's operations (production, regulatory, marketing/sales, human resources, finance)? What is the level of confidence in the accuracy of these records and the measurement equipment (where appropriate) used to obtain them?

Linkages between the Toolkits

This toolkit and the four others are interrelated. While this toolkit provides an overall framework for considering CCMPs in the broader context of SD, the other four provide the specific conceptual, and where appropriate, quantitative tools for developing and implementing CCMPs.

1. Introduction

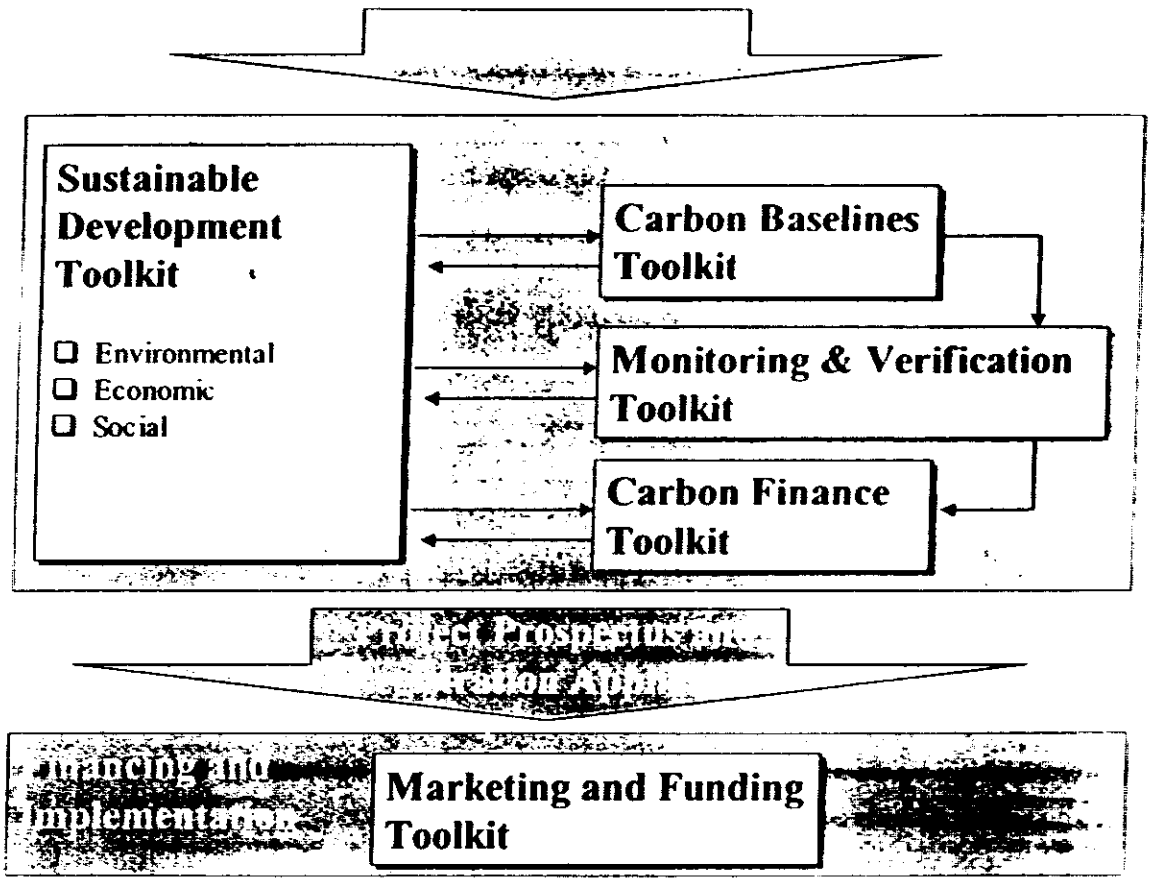
The objective of the sustainable development (SD) toolkit is to present a clear conceptual model of what SD means in general terms as well as in the context of climate change mitigation projects (CCMPs). The toolkit is designed to provide developers of projects to reduce emissions of greenhouse gases (GHGs) with the analytical methods and tools they need to assess the degree to which their projects incorporate SD principles, as well as to assist them in the process of incorporating SD principles. More specifically, the toolkit is designed to be used by Development Alternatives and organizations like it in their efforts to support project developers in India. Accordingly, the intended audience for this document includes businesspeople and practitioners of energy efficiency and renewable energy development – "project developers" in these areas – instead of theorists and academic specialists in the field. It is hoped, however, that both groups can benefit from, as well as apply, the ideas and materials contained here.

Because SD encompasses both micro- as well as macro-economic levels of analysis, from the enterprise to society and even the global community, it is especially important to understand that the primary focus of this toolkit is more modest, addressing the project and enterprise levels of analysis. Early work on SD, as well as more recent papers by Development Alternatives, stress the broader social and policy- related aspects of SD. Some more recent studies of corporate reporting and SD indicators have addressed ways for managers to incorporate SD considerations into company management, planning and business development. Similarly, the emphasis on this toolkit is on assisting Indian project developers and managers to understand SD and how it is related to climate change projects, and how to enhance the SD benefits generated by a given project. While this document does attempt to orient project developers within the broader macro-economic and global context of SD, its main purpose is to assist in the project development process only. As such, its main focus is on the project and enterprise level of activity and analysis, with the objective of assisting project developers to assess the SD attributes of their projects and to design more SD attributes into new projects.

This document is the first of five toolkits, and covers SD in general terms. The four companion toolkits comprising documents on (1) carbon baseline preparation, (2) development of carbon emissions monitoring and verification protocols, (3) the carbon finance model and (4) the marketing and funding of climate change mitigation projects, are more narrowly focused. In addition, this document orients its readers on the linkages between SD principles in general and the narrow focus of carbon analysis and project development implicit in the other four toolkits, and it provides a framework for

understanding the relationships between the other four as well as their individual uses. The relationship between the five documents is illustrated in Figure 3.

Figure 3: Relationships between the Five Toolkits



This toolkit contains three major components. The first component (Section 2) provides a very brief summary of the intellectual underpinnings and origins of the concept of SD, while the following one (Section 3) articulates the concept of SD in greater detail. Although this presentation cannot be construed as being a definitive treatment, it is representative of current thinking on the subject. The last major component (Section 4) provides a set of SD indicators for use in establishing an initial (baseline) assessment of SD benefits from a given project or company, as well as for measuring increases in the generation of SD benefits. These indicators are intended to be adapted to the needs and characteristics of each project and company, and to be incorporated into regular reporting procedures, in the same way as financial reporting is performed.

Finally, it is important to make clear what a toolkit is and is not, as understood and presented in the context of work by The Louis Berger Group Inc. on the Greenhouse Gas Pollution Prevention Project. First and foremost, the toolkits present the conceptual underpinnings along with the analytical methods and concepts for the development and implementation of projects that (1) reduce emissions of GHGs, and (2) incorporate SD

principles. As the metaphor "toolkit" suggests, neither this document nor the other four can be understood to provide ready-to-use solutions to complex problems involving a mix of quantitative and qualitative issues. Rather, these documents provide the "tools" that practitioners, who have some training and understanding of the issues involved, can use to solve the problems inherent in carbon accounting, preparation of monitoring and verification protocols, carbon finance and marketing. Because there is a significant amount of judgement involved in carbon analysis, and because the rules of the emerging carbon market are as yet undefined, it is impossible for the toolkits to serve as one-size-fits-all processors of carbon analysis problems for use by individuals who have not been exposed to the field. To the extent that these toolkits are used by those unfamiliar with the fields of SD and carbon accounting, they may serve as a useful primer and orientation course. It is expected that the toolkits will be presented in the context of formal training, through Development Alternatives as well as similar organizations throughout India, as well as in other emerging economies.

This toolkit, as well as the companion toolkits on carbon analysis and project financing issues, is expected to be updated continuously to reflect new developments. In particular, the efforts of Development Alternatives to support project development activities in India provide a useful forum for testing the methodologies and guidelines presented here, as well as a source of case studies. Development Alternatives has proposed that this toolkit and its companion documents be "tested" first on the 4.25-MW biomass gasification plant proposed by Ravi Entech Ltd. It is expected that these case studies will be incorporated into the toolkit binder in the section labelled "Annex: Project Case Materials."

2. Background on Sustainable Development

SD is a term that can and does mean different things to different people. Indeed, there are some who contend that SD is incompatible with economic growth, while others argue the opposite. While the more immediate origins of the term, and the debate over what constitutes sustainable development and how to achieve it, date back to the 1970s and the increasing international concern with environmental protection, the real intellectual precursors of the term and the debate over sustainability include figures from the age of classical economic theory, such as Thomas Malthus, John Stuart Mill, and David Ricardo.[13] The debate then – as more recently – was over the "limits to growth": would population growth lead humans to outstrip the productive capacity of a finite resource base, as Malthus argued, or would human ingenuity and scientific progress allow populations to enjoy improving standards of living based on the those same finite resources?

With the emergence of the modern environmentalist movement beginning in the 1960s, debate raged between the "technocentric cornucopians" (such as Julian Simon) and the "limits to growth" school of thought (such as the "steady state economics" articulated by Herman Daly), as well as even more uncompromising versions, such as the "deep ecology" espoused by various writers.[14] The term "sustainable development" first appeared in the work of the International Union for Conservation of Nature and Natural Resources (IUCN) in 1980.[15] By the late 1980s, with the publication of the findings of the World Commission on Environment and Development (the "Brundtland Commission") in *Our Common Future*,[16] the bases for several different threads of argument over the definition had emerged. Since the publication of the Brundtland report, with its well-known formulation of SD as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" a great deal of further theoretical, and increasingly, empirical work has been done. Recent scholarship as well as practical experience indicate that SD encompasses three broad areas: environmental, economic and social sustainability. Sustainability in any single one of these areas depends on the degree to which it is achieved in the others.

The presentation of SD in this toolkit stresses that the implementation of SD principles is an evolutionary process that will take time, and that there are different "levels of sustainability" as well as different aspects of sustainability. At the same time, the view that SD requires limits to economic growth is rejected here. This assertion is based on

[13] See Goodland, Robert, "The concept of environmental sustainability," *Annual Review of Ecological Systems* 26 (1995): 7.
[14] See Pearce, David and Turner, Kerry, *Economics of Natural Resources and the Environment*, (Johns Hopkins University Press, 1990): 12-15.
[15] Chatterjee, Kalipada and Hagler Bailly Services, "Measuring progress toward sustainable development in Indian climate change mitigation projects," Development Alternatives, (October, 1999): 5.
[16] Oxford University Press, 1987.

two assessments: first, that there is increasing evidence that the search for greater environmental sustainability fosters a significant degree of technological innovation that permits companies to "do more with less" (a process that offers limitless potential for development and growth); and second, that in the emerging economies of the world, it is impossible for there to be any political support for development policies that limit growth, at least in the near term. In the end, the move toward SD must include the development of sustainable economic activity – sustainable businesses – for without them, economic activity would revert to unsustainable activities.

It is also important to note that SD encompasses a broader range of environmental impacts than those addressed by climate change mitigation projects. Indeed, it is necessary to clarify that certain projects that reduce GHGs may not qualify as SD projects at all, while at the same time, not all SD projects involve GHG mitigation. Hence, while the presentation of SD criteria (Section 3) is more general in nature, the discussion contained in Section 4 – "Operationalizing and measuring implementation of SD principles in CCMPs" – is more narrowly focused on projects and corporate initiatives that deliver reductions in GHGs. It is hoped that specific case studies of projects will eventually be included in the document in the Annex.

issues, although economic analysis at both levels is relevant. In both instances, and especially the social aspect, the implications of SD in terms of public, political and cultural developments are also important. Clearly, advances in technology play a central role in this process, with advances permitting the financially viable implementation of enhancements in efficiency and reuse of otherwise waste materials. Also, the linkages (environmental-economic, or "eco-efficiency", socio-environmental, and socio-economic) between these facets of sustainability are important.[17] Figure 4 summarizes the salient issues encompassed by these three facets of sustainability.

Technology is an important part of all three facets of sustainability – indeed it is a common thread uniting them.[18] "Technology" itself is a potentially sweeping concept in and of itself, since it may be understood to encompass *hardware* – equipment, tools, machines, etc. – as well as *software* – understood to include not just what is commonly thought of as software, computer programs, etc. but also organizational management techniques, analytical tools, etc. For the purpose of this conceptual presentation, "technology" is understood in its most sweeping definition.

To begin with, technology is a critical part of improvements in environmental performance by business and industry, since new hardware, process techniques and management systems are responsible for reducing input requirements for specific types of output, for harnessing renewable resources, especially energy, that displace non-renewable resources.

Such improved technologies also create new business opportunities or enhance the profitability of existing businesses by reducing operations and maintenance costs, opening up new markets and displacing costly inputs. Businesses are, in turn, a major source of technological innovation, generating new hardware and software for internal uses in competitive markets as well as for sale to consumers, business customers, governments, and so forth.

Finally, new technologies and production methods contribute to social sustainability by enhancing social welfare, creating new economic opportunities for all segments of society, improving environmental quality, and facilitating communications and mobility. Society is the respository for technology, since technology is embodied in the cultural and intellectual knowledge of a given country or civilization. In this way, society not only benefits from advances in technology but in turn creates and operates the institutions (schools, universities and government) that are part of the well-spring of new technological innovations.

Figure 4: The Three Facets of Sustainability

[17] See, for example, Ranganathan, Janet, "Sustainability rulers: measuring corporate environmental and social performance," *Sustainable Enterprise Perspectives* (Washington: World Resources Institute, May, 1998): 2-3.
[18] Personal communication, Janet Ranganathan, WRI, May 9, 2001.

Environmental	Economic	Social
Overall environmental impacts of economic activities, in terms of their rate of extraction (relative to rate of regeneration) as well as discharge levels (relative to carrying capacity) – with new technologies and management techniques, as well as social patterns, contributing to improvements	Potential for companies and projects engaged in environmentally sustainable activities to sustain themselves commercially and financially, creating jobs, wealth, and the basis for further gains and improvements – technological, managerial, and products	Social sustainability refers to social well-being and political stability that ensure the continuation and growth of social welfare, and the health of society, which in turn are vital to the propagation of innovations in technology, management practices, and advances in social organization the are crucial to economic sustainability
Linkages between the Three Facets[19]		
Environmental-Economic	Socio-Economic	Social-Environmental
The interface between environmental and economic sustainability has been referred to as "eco-efficiency" – materials use efficiency, energy efficiency, and economic value-added per unit of waste or pollutant discharge into the environment	The interface of social and economic sustainability covers the mutually reinforcing aspects of each – employment creation, equitable distribution of wealth, businesses serving social needs, investment in education and other social infrastructure, minority supplier access, and empowerment of women	The interface between social and environmental issues involves a range of concerns, from impacts of pollution on human health to human impacts on the environment, especially in rural areas, as well as issues of equity in access to natural resources, land tenure

In the following sections, each facet is articulated in greater detail, with a discussion of the principle, the linkages between it and the techniques presented in other toolkits, and some illustrations of the relevance of the principle within the overall concept of SD.

Environmental sustainability

There are different levels of environmental sustainability. World Bank economist Robert Goodland[20] describes these as "weak", "strong," and "restorative" (Goodland uses "absurdly strong") environmental sustainability.[21] The distinction between the three degrees is based on a classification of the types of capital necessary for all natural and human production systems, and the types of flows or transformations that occur within and among them. The classification of capital involves natural capital (natural resources, both renewable and non-renewable, that produce a flow of materials and services, such as

[19] See Ranganathan, op.cit.
[20] See Goodland (1995):
[21] The notion of environmental restoration as investment is implicit in Hawken, Paul, *The Ecology of Commerce* (HarperCollins: New York, 1993): 209 ff.

water purification, pollutant decomposition, etc.), human capital (labor), human-made capital (the traditional material conception of capital, both in its "liquid" – financial – and "illiquid" forms), and social capital (cultural, intellectual and technological knowledge that is maintained by successive generations of workers, engineers, managers and artisans who embody human capital).[22] While the idea of natural capital is addressed here, the concepts of human, human-made and social capital will be reviewed in the context of the other sections of this Section (especially "Social sustainability," below).

Natural capital is defined as the stock of natural resources that provides both useful materials or products and services. This stock therefore includes renewable resources, such as fisheries or timber, as well as non-renewable resources, such as petroleum, coal or metals, as well as natural capability to process pollutants – referred to as absorptive capacity. In the "strong sustainability" described by Goodland, no resource depletion is permitted unless its utilization ensures that future needs will be met through some other use of a natural (preferably renewable) or human-made resource. For example, in the case of a non-renewable resource such as petroleum, its exploitation according to the principle of strong sustainability would require that some share of the proceeds by dedicated to the development of alternative resources. This is actually occurring today, as companies such as British Petroleum and Royal Dutch/Shell dedicate a part of their budgets to the development of new businesses based on renewable forms of energy. The idea is based on the potential for substitutability of natural capital for human-made capital, within defined limits.

Another example involves the concept of sustainably designed buildings and communities. There are numerous cases of efforts of this type all over the world, leading to the emergence of the architectural and construction discipline of "sustainable design" with practitioners and organizations in numerous countries. In the U.S., the Green Building Council is a clearinghouse of information on sustainable design, its practitioners and examples of its implementation. The headquarters of Development Alternatives in Delhi, which feature low environmental impact construction techniques and design, or the training complex at the Gwal Pahari campus of the TATA Energy Research Institute (TERI) provide examples of sustainable design principles in India.

In contrast, weak sustainability permits the substitution of one type of capital for another, so long as the total capital stock is not reduced. In essence, it suggests that all natural capital could be exploited and converted into human-made capital, leaving human beings no less off than before – clearly, this would imply an improvement on the present context, since at present a large amount of natural capital is lost in the production process as waste and pollution, leaving the ultimate stock of human-made capital at a level less

[22] These definitions are not given by Goodland, but are consistent with his presentation of the concepts. Other writers present the categories of natural, financial, material (human-made), and human capital. This classification is equally defensible, but is not adopted here because the notion of money seems just as "artificial" as that of human artifacts, and because the distinction between human beings of a given time-period from the corpus of technological and cultural knowledge of that time is especially relevant. In the past, human beings have lost or even destroyed recorded or memorized knowledge with damaging consequences.

than the natural capital at the outset. By advancing to weak sustainability, at minimum, the loss of resources to pollution is reduced to zero, so that the net change in capital is reduced to zero. However, it would imply the loss of natural capital over time, with the concomitant loss of the capacity of the environment to absorb pollution over time – leading to declining sustainability. This results from the fact that natural and human-made capital are far from being perfect substitutes for one another; rather, they are complements to a large degree.

"Restorative sustainability," on the other hand, calls for at minimum no net depletion of natural resources, and preferably some level of resource recharging or recovery. Goodland terms this level of environmental sustainability "absurd," since it clearly would limit economic activity to levels permitted by the productive capacity of natural capital by itself – the "interest" generated by natural capital in the form of biomass growth, fishery productivity, etc. This implies a failure to exploit the potential substitutability of natural capital for human-made capital, which, though limited, can be utilized. Substitutability is limited, however, because human-made capital cannot provide the depth, breadth and volume of environmental services that natural regularly does. Indeed, it is increasingly clear that the services provided by natural capital are complements to human-made capital – that is, they are required in order for human-made capital to achieve full productivity.

Given the current context of badly degraded ecosystems – with the correspondingly diminished levels of "interest" generated by those ecosystems – the notion of "restoration" implies investment in the productive capacity of natural capital so as to permit utilization of that capacity in the future. The need for restoration arises because natural capital's substitutability for human-made capital is limited – to a significant extent, the existence of natural capital is a necessary complement to the creation of human-made capital in order to support human life.

Examples of complementarity of natural capital and human-made capital abound: the capital stock for landing, processing and marketing fish products is dependent on the health of fisheries; hydroelectric generation facilities in many parts of the world depend on the health of the watersheds that drain into the rivers on which they are located – with deforestation, erosion and topsoil loss, the generation capacity of the turbines is reduced; rising sea levels around the world brought on by global warming will alter the operation and productivity of various types of installations, such as seaports; and wetlands loss diminishes the water purification services they provide, limiting the productivity of a wide range of riverine, marine, and lacustrian ecosystems on which industrial and commercial activities, from food production to tourism, all depend.

Over time, the implementation of SD principles must aspire to slow the utilization of natural capital through efficiency enhancements until it stops altogether when closed-cycle production is achieved. Once this level is achieved, businesses and society as a whole can live off the interest that natural generates, using this to build and expand on the stock of human capital utilized in the closed-cycle production system. At that time, investment in environmental restoration might also be undertaken. This process would

take a substantial amount of time to yield lasting changes, and it may not be achievable in a uniform fashion across regions or sectors. Subsequently, the productive capacity of natural capital would be enhanced, making it possible to achieve faster rates of development than would be possible based on the degraded ecosystems that exist at the present time.

Hence, the achievement of SD involves reducing the amount of material and energy required to create a unit of the final product, through *efficiency* enhancements, as well as finding ways to use what would otherwise be waste material as an input for other productive processes. This concept, which is complementary to efficiency and may be referred to as the identification of *process symbiosis*, is based on the assertion that only completely self-contained processes are truly sustainable. In a closed industrial production system, waste from one process is used as inputs for others. In short, these two concepts form the basis for attributes of environmental sustainability in industrial processes and/or projects.

Initially, enterprises or projects may begin with the implementation of actions that enhance the efficiency of resource or energy use in the overall production process without altogether eliminating the formation of wastes and effluents. The types of measures adopted range from actions that carry virtually no cost – implementation of good housekeeping procedures – to those that carry successively more significant costs and capital investment requirements – input substitution, process controls, equipment modification, and technology change. The end product might also be modified to reduce input requirements in manufacturing and/or fuels and material requirements when used as designed.

Subsequently, enterprises or projects can build on efficiency gains to identify and implement actions that actually reorganize processes, or link them to other, unrelated processes, to find productive uses for wastes and effluents in an effort to squeeze pollutant formation to zero. The goal of zero emissions comes about not just by reducing the generation of pollutants, but more importantly through the redefinition of pollutants as inputs for another process. This is referred to as symbiosis here, but has variously been labelled "biomimesis," "industrial ecology," "clean production," or "zero-emissions production." The key notion is that of imitating ecological systems – in the natural world, no material is wasted, energy is conserved, and balance is preferred to concentration, imbalance and inactivity. As Paul Hawken puts it, in nature, "waste equals food."[23]

The permanence of the environmental benefits obtained through the implementation of SD principles – or their "environmental integrity" – is enhanced as the types of actions proceed up the ladder from efficiency enhancements towards actions that close the loop and result in truly symbiotic processes. The importance of technology – both hardware and software – to this process is clear. Successive advances in production processes, management methods and equipment enable the same level of output to be obtained with

[23] See Hawken, Paul, *The Ecology of Commerce* (HarperCollins: New York, 1993).

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reduced inputs and diminished waste generation. Meanwhile, product improvements enable consumers to obtain the same level of service or performance with lower energy consumption, materials use, and waste generation.

Corporate actions to move toward environmental sustainability

In the last decade and half, many businesses throughout the world have begun to adopt environmental principles[24] and take the first steps toward SD. These actions may take the form of changes in management practices intended to result in alterations in productive processes, changes in the types of inputs used, development of new product lines, and changes in the business models employed. Complementing these actions, entrepreneurs and project developers have sought ways to provide services and equipment to enhance the efficiency of industrial processes, alter the environmental impacts of producing basic inputs, such as electricity and steam, reduce the pollution in different types of effluents and emissions, or even begin to close the loop and reuse or find productive uses for wastes.[25]

Clearly, these actions have reflected regulatory requirements. But while this was predominantly the case early on in the age of environmental protection – beginning in the 1960s and 1970s – business leaders and managers have become more sophisticated. Increasingly, they have come to recognize that environmental performance is an attribute of quality that customers and shareholders demand, that reducing environmental liabilities can enhance financial performance, and that securing environmental excellence can have competitive benefits. Two examples illustrate how such activities are occurring, and how the benefits obtained can reinforce the trend toward even greater environmental performance. The benefits obtained in the financial realm have been dubbed the "SD premium," a concept that is central to the notion of economic sustainability.

There are numerous examples of companies that have taken steps to make the environmental and social dimensions of their activities an intrinsic part of their

[24] Such as the CERES Principles, the Business Charter for Sustainable Development, as well as others.
[25] Alan Hecht provides some examples of this process in "The triad of sustainable development: promoting sustainable development in developing countries," *The Journal of Environment and Development* 8 number 2 (June, 1999): 123-126.

Table 1: CCMP Types, Climate-Related Environmental and SD Benefits

General type of action / Project types	Climate-Related Environmental Benefit	Sustainable Development Benefit
Reduction of emissions of GHGs		
❑ Efficiency measures in fuel extraction and processing, and electricity production using fossil fuels ❑ Efficiency measures in fossil fuel consumption for energy requirements (industrial, agricultural, residential, transportation, commercial, other)	Primarily CO_2 and CH_4 impacts: slows buildup of GHGs over and above naturally observed atmospheric concentrations	Contribution to enhanced efficiency, but does not yield improvements in terms of finding opportunities for symbiosis or reduction in dependence on non-renewable resources
❑ Fuel switching in production of electric energy ❑ Fuel switching in fossil fuel consumption for energy requirements (industrial, agricultural, residential, transportation, commercial, other)	Primarily CO_2 and CH_4 impacts	Contribution to enhanced efficiency, but does not yield improvements in terms of finding opportunities for symbiosis or reduction in dependence on non-renewable resources
❑ Displacement of fossil-fired electric generation capacity with renewable (hydro, wind, solar, geothermal, tidal, etc.)	Primarily CO_2 and CH_4 benefits	Represents advance toward SD by switching to renewable energy resource use from non-renewables
❑ Capture of CO_2 for use in other industrial processes	Reduction in CO_2 emissions	Represents advance toward SD by creating symbioses in industrial processes that reduce net CO_2 emissions
❑ Capture of CH_4 generated in landfills and agricultural production for use as fuel for thermal energy production or electricity generation	Shifting CH_4 emissions to CO_2 emissions, with benefit deriving from higher global warming potential of CH_4	Represents advance toward SD by switching to renewable energy resource use from non-renewables

General type of action / Project types	Climate-Related Environmental Benefit	Sustainable Development Benefit
Reduction of emissions of GHGs, con't		
❑ Reduce combustion of biomass for agricultural clearing or from accidental fires through conservation programs	Primarily CO_2 impacts	Represents advance toward SD by reducing conversion of natural capital to human-made or quasi human capita (livestock), or resource waste; Reduces ecosystem damage in rivers and water resources in watersheds where actions take place
❑ Reduce agricultural production of CH_4	Reduction in CH_4 emissions	Contribution to enhanced efficiency, but does not yield improvements in terms of finding opportunities for symbiosis or reduction in dependence on non-renewable resources
Removal of GHGs (primarily CO_2) from atmosphere		
❑ Afforestation and reforestation	Extracts GHGs from atmosphere for "storage," slowing increase in atmospheric concentrations	Contribution toward increased symbiosis, by increasing volume carbon (compensated emissions) that is cycled back into biomass; water quality and erosion prevention benefits
❑ Development of biofuels – use of sugarcane bagasse, other agricultural waste for thermal energy production and electricity generation	Creates a "closed-cycle" of carbon emissions and carbon capture, displacing non-renewable energy production	Contribution toward increased symbiosis, by displacing carbon emissions that are not compensated by biomass growth – increasing volume of carbon in cycle

Table 2: Non-Climate Environmental Benefits Derived from Project Types

Project types	Potential Non-Climate-Related Environmental Benefit	Potential Non-Climate-Related Environmental Negatives
❑ Efficiency measures in fuel extraction and processing, and electricity production using fossil fuels ❑ Efficiency measures in fossil fuel consumption for energy requirements (industrial, agricultural, residential, transportation, commercial, other)	❑ Air quality: reduction of pollutants emitted with local and regional impacts ❑ Water quality improvements: reduced pollutant depositions in bodies of water and rivers ❑ Soil quality: reduced acidification of soils	
❑ Fuel switching in production of electric energy ❑ Fuel switching in fossil fuel consumption for energy requirements (industrial, agricultural, residential, transportation, commercial, other) ❑ Construction of transmission lines to permit broader distribution of hydroelectric resources, displacing fossil-fired generation	❑ Air quality: reduction of pollutants emitted with local and regional impacts ❑ Water quality improvements: reduced pollutant depositions in bodies of water and rivers ❑ Soil quality: reduced acidification of soils	❑ Change in pollutant emission patterns – such as increased NO_x associated with combustion of natural gas, instead of SO_x emissions from coal or fuel oil ❑ Land-use and habitat impacts, scenic issues associated with construction of transmission lines
❑ Displacement of fossil-fired electric generation capacity with renewable (hydro, wind, solar, geothermal, tidal, etc.)	❑ Air quality: reduction of pollutants emitted with local and regional impacts ❑ Water quality improvements: reduced pollutant depositions in bodies of water and rivers ❑ Soil quality: reduced acidification of soils	❑ Watershed impacts and/or flooding associated with development of large-scale hydroelectric facilities ❑ Scenic and aesthetic impacts of wind and large-scale solar PV or solar thermal energy development ❑ Industrial pollution associated with production of solar PV, batteries, and other renewable energy project components ❑ Navigational and/or scenic and aesthetic impacts of tidal power development

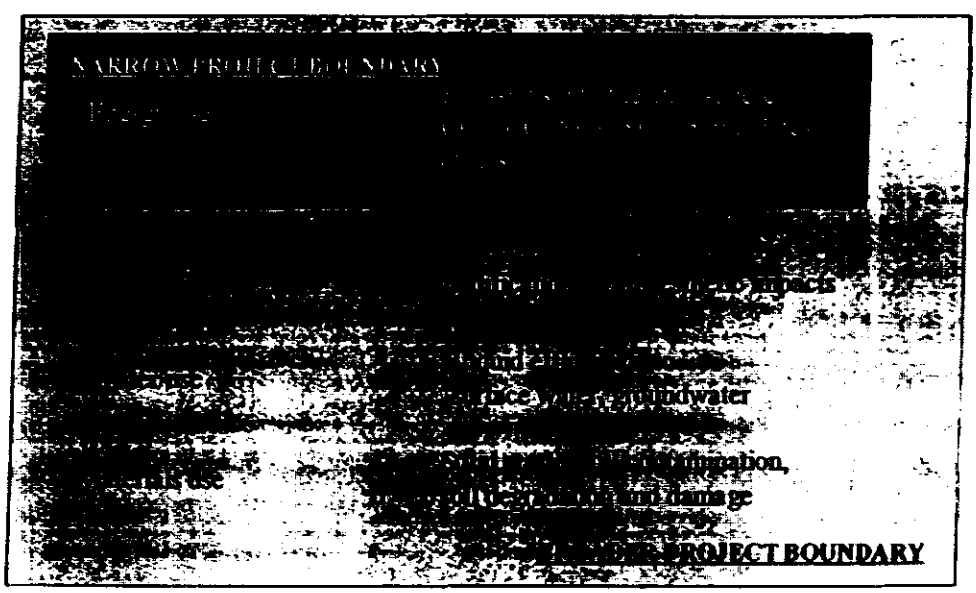
Project types	Potential Non-Climate-Related Environmental Benefit	Potential Non-Climate-Related Environmental Negatives
❑ Capture of CO_2 for use in other industrial processes		
❑ Capture of CH_4 generated in landfills and agricultural production for use as fuel for thermal energy production or electricity generation		
❑ Reduce combustion of biomass for agricultural clearing or from accidental fires through conservation programs	❑ Water quality: enhanced water purification through water retention in forest soils and root systems; reduced turbidity in rivers and lakes due to reduced run-off ❑ Soil quality: reduced soil loss through erosion ❑ Air quality: reduced formation of regional haze from forest burning	❑ Forest-fire risk: Increased risk of naturally caused forest fired in dry regions
❑ Reduce agricultural production of CH_4		
❑ Afforestation and reforestation	❑ Water quality: enhanced water purification through water retention in forest soils and root systems; reduced turbidity in rivers and lakes due to reduced run-off ❑ Soil quality: reduced soil loss through erosion	❑ Biodiversity: potential for negative impacts due to monocultural forest plantations
❑ Development of biofuels – use of sugarcane bagasse, other agricultural waste for thermal energy production and electricity generation	❑ Air quality: reduced air pollution from combustion of petroleum products	❑ Water quality: pollution impacts from agricultural developments ❑ Air quality: alteration of emissions patterns due to fuel switching

businesses and accordingly, their reporting procedures. In addition, a large number of business initiatives intended to establish guidelines or principles for business behavior with environmental as well as social criteria in mine – have emerged of the last two decades. Many of these are summarized by Ranganathan in the annex to her article "Sustainability rulers."[26]

Linking SD with climate change benefits and CCMPs

From the climate change perspective, the relevant environmental impacts encompass emissions of GHGs – primarily carbon dioxide (CO_2) and methane (CH_4), but also other gases emitted in smaller volumes – from various types of industrial, agricultural, or transportation activities. In order to represent an improvement in terms of the introduction of SD principles, efforts at the enterprise level or projects will typically take one of the forms outlined in Table 1. What is clear from the presentation given there is that the scope of CCMPs, in terms of the environmental benefits that they generate, may be more limited than the SD projects with the broadest scope of environmental benefits. Put another way, SD incorporates actions that address climate change, but not all projects

Figure 5: Boundaries and Environmental Impacts of CCMPs and SD Activities



Flora and fauna — **Loss of biodiversity, genetic resource losses and/or modification**

[26] Detailed descriptions of the initiatives may be accessed at http://www.wri.org/wri/meb.

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addressing climate change contain components that make them SD projects. This is illustrated in Figure 5.[27]

The "narrow project boundary" for CCMPs refers to cases where the environmental benefits do not extend past the reduction in GHG emissions or the capture of GHGs resulting from the project. This might be the case in the context of certain energy efficiency projects, either on the supply side or the demand side, where no actions are taken that address water consumption, materials use, or other impacts. In contrast, a project involving process reengineering intended to reduce water consumption and/or material inputs – with reductions in energy requirements and hence GHG emissions – provides an example of a "broader project boundary" case. It is arguably most difficult for EE and RE CCMPs to encompass actions that would benefit flora and fauna, or conversely, for forestry projects that provide significant benefits in terms of flora and fauna, to generate emissions reductions (as opposed to the carbon capture benefits they generate) unless paired with a biomass generation project – and even then, the monoculture required for such projects may be of limited benefit from a biodiversity standpoint. While all of the project types described in Table 2 offer environmental benefits in terms of reducing emissions or atmospheric concentrations of GHGs, certain project types offer more in terms of SD benefits than others. The non-climate-related environmental benefits ("co-benefits"), as well as possible environmental impacts, that each project type yields must be considered.

There may be negatives associated with the implementation of specific types of projects as well, as identified in Table 2. While many of the trade-offs associated with the project types described in Table 2 may be avoided or mitigated through proper project design, some could be more difficult to address. An example of this is the change in pollutant emissions associated with the combustion of biofuels, especially for transportation applications. The Brazilian experience with alcohol fuels offers an example of how emissions of CO, NO_x, hydrocarbons and other pollutants associated with gasoline-powered engines may be displaced with emissions of formaldehyde and other related compounds, contributing to more favorable air quality conditions in urban areas overall, but not without introducing new pollutants to the air quality situation.

Conversely, projects undertaken to address other non-climate related environmental concerns, such as solid waste or water quality, may be implemented in such a way as to create opportunities to obtain climate benefits as well. An example of this might be the use of anaerobic digestors, which produce methane, in water treatment plants. The methane could be used to generate electricity or as a fuel for thermal energy production.

The toolkits that complement this document focus exclusively on the quantification, monitoring and verification of carbon emissions reductions, the monetization of the carbon osffset (Offsets) that result from these physical reductions, and the placement of

[27] As noted at the outset of this section, SD encompasses three facets. While the discussion presented in this section focuses on the environmental impacts of CCMPs, the project boundaries encompassing non-environmental impacts of the project must also be considered. These are addressed in the section covering the integration of the three facets of sustainability.

these Offsets on the international carbon market. As such, the focus of the companion toolkits to this one are narrowly focused on one aspect of implementing SD principles.

Economic sustainability

For enterprises as well as policymakers, sustainability is an attribute consistent with commercial and economic realities, namely that a SD project must be economically sustainable – a viable venture grounded on a solid business concept – and must generate economic benefits to the community and broader social and economic context in which it is implemented. Over the longer-term the move toward reduced emissions and waste yields what some analysts have dubbed the "sustainable-development premium," the financial payoff to businesses, especially existing businesses, from the implementation of SD principles.[28]

In the long run, economic sustainability is essential to the proliferation of SD principles. This must be so, for in the absence of economic sustainability, activities that provide benefits in terms of environmental sustainability would depend always on government funding or donations – this would limit the extent to which they were implemented, on the one hand, and would subject them to the vagaries of political and public preferences. In contrast, economic sustainability implies that there is a financial or commercial incentive to undertake environmentally sustainable activities, thereby creating the potential for a virtually automatic process of expansion and economic transformation.

The supposed tension between the pursuit of environmentally sustainable business strategies and economic sustainability has been a subject of debate. Conventional thinking has typically held that economic activities and environmental protection are incompatible. This perception has generally been thought to have held back the spread of environmental regulation in emerging economies, and has been the subject of political debate in the industrial world. However, recent experience in numerous businesses in many countries and the work of contemporary theorists challenges this view. The new thinking argues that the incorporation of environmentally sustainable practices and insights, together with the transformation of management practices and business strategies, can lead to enhanced profitability and, to the extent that they are disseminated broadly enough, could even dampen the business cycles that have been the bane of economic policymakers and politicians ever since the industrial revolution.[29]

For environmental sustainability to yield the economic transformation necessary to achieve long-range environmental and social objectives, the SD premium is indispensable – without it, there can be no generalized incentive to adopt "sustainable thinking." There are several factors that result in the premium:

[28] See Hedstrom, Gilbert; Shopley, Jonathan; and LeDuc, Colin, "Realizing the Sustainable-Development Premium," *Prism* Q1/2000 (Arthur D. Little): 12-17.

[29] Various aspects of this general argument are presented in great detail in Hawken, Paul; Lovins, Amory; and Lovins, L. Hunter, *Natural Capitalism* (Boston: Little, Brown Co., 1999).

- Implementation of SD principles results in *option creation* for the firm, meaning that new product lines, new processes, and new markets emerge, all of which enhance commercial opportunities for the firm;
- Reduction in pollution and material inputs yields *cost leverage* opportunities, because eco-efficiency enhancements generate savings that go straight to the bottom- line performance of the company;
- Pollution reductions also permit substantial *risk reduction* benefits for firms, enabling businesses to shed "unsustainable" assets and prepare for tighter environmental regulations; and
- Implementation of SD principles positions businesses better to offer products and services in line with *customer preferences*, thereby enhancing market position and often, attracting new sources of capital.

As a result of each of these factors, the premium can take the form of reduced operating costs, reduced liabilities and insurance requirements, new market opportunities and new customer bases. Clearly, in the case of CCMPs, the degree to which these benefits are obtained will depend on the type of projects undertaken. For example, a simple energy efficiency project is most likely to generate cost-leveraging opportunities, but may not create new business options for the firm. In contrast, a cogeneration project implemented at a sugar mill, using state-of-the-art emissions control equipment, in conjunction with end-use efficiency measures could open up new revenue-generating opportunities for the mill – sales of excess power and electricity, distribution or sale of organic fertilizer produced from fly-ash recovered in the smokestacks – thereby expanding the mill's revenue-generating potential and not just the efficiency of its use of energy.

The SD premium results in increased profitability for the firm or project, but it is also likely to drive capital formation at the firm level, although the patterns of capital formation may be different in the case of a firm employing SD principles compared to one that is not. Where a company is successful in the implementation of a SD project, and it generates higher returns on investment and increased capital formation, it is possible to assert that the higher efficiency of resource by the firm enables a more rapid pace of human-made capital formation, and hence more efficient transformation of natural capital into human-made capital.

It is important to bear in mind that there are numerous ways in which the economic environments in which individual companies are forced to compete are conditioned to promote unsustainable activities. Such national and state-level policies as subsidies (on water, fuels, electricity, roads, mineral rights, etc.), fiscal spending, tax incentives, research programs and so forth are often designed to promote economic growth, job formation and regional development, but in ways that fail to consider the environmental costs of the activities being promoted.

The distortions created by such policies may often appear to undercut the economic benefits of implementing SD practices – as in the case of energy subsidies that undercut the economic viability of energy efficiency projects. However, the introduction of SD principles in a project or enterprise involves more integrated approaches that result in

multiple benefits, some of which may not immediately seem quantifiable – such as a more enjoyable work environment – but do yield tangible benefits in the medium and longer term. A recent book on SD, *Natural Capitalism*,[30] contains numerous cases of building developments that employ SD principles, which yield higher rates of productivity in the workforces they house, thereby accelerating the recovery of the initial investment in the energy, water, and materials conservation measures undertaken at the outset.

As a counterpoint to the perverse incentives that stimulate unsustainable activities, government and international policies mandating environmental protection create a set of incentives to improve environmental performance. Although early policies in this area favored "command-and-control" style regulation, which introduced its own set of perverse incentives, more recent initiatives have incorporated incentive- and market-based systems, with favorable results.

Social Sustainability

As companies undertake the longer-term move toward achieving the goal of zero-emissions and waste, other transformations occur that begin to extend the commercial benefits deriving from implementing SD principles to broader indicators of social sustainability at a macro-economic level. A venture based on SD principles benefits the community and country where it is located through job creation, local environmental benefits and resource recovery, enhanced standard of living, and creation of new educational opportunities. All of these benefits contribute to long-term social welfare, improved health for the human (as well as flora and fauna) in the community, political stability, and reinforcement of the trend toward SD.

Since the process of reducing and eventually eliminating waste and pollution demands the cultivation of engineering and management skills, it is knowledge-intensive, requiring continual social advancement. Hence, this process results in the formation of human capital, diminishing the emphasis on material capital (human-made as well as natural capital) for economic development. *Social capital formation* in turn promotes the expansion of markets for consumer goods and services by creating jobs. To the extent that this occurs in rural or urban areas where unemployment is high, this process benefits the poorest segments of the population. To the extent that this leads to increased employment opportunities for women and minorities, the trend contributes to enhanced, empowerment of women, gender equality, and reversal of discrimination and barriers to minority groups. Finally, social capital formation enhances the receptivity and ability to improve the technological base of society, which is essential to successful technological innovation and advancement.

It is important to note that the process of social capital formation may be as much the desired but indirect result of company actions to implement SD principles, as the direct result of corporate actions in support of local educational institutions, scholarship and

[30] *Ibid.*

internship programs, or simply community relations and outreach. The latter is especially important in the case of industrial facilities where hazardous materials, processes or equipment are present.

The broader, community-based economic and environmental benefits and longer-term prospects flowing from a project may be characterized as attributes of social sustainability. This is critical, for in emerging economies, such as India, people cannot and will not allow environmental protections and other regulations to stand in the way of improving standards of living and opening up economic opportunities for their children. Therefore, any truly useful notion of SD has to be grounded in the need for *equity* between generations as well as among groups in the current generation (within countries as well as among countries). This notion of equity is not simply an environmental consideration – it is a social, economic and above all, a political one – and is vital to the socio-economic sustainability of a project or business.

Social capital and human capital are necessary elements in the efficient utilization of natural capital and its transformation into human-made capital. Human capital refers to the actual labor force involved, while social capital refers to the cumulative body of knowledge and experience – management, engineering, scientific, artistic and so forth – that successive generations of workers, scientists, engineers and managers must absorb so that the process of adopting SD practices moves forward as opposed to backwards.

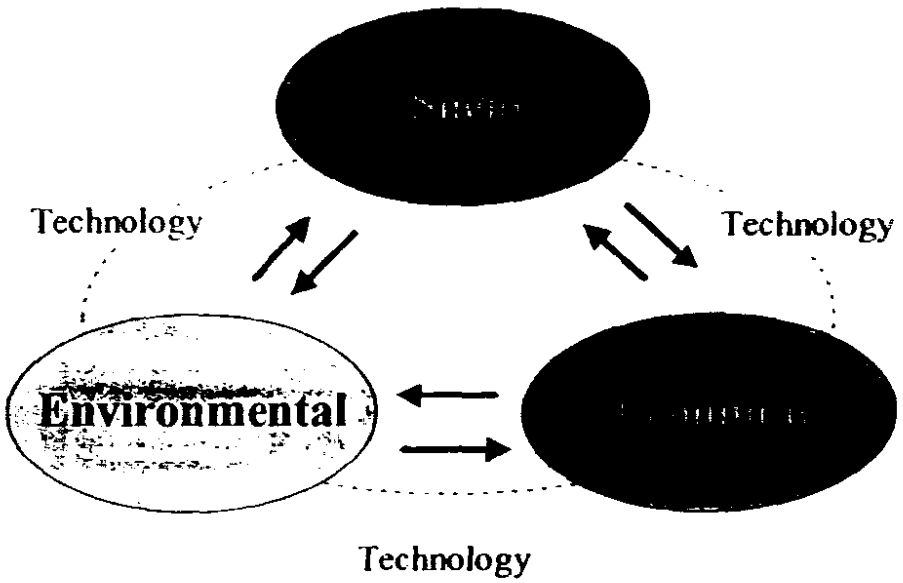
As companies implement SD principles, they must inculcate these principles in the workforce, and in their search for solutions to the challenges of conserving resources in production processes; they stimulate the development of SD know-how in their workforces. The body of experience and knowledge that is developed in this way is vital to the continuity of SD at the societal level as much as it is essential at the enterprise level.

More important, theorists of SD argue that companies that manage to reduce their utilization of natural capital – an industrial input that has traditionally been undervalued but is becoming increasingly scarce – will re-orient their production processes to utilize more human capital and/or human-made capital. In countries where well-trained as well as unskilled labor (human capital) enjoys a comparative advantage, as is the case in India, the societal and macro-economic advantages of an approach predicated on SD principles are obvious.

Figure 6: Three Facets of Sustainability

Environmental	Economic	
▫ **Natural capital conservation and restoration**	▫ **Capital formation**	▫ Social capital formation
▫ **Efficiency**	▫ **Options creation**	▫ Equity
▫ **Process symbiosis**	▫ **Cost leveraging**	
	▫ **Risk reduction**	
	▫ **Customer preferences**	

Figure 7: Integration of the Three Facets of Sustainability



Integration of the Three Facets of Sustainability

At the most fundamental level, sustainability in each of the three areas, as summarized in Figure 6, is essential to achieving sustainable development overall and over the long term – without each of the three, any advances in any one area are undercut, sooner or later. This relationship is described in Figure 7.

However, this is not helpful from a practical stand-point, which makes the achievement of results in the implementation of SD principles its highest priority. It is important to note the development sequence for implementing SD principles and enabling them to create the positive feedback loop that characterizes SD, in the opposite way that unsustainable practices create negative feedback loops that create a downward spiral of

ecosystem health, natural capital degradation, negative impacts on businesses, society and the macro economy.

Clearly, therefore, the fundamental underpinning must be environmental sustainability. Without movement towards this goal, progress on the other two fronts is largely meaningless, and could even risk reverting to that business-as-usual practices that have created the environmental damage that SD seeks to reverse.

However, in order for the advancement toward environmental sustainability to be replicable and continuous, the second facet – that of economic sustainability – must also be achieved. As noted earlier, the SD premium is the payoff from implementing SD principles, and provides the necessary justification for their continued implementation and will provide examples for replication and dissemination of those principles and projects based on them.

The process described by the first two provides the foundation and the drivers for the socio-economic transformation implicit in the formation of social capital based on the implementation of SD principles. This takes place in two areas: first, the environmental benefits and economic development that flows from activities based on the first two facets create political and social consensus around the value of SD in general and its broader implementation, and second, the economic benefits at the project and enterprise levels yield broader economic benefits that spill out into all areas of economic activity.

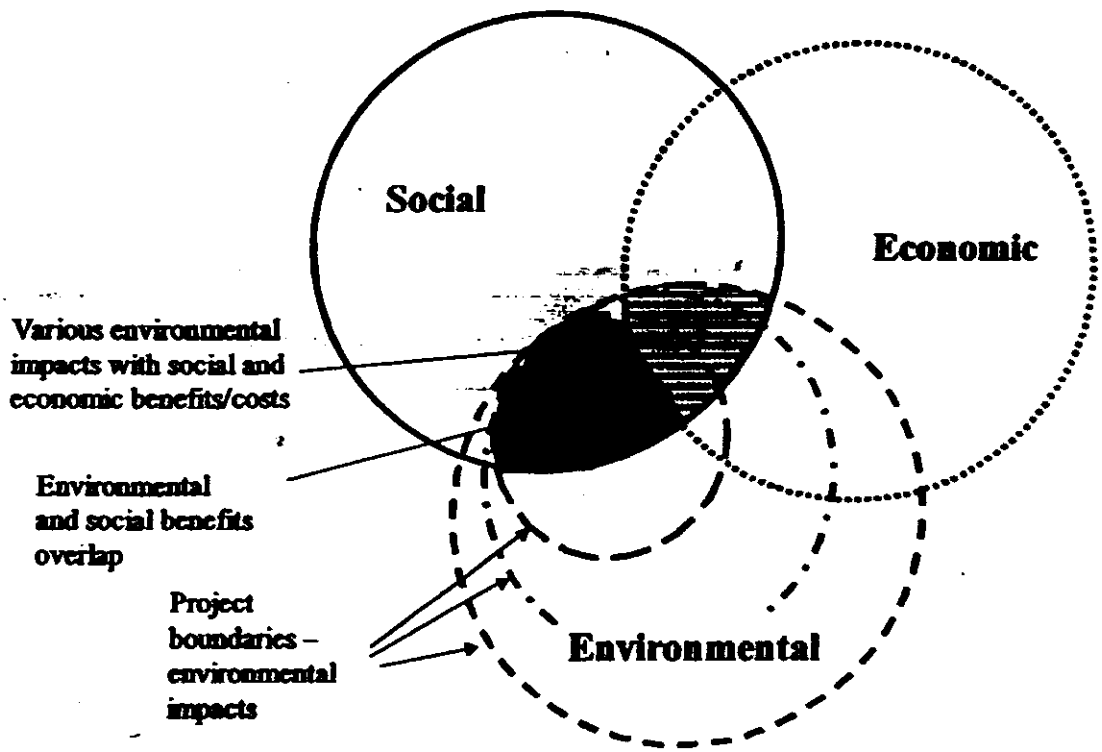
From the social and economic standpoint, the impacts and benefits of a given project may well depend on the nature and scope of the environmental benefits as well as the corresponding economic impacts. Further to the discussion of the project boundaries in terms of environmental benefits presented earlier, and in Figure 5, the boundaries for a CCMP may encompass all three facets of SD. In addition, the scope of the benefits and/or impacts may vary as a function of the environmental benefits obtained. This is illustrated in Figure 8. Examples of projects with different social and economic benefits as a function of the environmental benefits obtained might include the following:

- Narrow environmental project boundary. An energy efficiency project implemented at an industrial facility yields reductions in electricity and fuel consumption, with benefits obtained on site, where the fuel is used, and at the facilities of the local electricity supplier, which has a generation station in the vicinity of the project. The social and economic impacts of the project may be limited to improved economic performance at the industrial facility, with the corresponding result that it may hire an additional worker from the community or invest additional resources in new activities that create jobs.
- Broader environmental project boundary. A small-scale hydroelectric facility on a small dam, combined with a reforestation project in the watershed draining into the reservoir created by the dam, would yield a number of environmental benefits over and above the emissions reduction resulting from the displacement of fossil energy elsewhere and/or avoidance of a new thermal facility, including reduced watershed degradation and erosion. Of course, the dam may also occasion some damage

downstream of the facility. However, the social and economic benefits of the project may include flood control, improved availability of water for irrigation of cropland in the river valley, as well as for human consumption.

- Broadest environmental project boundary. The project suggested above might also generate biodiversity benefits in the event that the reforestation project is accomplished in such a way that the species mix of the forest is imitated so as to expand habitat for local wildlife, which had declined due to deforestation before the project was implemented. Another example might be projects utilizing solar energy resources for local energy requirements for cooking, lighting and operation of refrigeration equipment at a local clinic, thereby displacing pressure on forest resources for gathering fuelwood or producing charcoal and expanding energy availability. Here the social and social and economic benefits may encompass considerations relating to human health by eliminating smoke in homes, improving access to medicines and vaccines, expanding educational opportunities and the potential for cottage industries (employing women as well as men) that would generate additional income for local families.

Figure 8: Overlap of Project Boundaries in the Facets of SD



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4. Operationalizing and Measuring Implementation of SD Principles in CCMPs

This section builds on the conceptual discussion presented in Section 3 to provide a tool for assessing the extent to which a project or enterprise is implementing SD criteria. Quantitative as well as qualitative yardsticks for assessing the degree to which projects and companies adhere to SD criteria are presented for each of the three facets of SD. This section also provides a critical path to guide developers of climate change mitigation projects (CCMPs) through the project design process and implement these sustainability criteria. In addition, this section describes the linkages between this toolkit and the four other toolkits developed as part of the Greenhouse Gas Pollution Prevention Project.

Measuring and Assessing Environmental Sustainability

The process of implementing measures to enhance environmental sustainability begins with the enhancement of resource-use efficiency (energy efficiency, waste minimization, water use reduction), followed by the implementation of measures intended to slowly squeeze the volume of waste material generated by industrial facilities. Although opportunities to exploit symbioses between industrial processes may sometimes be available at the same time as opportunities to invest in efficiency, it is likely that opportunities to exploit input-output symbiosis will emerge only in the context of close coordination and communication between companies from different sectors and access to information that might otherwise be considered confidential.

From the perspective of CCMP developers, many of the basic engineering analyses that form part of any feasibility study provide all the information necessary to evaluate the extent to which a project or corporate initiative moves toward the goal of environmental sustainability. Specifically, two (closely related) engineering measures may be used as sustainable development indicators:

- *Developing mass/energy balances for projects.* Before developing narrow measures of process efficiency and resource consumption, it is necessary to develop integrated assessments of resource use and process efficiency through the preparation of a detailed mass-energy balance for a given project or process. The balance is intended to identify and quantify all material and energy inputs and outputs from a process or series of processes, and is helpful in tracking down areas of opportunity to reduce waste and inefficiency. Mass/energy balances for a project or process may be expanded upon to identify where specific waste streams may be directed to reduce resource waste further.
- *Measurements of productivity in resource utilization, usually in terms of unit output.* Such measures might include measures of energy consumption per unit of production (electricity consumed per unit of production, water consumed per unit of production, or fuel consumed per unit output). In sugar mills, for example, one measurement that is often used as a rough yardstick of milling productivity is the consumption of "steam on cane," or the steam (measured in tons) required to mill each ton of

sugarcane. A similar measure is the requirement of fossil fuel (typically fuel oil) per ton of cane crushed.

- *Resource consumption of end product.* One of the most important environmental impacts of a given product is often its lifetime consumption of resources when employed as directed by the manufacturer. There may be net environmental gains to be exploited by designing the product to be more efficient or to dispense with energy or water inputs altogether. In the latter case, specialized marketing and consumer support may be required.

  The measurements of resource consumption by the end-product when operated as directed are similar to the production process itself – the measures might involve water consumption, raw material uses, operational inputs such as refrigerants or oil, and, of course energy. Consumption would tend to be measured in terms of unit output, distance traveled or duration of service.
- *Measuring recyclability and use of waste or recycled materials in production process.* In the context of production of a wide range of consumer products, as well as durable goods, capital goods and the construction of various types of buildings, recycled materials can be incorporated into the input stream, thereby reducing the use of virgin materials. The recycled content of many product types, such as paper and packaging, plastics and glass, shipping pallets and a wide range of other products are already regularly reported. In addition, the degree of recyclability that is designed into durable and capital goods is another important indicator that is beginning to be adopted in several sectors, such as automobiles, white goods, and other durable items. Clearly this is an important internal measure, but it only has meaning as an example of the implementation of SD principles once a program for recovering and recycling that content is in place. There is no value, from the perspective of environmental sustainability, to say that something is *recyclable* and not take the appropriate steps actually recycle that material. Utilization of otherwise waste materials is also contemplated here.

This type of analysis forms the basis for the technical evaluation of project benefits in terms of reductions in GHG emissions, as described in greater detail in the Toolkit on Baseline Preparation and the Toolkit on Preparing Monitoring and Verification Protocols.

Measuring and Assessing Economic Sustainability

The financial measures typically used to evaluate any investment opportunity are relevant in the assessment of economic sustainability. All of the same issues regarding the evaluation of risk apply in CCMPs – as is made clear in the toolkit on the carbon finance model. However, there are also additional measures involving the provision of carbon osffset (Offsets) by CCMPs that require additional analysis. These are likely to be quantifiable, but they may also be qualitative in nature. Beyond the more traditional measures, there are also specific ones that will require more qualitative assessment, reflecting the fact that they have a great deal to do with the company management issues as much as engineering concerns.

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- *Conventional measurements of financial sustainability.* Corporate actions that enhance efficiency or even yield process symbioses must be subjected to the same sorts of financial evaluation and scrutiny that any other investment receives. Even in cases where compliance with regulatory requirements is at issue it is possible to argue that decision making is consistent with the pursuit of economic returns – in the context of regulatory compliance, the avoidance of fines, legal fees in litigation, and the cost of bad publicity in terms of negative press.

  Among the conventional measures, projects may be evaluated on the basis of cost-benefit analyses, the calculation of net present value (NPV) and internal rate of return (IRR). Sophisticated financial valuation techniques, such as the capital asset pricing model (CAPM) and the weighted average cost of capital (WACC) for the firm, or advanced financial instruments such as options and other derivatives, may also be employed in the evaluation of such projects. The results of these analyses and financial innovation may be presented in the broader context of business and investment plans and strategies where risks and returns on investment are evaluated, corporate budgets or risk capital and debt are solicited, and are often communicated to company shareholders, customers and regulators in annual reports and other presentations.

  In short, all the same analytical techniques and procedures for presenting and implementing projects – either as internal investments by companies, new ventures and project finance opportunities – apply to the evaluation, presentation and implementation of CCMPs and SD projects. These measures provide the best assessment of managers or project developers of the financial returns of a given investment. If the results indicate that the project meets the necessary criteria for investment, then it can be said that the project is likely to be financially sustainable according to the information available to developers and managers at the time.
- *Rethinking business models – service versus product.* Much of the thinking about how to align business interests with environmental sustainability concerns center on methods for making the producer responsible for the product throughout its entire life-cycle, from production through use and finally to final disposition. In this way, the environmental impact of its creation, use and disposal are translated into costs to the producer (and through pricing, to its user). The purpose of policies such as those in Germany requiring a certain degree of recyclability in products such as automobiles, product packaging, or white goods is to internalize environmental costs. Clearly, this approach can produce the desired results. But just as reengineering production processes can yield significant environmental benefits, so too can reengineering business models achieve the desired outcomes – bypassing the regulatory driver.

  These results can be achieved when the customer's interest and the enterprise's interest are aligned, as opposed to being counter posed. This is done by recognizing that when a firm produces a tangible product – whether for the consumer, the industrial customer, or government – it is really delivering the service of the product as opposed to the product itself. That is, an automobile manufacturer sells cars that provide their owners with transportation and the ability to move cargo, more than the car itself (of course, this is generally, but not always, the case). If the automobile manufacturer offers cars on a lease ("service") basis, with the commitment to take it

back at the end of its useful life, then the interests of purchaser and manufacturer are aligned – they benefit (make money) in the same way, by extracting maximum productivity from the asset – and environmental sustainability is advanced at the same time that financial sustainability is ensured.[31]

The interests of both sides are aligned because the manufacturer seeks to deliver the vehicle to the user in the most efficient way possible, based on a design that enables it to recover as much or (ultimately) all of the vehicle it can, while the user receives the best possible vehicle to provide mobility and freight capability that it requires. The manufacturer benefits from this business model because it establishes a long-term client relationship, as opposed to a one-off transaction, and provides the manufacturer with more ways to control costs, build up its asset base, and obtain tax benefits through depreciation. The user, in turn, can more easily gain access to the use of costly goods or capital equipment, is ensured of improved service from the manufacturer, and reduced exposure to decreasing asset value.

Measuring the degree to which a company or project is adopting a service orientation as opposed to a conventional sales model is necessarily a qualitative assessment, unlike the evaluation of return on investment. Further, a service-oriented approach is not applicable to all product types. An assessment of the extent to which this is achieved might begin with a simple question as to whether or not products are placed as part of a service package, as opposed to delivery of the product alone. A separate but related question is the degree of recyclability that the manufacturer builds into the product, thereby facilitating user disposal in an environmentally sustainable way even if the service orientation is not a part of the company's business model. Although the measure of the degree of recyclability is an indicator of environmental sustainability, it must be considered in the context of the management of an enterprise because the environmental benefit accrues only when the recycling actually occurs – i.e., when recycling is part of the business model employed.

- *Rethinking productive processes – "flow."* The production management approach referred to as "just-in-time" manufacturing has important implications for the reduction of waste in an enterprise. Numerous enterprises have concluded that the mismatch between the output and uptake of inputs or partially finished product during the production process, as well as the placement of finished product in markets characterized by variable demand, is a source of waste and unnecessary cost. Production reengineering strategies based on streamlining production throughout the manufacturing process – measures such as adoption of just-in-time practices, resizing specific process equipment, and reducing the number of steps in producing product components, for example – can reduce storage times, eliminate unnecessary processing steps, reduce cost and reduce waste. A central observation involved in this type of reengineering is the notion that production lines should pull inputs from the previous step, rather than having the previous step push its output into the following one. The former approach avoids bunching and build-up of materials, product – even people, in the service sector – and hence the waste, inefficiency, and

[31] *Ibid.*, 136.

unproductive assets that go with these phenomena. The latter has been dubbed "flow."[32]

How flow might be measured depends on the nature of the enterprise or project under study. In general terms, the degree to which flow is observed will depend on the number of points in a productive process – as well as in its relationship with other processes outside the boundaries of the process under study – where the speed of transformation changes. An example of this might be in an automobile assembly plant, where hundreds of components are received, organized and processed (assembled) into finished vehicles. Multiple production lines for components must all coalesce into one final assembly line, with the flow of components calibrated to the speed of every other. If a specific component, such as a mirror, requires dozens or even a hundred steps to produce, any effort to simplify its production will improve the overall flow of production. In cases where multiple models are produced, the potential for mismatches of demand and supply increase, thereby increasing the benefits of creating flexible manufacturing processes (using easily shaped – and recycled! – plastics, for example) that enable a small number of production lines to turn out multiple model types.

The measurements used might therefore include indicators of velocity of output at all the various points in the production process, as well as measures of the accumulation of raw materials, partially processed product, and final product at the various transition points in the process. These accumulations might be measured in terms of daily or monthly output. In those points, as well as all others, ways to shift from "push" to "pull" processing should be identified.

There may be cases, however, where accumulation might be justified precisely on the grounds of environmental benefit and sustainability. In sugar mills that implement bagasse-fired cogeneration in conjunction with efficiency measures to reduce and even eliminate the need for use of fuel oil or natural gas, energy requirements and generation capacity may be exceeded by the volume of bagasse produced during the crushing season. In such cases, one possible strategy involves storing the bagasse for combustion for at least part of off-season. To the extent that the storage facilities prevent degradation and rotting, this accumulation of fuel may be justified.

Measuring and Assessing Social Sustainability

Social sustainability is the most difficult facet of SD to assess and progress in this area is arguably less amenable to quantitative measurement. As in other areas of social science, however, certain statistical and data collection techniques are applicable here. To begin with, broad, macroeconomic and demographic indicators will provide information relevant to the assessment of progress in this area as well. In addition, good record-keeping on the part of companies involved in projects with social components, as well as those concerned with community development activities, will also yield adequate information for gauging progress in this area.

[32] *Ibid.*, 125-143.

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- *Formation of human and social capital.* A crucial part of the development of social capital that is essential to the emergence of SD is the education and training of workers and managers in the context of a project or corporate initiative. The successful implementation of such projects, as well as their replication elsewhere, depends on the extent to which the management practices, technical knowledge, and results of the project are well understood, disseminated, maintained and improved upon by managers and employees. The permanence of the results of the project may also depend on the amount of follow-on training and review included in the implementation plan for the project, as well as plans to disseminate the results of the project in conferences, seminars, technical papers and other media.

  Accordingly, the extent to which a project contributes to human and social capital formation may be measured as a function of the amount of training that employees receive as part of the implementation of the project. Specifically, several indicators might be used: (1) amount of resources (money) spent on training as part of the project; (2) number of person-days of training; (3) percentage of employees receiving training at the specific plant involved, or company-wide; (4) number of person-days of follow-on training provided to employees and managers in the years following project implementation; (5) number of women employed and trained; (6) number of employees and trainees from ethnic, racial, religious and other minorities. More simply, the criterion might be expressed as whether or not the project includes some form of training for managers and workers.
- *Creating constituencies for SD.* SD cannot be "sustainable" unless company owners, employees, and the surrounding communities have a stake in the implementation of SD principles. This goes beyond the environmental benefits generated by a project or corporate initiative. While these are important, they do not ensure sustainability. Rather, it is crucial that owners, employees and their communities have an economic interest in the successful implementation of SD, thereby creating a source of continued support for these changes. Without this support, and the example that it provides to others, the implementation of SD principles will ultimately fail.

  How constituencies for SD are created is as much a matter of corporate governance and organization as it is one of project design. For example, project design may include community outreach and employee training to create understanding and awareness of the benefits and results of a project or corporate initiative. The awareness of the environmental benefits from the project or corporate initiative, as well as generalized material benefits to the surrounding community flowing from its implementation in the form of jobs, high wages, and corporate support for local schools, clubs, charities and community organizations, are both important factors in creating a constituency for SD. But support for the project or initiative will be deeper and stronger to the extent that employees share in the financial returns from the project or initiative through bonuses or stock option programs, and the general public has an opportunity to participate through public offerings of stock on national or regional equity markets.

  Indicators of the role this feature plays in SD might include various measures of the economic impact a corporate initiative or project plays in the community, as well as the employees and investors who make up the broader corporate community. These might include: number of jobs created and supported; corporate support for

local community institutions; number of employee-shareholders or share of profits distributed in bonus programs; number of publicly held shares in the company. Some or all of these features, to the extent that they are identified and communicated to the general public, will help create constituencies for the implementation of SD principles.

- *Generating project replicability.* To the extent that the other measures and results of projects or initiatives to implement SD are communicated to stakeholders, businesses, government officials, the media and the general public, the potential for similar initiatives elsewhere grows as well. With replication of projects and initiatives in other regions and other business sectors, the spread of SD principles is assured.

  The most appropriate assessment of replicability would be the number of times that a particular project type is duplicated throughout a given sector or in multiple sectors. Since it is hard to assess whether project implementation is the result of the example provided by a similar project elsewhere, it seems more appropriate therefore to simply estimate the number of projects implemented, or check with licenses or permits for specific project types, as appropriate. One example would be to track the number of permits (or other relevant official approval) issued for cogeneration projects at industrial facilities.

Implementing SD Criteria in Projects and Corporate Initiatives

Checklist for Implementing SD Principles and SD Indicators

The following checklist can be used as a questionnaire and self-assessment tool to identify the extent to which a project or corporate initiative integrates SD principles, and the list of SD indicators provides a representative selection of possible indicators that might be used. The indicators suggested here are of a sufficient level of generality to accommodate their application as appropriate to any industrial process. Others not mentioned here may obviously be included by individual companies. The main objective is to develop a set of indicators to begin taking measurements and to record progress in increasing resource utilization efficiency. Experience in many industrial facilities suggests that over time, this process will lead to the elimination of whole areas of waste that were otherwise considered unavoidable.

Checklist

Before beginning the process of developing a strategy for implementing SD principles at the enterprise or project level, it is helpful to consider the following questions:

- Does the initiative to incorporate SD principles have the backing of senior management in the company, project developer or project company?
- Does senior management support public reporting of the scope and results of the initiative?
- Are sufficient human and material resources being allocated to this effort? Will the staff assigned to the task have sufficient time to work on it?

- Does the team assigned with this task comprise individuals familiar with the production (engineering), regulatory (including environmental compliance), marketing/sales, human resources and financial aspects of the company's business?
- Are adequate records kept of all aspects of the company's operations (production, regulatory, marketing/sales, human resources, finance)? What is the level of confidence in the accuracy of these records and the measurement equipment (where appropriate) used to obtain them?

The answers to these questions will significantly influence the level of effort required in establishing the SD initiative and the degree to which it can be successfully implemented. Obviously, managers must determine what level of effort and amount of time and material resources is required to complete the job. The list of possible indicators presented in the following section will assist in defining the scope of work required.

Environmental sustainability

Based on the conceptual discussion presented in the previous section, this section presents a series of indicators of environmental sustainability that project developers and company managers could consider as indices for internal use. The first challenge for managers will be ensuring that the measurements are taken and recorded accurately. This issue, which is beyond the scope of this toolkit, is critical to the process of improving environmental sustainability. Without good measurements, progress is impossible – or, to quote the dictum of quality control and total quality environmental management, "you cannot change what you do not measure."

With accurate measurements and adequate record-keeping, each of these indicators will produce a data set that will permit managers to understand the structure of resource consumption at the plant or individual process. Once the record keeping systems are in place, evaluations of alternative processes and production techniques may be tested to gauge the impact of the changes on resource consumption. The results will in turn yield new data that can be used to identify new opportunities for efficiency. With each iteration, resource consumption declines, and efficiency increases, pushing the process, plant and company closer toward the zero-emissions goal and that of environmental sustainability. The first step in the measurement process is to develop a precise measurement of all inputs and all outputs of a given process or plant. Measurements of those operational parameters that may be directly measured will inevitably assist in the identification of waste streams that may not have been readily identifiable, and provides a framework for continued measurements.

[illegible]	
Inputs	◆ Energy consumption ◆ Water consumption ◆ Raw materials consumption ◆ Utilization of catalysts, reagents, solvents ◆ Incident energy (for buildings)
Outputs	◆ Waste heat ◆ Effluent(s) ◆ Emissions into atmosphere ◆ Solid waste ◆ Final product for sale ◆ Net energy retained (for buildings)

[illegible]	
Energy consumption	BTUs or Tjoules per unit of output
Water consumption	Liters per unit of output
Raw materials utilization	Kg or M3 per unit of output
Utilization of catalysts, reagents, solvents, etc.	Kg or M3 per unit of output

[illegible]	
Energy consumption	BTUs or Tjoules per unit of output, distance traveled, duration of service
Water consumption	Liters per unit of output, duration of service
Operating inputs (refrigerants, oils, etc.)	Kg or M3 per unit of output, duration of service
Materials requirements	Kg or M3 per unit of output or duration of service

[illegible]	
Product that is of uniform material (Generally consumer non-durables, such as paper)	◆ Complexity of process required for recycling ◆ Energy savings through use of recycled product ◆ Water savings through use of recycled product ◆ Consumption of other inputs (solvents, paint, etc.)
Manufactured goods (automobiles, white goods)	◆ Percentage of parts that may be recovered and recycled ◆ Recyclable components as share of product volume/weight ◆ Energy savings through use of recycled product ◆ Water savings through use of recycled product ◆ Consumption of other inputs (solvents, paint, etc.) ◆ Complexity of process for recycling or remanufacturing
Real estate	◆ Recyclable components as percentage of construction volume or weight ◆ Uses to which recyclable materials may be put

Product that is of uniform material (generally consumer non-durables, such as paper)	Percentage of post-consumer recovered material in finished product (eg., glass, fiber in paper)
Manufactured goods (automobiles, white goods)	Percentage of product containing recycled parts or material
Real estate	Percentage of structure that is recovered or recycled material
Basic infrastructure	Percentage of structure that is recovered or recycled material

Gaseous emissions (Gases and/or particulate matter)	♦ Tons annually ♦ Tons annually from incinerated material
Solid waste	♦ Tons or M3 land filled, dumped or buried annually ♦ Tons or M3 of ashes annually from incinerated material ♦ Tons or M3 dumped into bodies of water annually
Liquid waste	♦ Liters/tons incinerated (in case of inflammable materials) ♦ Liters/tons discharged into bodies of water ♦ Liters/tons evaporated in evaporation ponds ♦ Liters/ton re-injected into wells

Economic sustainability

The quantitative measures of economic sustainability suggested here the same as the standards used by any business. In contrast, some of the more qualitative indicators identified here are intended to reflect the extent to which a company or project is transforming itself towards the utilization of business models that enable the delivery of environmental and social to reinforce economic performance, rather than work at cross-purposes to it.

Overall investment attractiveness	♦ Internal Rate of Return (IRR) ♦ Net Present Value (NPV) ♦ Cost-benefit ratio ♦ Simple payback period (months/years)
Investment returns	♦ Return on Equity (ROE) ♦ Return on Investment (ROI)
Debt analysis	♦ Debt coverage ratio ♦ Exchange rate exposure in debt portfolio ♦ Exchange rate exposure in revenues ♦ Hard currency revenues as percent of total
Market analysis	♦ Market penetration of product ♦ Size of potential market

Does current business model involve …	
… a relatively high-value consumer or capital good for which maintenance and upkeep is an important part of continued product performance (eg., automobile, scooter, trishaw) ?	♦ It should be possible to create a service- or lease-based sales model, where financing, maintenance and upkeep, and product recovery and recycling are factored into the overall lease cost. ♦ Alternatively, a sale and buy-back arrangement could also be attempted.
… a relatively high-value consumer product or process input that is (1) highly toxic, (2) highly inflammable, or (3) concentrated?	A service-based sales model could be employed, whereby collection receptacles can be placed with service recipient for regular changing and product recovery.
… a relatively low-value consumer good that requires packaging or wrapping that could be recycled?	A deposit-refund arrangement could also be employed. This may be applied at all levels of the distribution chain.

Does current business model involve …	
… a complex manufacturing or assembly process, with multiple intermediate steps and subprocesses that require storage and materials handling infrastructure?	♦ A pull-based production model might be tested to gauge whether the same level of output could be achieved without the same storage and materials handling requirements. ♦ Simplification of certain components or steps in the manufacturing or assembly process may be possible, reducing energy and input requirements.
… a complex supplier chain, whereby the producer receives inputs or parts from suppliers unrelated to the recipient company, with large storage and handling requirements?	♦ A just-in-time manufacturing process could be implemented, reducing storage and handling requirements. ♦ Alternative component-production models might also be considered at the supplier companies, as a way of reducing cost.
… sales of relatively high-value products in different models or types that require large storage and display areas?	♦ A just-in-time manufacturing process could be implemented, reducing storage and display requirements. This model may permit production to be consolidated to one production center.

Social sustainability

The indicators suggested under this heading are as much qualitative as they are quantitative. To the extent that data are available to provide some quantitative points of reference for the items identified here, the evidence of how a given project or corporate initiative contributes to socio-economic sustainability will be strengthened. Nevertheless,

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managers should bear in mind that the qualitative indicators may well provide strong evidence of sustainability as well.

[illegible]	
Employee and manager training on SD project or corporate initiatives	◆ Number of person-hours of training ◆ Is training optional or mandatory? ◆ Coverage of main SD issues in training ◆ Programs to recognize employee contributions and initiatives
Project or corporate support for and involvement in local community	◆ Support for schools, clubs, associations, neighborhood groups, cultural institutions ◆ Internships and training programs for youth

[illegible]	
Employment	◆ Number of jobs created ◆ Wage levels of positions created
Investment	◆ New investment due to project or initiative ◆ Applications of investment resources
Economic contribution to local community	◆ Tax revenue generated by company ◆ Overall economic contribution to local community

[illegible]	
Employee bonuses	◆ Aggregate size ◆ Linkage to profits from implementation of project or SD initiative
Equity participation	◆ Number of employees benefited ◆ Percentage share of employees in project/corporation

[illegible]	
Project/corporate communications	◆ Inclusion of SD project or initiative in Annual Report, company website, other corporate publications and information sources ◆ Provision to project information and sharing experience with government agencies, independent research organizations, associations, other companies ◆ Media strategy
Community relations	◆ Community visits to plant, outreach and emergency preparedness programs

Replication [illegible]	
Evidence of potential for replication of project	♦ Number of company facilities where project might be implemented ♦ Number of other companies where similar projects might be undertaken ♦ Availability of technology and know-how in sector and country to permit replication
Evidence of replication of project	♦ Number of permits or licenses for specific project types (eg., cogeneration permits) ♦ Sales of specialized equipment required for project ♦ Reported projects and case studies ♦ Environmental quality indicators (air quality, water quality, solid waste) in areas benefited by projects and/or initiatives

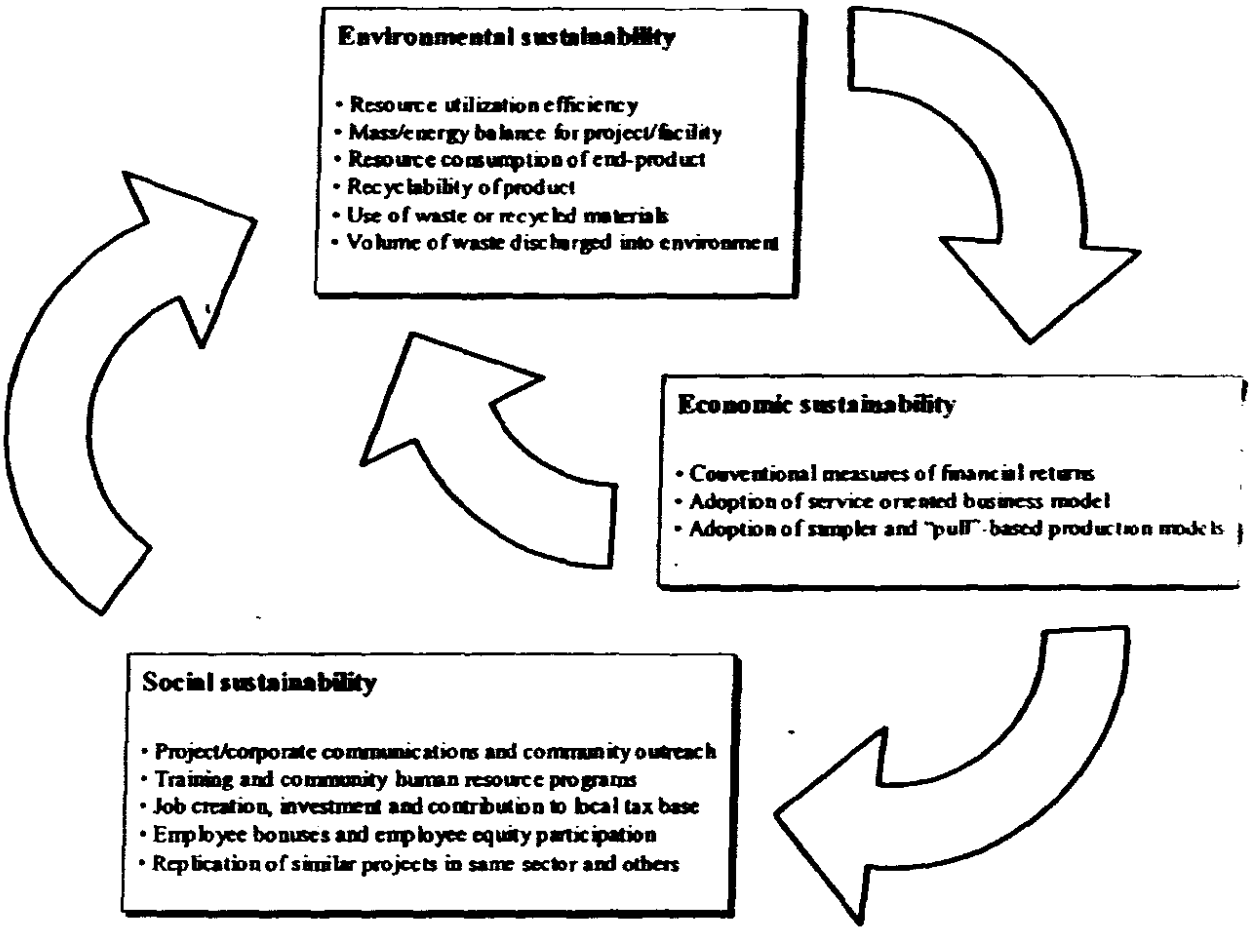
Critical Path for Integrating SD Principles in Projects and Corporate Initiatives

The path to integrating SD principles into projects and corporate initiatives is necessarily a circular one, since that actions taken at the outset lead to conclusions that suggest new actions, and so forth. The process is iterative, and based on the basic total quality environmental management cycle of "plan – do – check – act, and repeat." The relationship between the three facets of SD, in terms of where they fit in the critical path of SD implementation, is summarized in Figure 9.

As noted in the discussion of the facets of SD, the process of implementing SD begins with the identification of opportunities to enhance environmental performance. Actions to achieve improvements in environmental performance, in turn, begin with the implementation of systems to measure and record various parameters of plant operation. It is expected that the first actions will be relatively simple to implement. As efficiency and environmental performance improve, the number of new actions that can be taken will tend to diminish, while the level of complexity and cost of investment may increase. Hence the cycles of innovation and change will tend to slow. However, it is important to note that the normal process of upgrading and investment in new process equipment will enable companies to install more efficient processes as part of the regular investment program. Further, it is also important to note that the traditional understanding that the economics of pollution prevention experience diminishing returns may well be open to radical revision as engineers seek ways to optimize entire productive systems – as opposed to individual pieces of equipment – and seek compounded savings and efficiencies the accrue from seeking efficiencies in the first steps of the production process.[33]

[33] *Ibid*, 111-124.

Figure 9: Critical Path for Implementation of SD Principles



The process of identification of opportunities for efficiency enhancements and synergies necessarily includes rigorous financial evaluation. Indeed, the evaluation of costs and benefits, simple paybacks and internal rates of return is a vital part of the project planning process. However, the other aspects of financial and commercial sustainability may well not be considered until after several, perhaps many iterations of the cycle of seeking out efficiency opportunities, identifying the economic returns on those actions, and measuring their benefits in economic, social and environmental terms.

Meanwhile, the impact of these activities on the surrounding community, as measured and evaluated using the indicators identified in the section on social sustainability, will require multiple iterations in the cycle of identifying efficiency enhancements, implementing actions to obtain these benefits, measuring the results and planning new actions. Over time, however, it is expected that the immediate economic and environmental benefits will generate broader gains in the community, while information of the actions taken and the results will also spread through the community. This

Figure 11. Those matrix cells that are identified with the cross-hatched shading have limited relevance to the carbon baselines and monitoring and verification toolkits, and hence are not addressed in detail in those two documents.

Together, the five toolkits address five key stages of the development of a CCMP: project design, with maximum environmental and SD benefits in mind; the identification of the carbon emissions reductions flowing from the project; the assurance for the buyer of the Certified Emissions Reductions (Offsets) that the reductions are actually obtained (the development of the M&V protocol is a vital part of the registration application); the role of carbon in project finance; and the marketing of the project and securing investment for it. This critical path is described in Figure 12.

Figure 11: Linkages between the SD Toolkit and the Carbon Project Toolkits

	Carbon Baselines	Monitoring & Verification	Carbon Finance	Marketing & Funding
Environmental sustainability				
Development of mass/energy balances				
Measurements of resource utilization				
Resource consumption of end product				
Measuring recyclability/recycling				
Economic sustainability				
Measures of financial sustainability				
Rethinking business models				
Rethinking productive processes				
Social sustainability				
Formation of human and social capital				
Creating constituencies for SD				
Generating project replication				

* The issues identified with cross-hatching have limited relevance to the two toolkits identified, and hence are not explicitly addressed in the toolkits.

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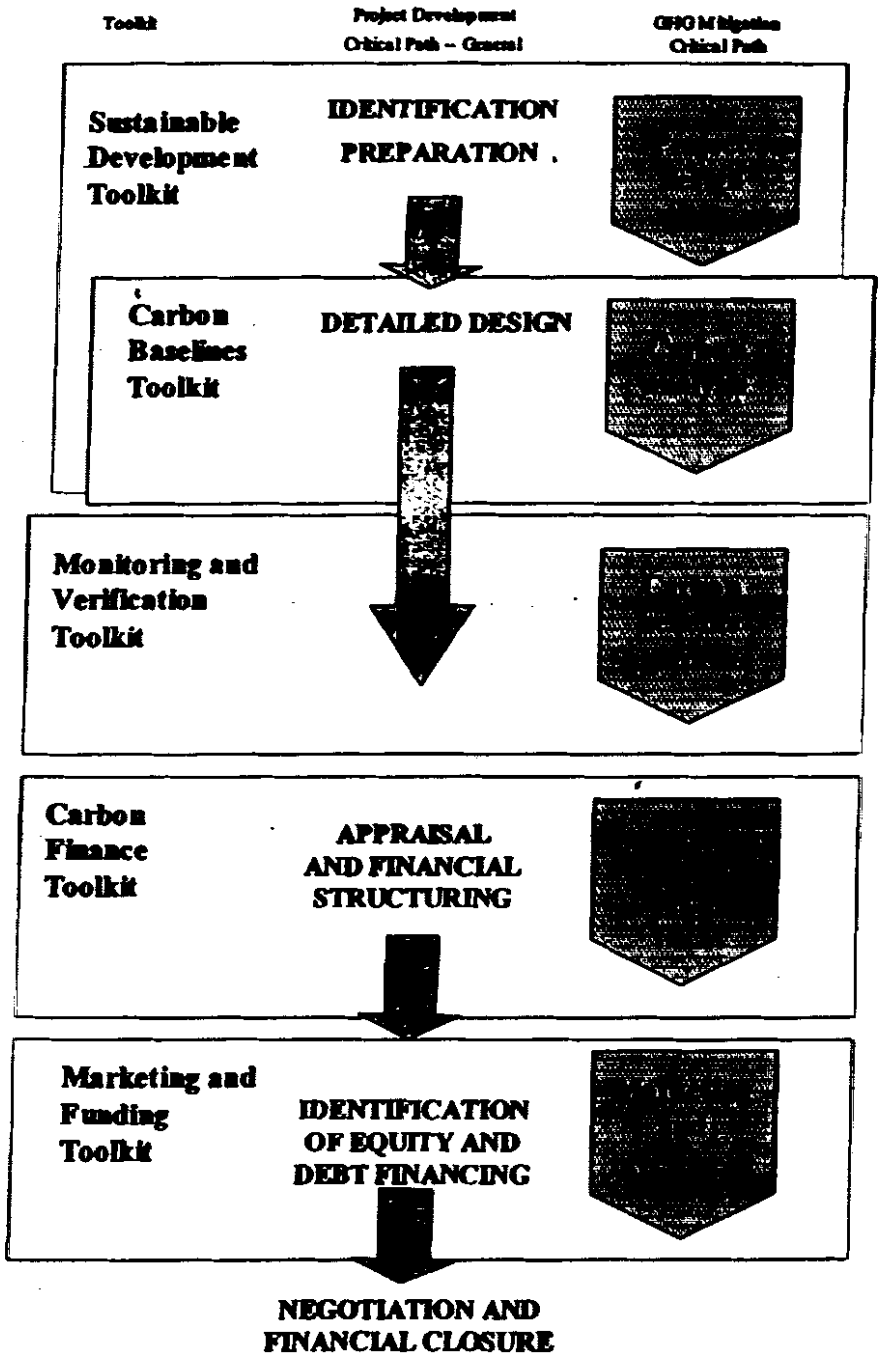
Figure 12: Project Development Process and Linkages to the Toolkits



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5. Concluding Remarks

This toolkit and the four companion documents covering the evaluation and preparation of climate change mitigation projects is intended to orient the user in the utilization of a broad set of sustainable development indicators that monitor the environmental, economic and social aspects of SD.

While there is still debate over the definition of SD, as well as the most appropriate conceptual framework for understanding it and applying SD principles at the enterprise level, a general consensus among business organizations, businesses, government and academia has emerged on the relevance and value of SD indicators (SDIs) as a tool for evaluating company and project performance with respect to SD principles. This toolkit has presented a series of indicators for consideration and use by firms engaged in the development of CCMPs.

Progress toward SD will necessarily be slow and fraught with difficulties. However, a large number of organizations and companies from many countries, both in the industrialized nations as well as the emerging economies, have made progress toward developing principles for SD as well as metrics and measurement systems for evaluating progress toward the goal of SD. The information presented here is intended to serve as an introduction and a preliminary guide to the project developer and or corporate manager, and not an exhaustive treatment of the subject.

At the same time, this document is intended to provide the beginning of a reference document that will be updated in the future with case studies, new references and Internet resources, and possibly other material.

Bibliographical References

This section presents titles and web links of sources of additional information:

- Austin, Duncan et al., "How Much Sustainable Development Can We Expect from the Clean Development Mechanism?" World Resources Institute *Climate Notes*, November, 1999.
- Bardouille, Pepukaye and Koubsky, Jan, "Incorporating sustainable development considerations into energy sector decision-making: Malmö Flintrännen District Heating Facility case study, *Energy Policy* 28 (2000): 689-711.
- Chiras, Daniel, *Voices for the Earth: Vital Ideas from America's Best Environmental Books* (Johnson Books: Boulder, CO, 1995).
- _____, *Lessons from Nature: Learning to Live Sustainably on the Earth* (Island Press: Washington, DC, 1992).
- Goodland, Robert, "The concept of environmental sustainability," *Annual Review of Ecological Systems* 26 (1995): 1-24.
- Hansen, Stein, "Towards a sustainable economy: can we survive green advice?" Environment Department Papers no. 36 (June, 1996), The World Bank.
- Hawken, Paul, *The Ecology of Commerce* (HarperCollins: New York, 1993)
- Hedtrom, Gilbert et al. "Realizing the sustainable development premium," Prism (Arthur D. Little), 1Q 2000: 5-19.
- Hecht, Alan, The triad of sustainable development: promoting sustainable development in developing countries," *The Journal of Environment and Development* 8 number 2 (June, 1999): 111-132.
- Ranganathan, Janet, "Sustainability rulers: measuring corporate environmental and social performance," *Sustainable Enterprise Notes* (Washington, DC: World Resources Institute, May 1998).
- Smart, Bruce, *Beyond Compliance: A New Industry View of the Environment* (World Resources Institute: Washington, DC, 1992).

Internet resources:

- Applied Sustainability: http://www.as-llc.com
- Center for Clean Air Policy: http://www.ccap.org
- Center for Sustainable Development in the Americas: http://www.csdanet.org
- Coalition for Environmentally Responsible Economies: http://www.ceres.org
- Business Council for Sustainable Development—Gulf of Mexico: http://www.wbcsdgm.org
- Global Environmental Management Initiative: http://www.gemi.org
- International Institute for Sustainable Development: http://www.iisd.org
- United Nations: http://www.un.org/esa/sustdev/program.htm
- World Business Council for Sustainable Development: http://www.wbcsd.ch/aboutus.htm
- World Resources Institute: http://www.wri.org and www.wristore.org

Annex: Project Case Materials

As of this writing, Development Alternatives has received project descriptions for 15 projects in India, as identified in Table 3.

Table 3: Projects identified as of April, 2001

Sponsor	Size (MW)	Technology
Ankur Scientific Energy Technologies Ltd.	1	Biomass gas
Bhoruka Power Corporation Limited	3	Hydro
Great Milieu Conserve (Pvt) Ltd.		Methanation
Kakatiya Alloys (Pvt) Limited	6	Methanation
Kirloskar Electric Company Limited	1.6	Wind
Larsen And Toubro Limited	50	Biomass
Market Dynamics Private Limited		Biomass
Market Dynamics Private Limited	0.6	Solar PV
Polyene Film Industries		Solar PV
Ravi Entech Limited	4.25	Biomass gas
Ravi Entech Limited	32.8	Biomass gas
Shree Papers Limited	4	Biomass
Shree Papers Limited	2.5	Mini-hydro
Tata Bp Solar Limited	1	Solar PV
Trimbak Power Company Limited	30	Biomass

Greenhouse Gas Pollution Prevention-Climate Change Supplement (GEP-CCS)

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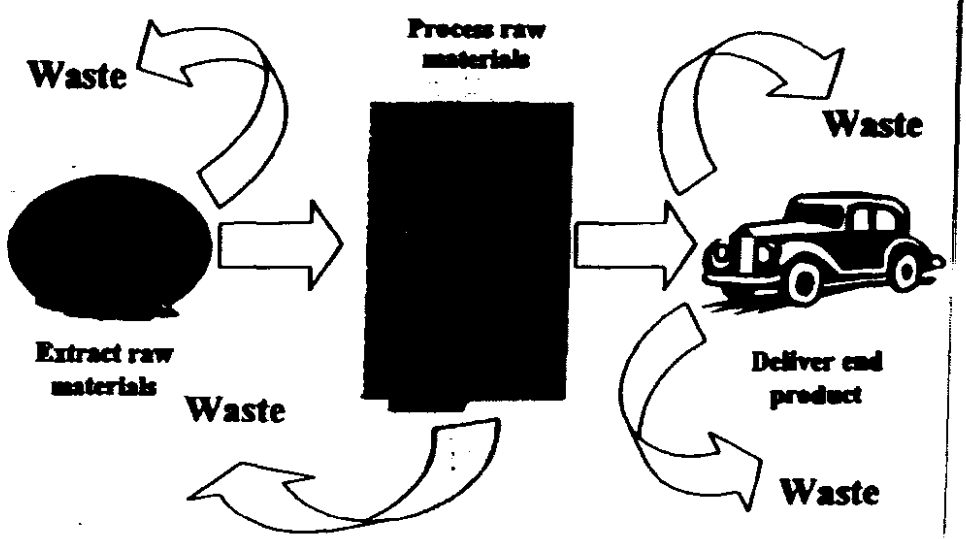
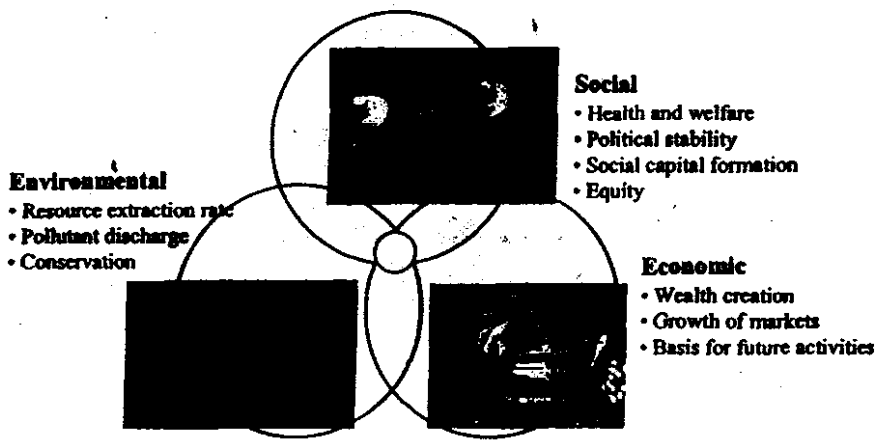
Sustainable Development Toolkit

The Louis Berger Group, Inc.

Industrial Development – Historically, A Linear Process



Criteria for Sustainable Development – three facets of SD



The Three Facets of Sustainability

- ⇨ Environmental – Impacts of economic activities, in terms of the rate of extraction (relative to rate of regeneration) as well as discharge levels (relative to carrying capacity)
- ⇨ Economic – Potential for companies and projects engaged in environmentally sustainable activities to sustain themselves commercially and financially
- ⇨ Social – Social well-being, political stability, social capital formation

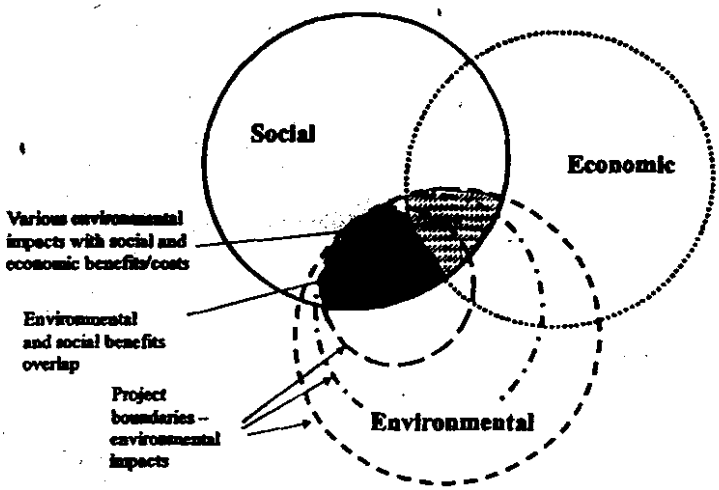
Linkages between Facets of Sustainability

- ⇨ Environmental-economic: eco-efficiency
- ⇨ Socio-economic: employment creation, equity, businesses serving social needs, investment in education, minority supplier access, empowerment of women
- ⇨ Human health impacts of pollution, human impacts on environment that derive from social organization and governance (land tenure, access to natural resources, etc.)

Role of Technology

- ⇨ Hardware and "software"
  - Equipment, tools, machines and infrastructure
  - Software programs, management systems, analytical methods – *intellectual property*
- ⇨ Critical to improved environmental performance
- ⇨ Critical to improvements in production and company operations
- ⇨ Contribute to social welfare, communications

Overlap with Social and Economic Facets



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Economic Sustainability

⇨Self sustaining - SD projects must be financially and commercially viable, grounded on a solid business concept and must generate economic benefits to the community and broader social and economic context in which it is implemented.

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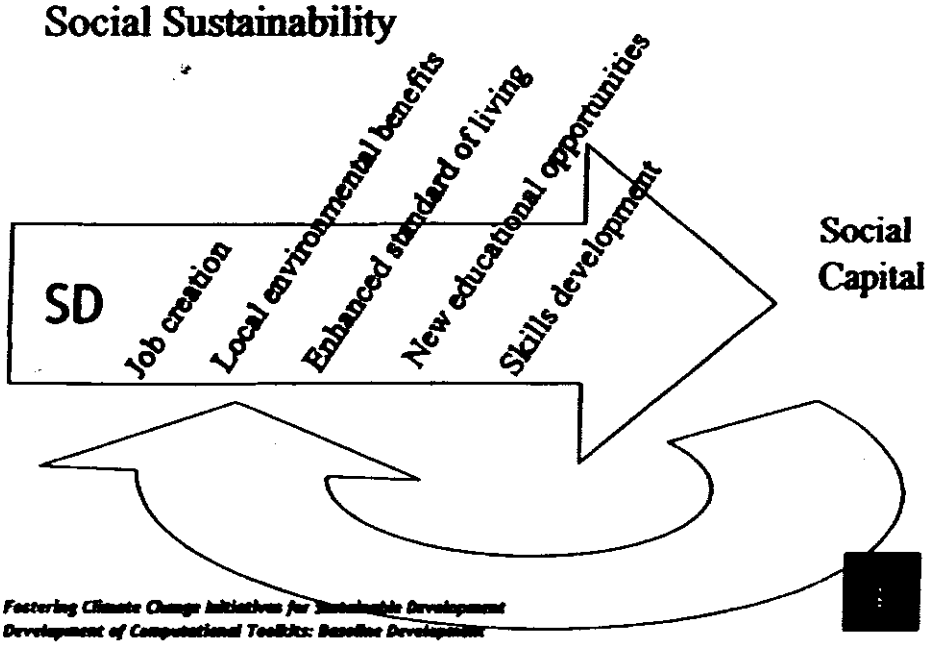
The Sustainable Development Premium

Benefits:

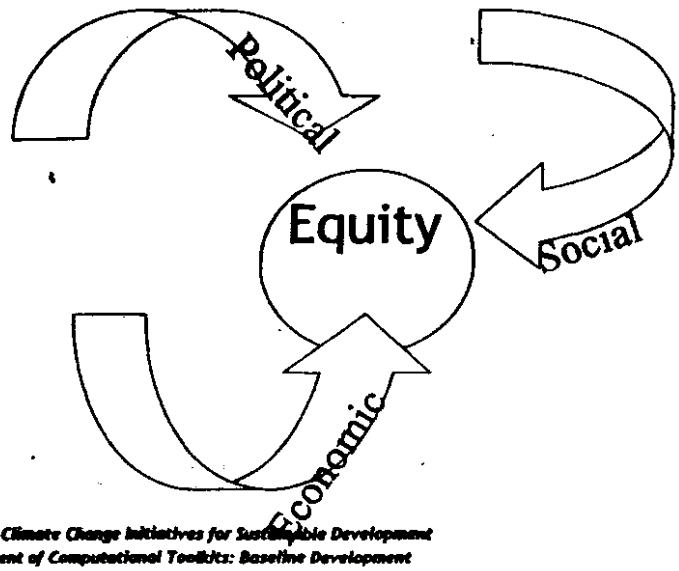
- **reduced operating costs**
- **reduced liabilities and insurance requirements**
- **new market opportunities**
- **new customer bases**

- Option creation – new product lines, processes and markets emerge, enhancing commercial opportunities
- Cost leverage – eco-efficiency enhancements generate savings that benefit the bottom line
- Risk reduction – enables businesses to shed unsustainable assets and prepare for tighter regulations
- Customer preferences – enhances market position and often attracts new sources of capital

Social Sustainability



Social sustainability



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Environmental Sustainability Indicators

- ⇨ Developing mass/energy balances for projects, i.e. integrated assessment of resource use and process efficiency
  - Identify and quantify all material and energy inputs and outputs from a process
  - Helpful in identifying areas of opportunity to reduce waste and inefficiency
- ⇨ Measures of productivity in resource use, i.e. environmental resource consumption per unit of production
  - Electricity consumed per unit of production
  - Water consumed per unit of production
  - Fuel consumed per unit of output

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Environmental Sustainability Indicators (cont'd)

⇨ Resource consumption of end-product

- Estimate the lifetime consumption of resources by the end-product, i.e. water consumption, raw material uses, etc, in terms of unit output, distance traveled or duration of services
- Identify net environmental gains to be exploited as efficiency measures

⇨ Measuring recyclability and use of waste or recycled materials

- Recycling of materials can reduce the use of raw materials once incorporated into the input stream
- Degree of recyclability that is designed into durable and capital goods as an internal indicator of SD principles. From environmental sustainability perspective, take the appropriate steps and RECYCLE the material!

Economic Sustainability Indicators

⇨ Conventional measurements of financial sustainability

- Cost-benefit analyses, calculation of net present value and internal rate of return
- Other advanced evaluation techniques

⇨ Rethinking business models – service vs. product

- Deliver the service of the product as opposed to the product itself
- It depends on the degree of recyclability built into the product (if applicable)
- Environmental benefit accrues only when the recycling actually occurs

⇨ Rethinking product process – "flow"

- "Just-in-time" manufacturing
- Reduce waste

Social Indicators

⇨ Formation of human and social capital
- Education and training of workers and managers
- Use amount of resources available for training, number of people and days as indicators

⇨ Creating constituencies for SD
- It does not ensure sustainability, but it is crucial for the successful implementation of SD
- Use number of jobs created, corporate support for local communities, share of profits distributed, etc. as indicators

⇨ Generating project replicability
- To assure the dissemination of SD principles and projects
- Estimate the number of similar projects implemented as an indicator

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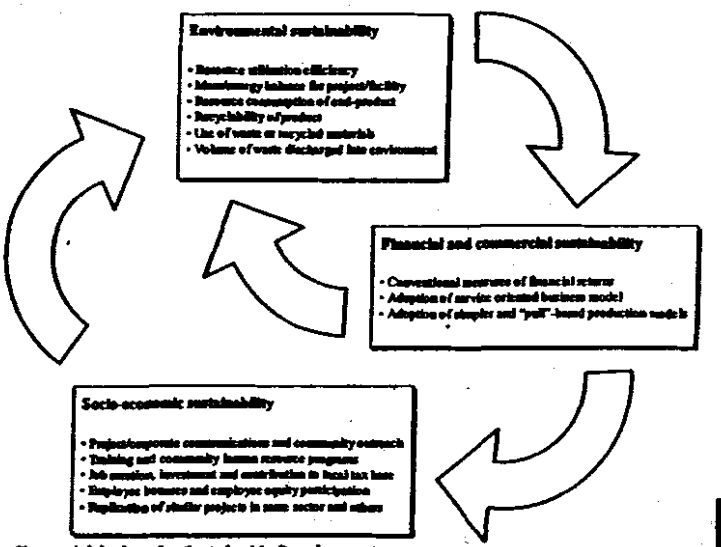
Critical Path for Implementation of SD Principles



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Linkages to Other Toolkits

	Carbon Baseline	Monitoring & Verification	Carbon Finance	Marketing & Funding
Environmental sustainability				
Development of ecosystem balances				
Measurements of resource utilization				
Resource consumption of end product				
Measuring recyclability/recycling				
Financial and commercial sustainability				
Measures of financial sustainability				
Establishing business models				
Establishing production processes				
Socio-economic sustainability				
Promotion of human and social capital				
Creating contributions for SD				
Generating project replication				

The issues identified with cross-hatching have limited relevance to the [redacted] identified and hence are not explicitly addressed in the toolki[redacted]

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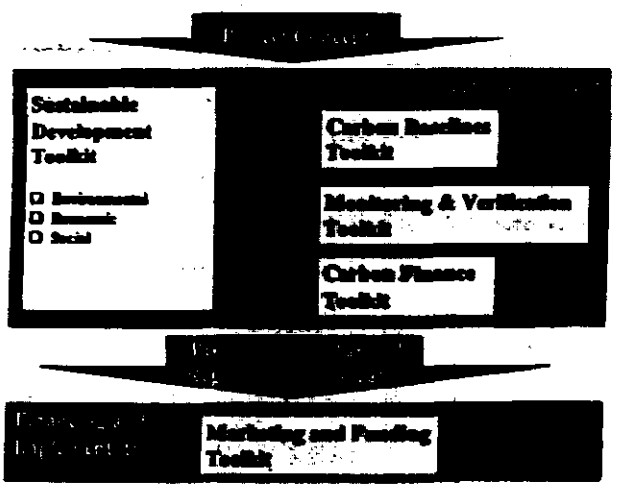
Linkages to Other Toolkits



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