CLEAN DEVELOPMENT MECHANISM
PROPOSED NEW METHODOLOGY: BASELINE (CDM-NMB)
Version 02 - in effect as of: 15 July 2005

CONTENTS
PROPOSED NEW METHODOLOGY: BASELINE (CDM-NMB)

SECTION A. Methodology title and summary description

Methodology title:

Increased electricity generation from existing hydropower stations through Decision Support System optimization
Version 2
November 11, 2005

Summary description:

There is a certain amount of energy embedded in water held in a reservoir or flowing through a river. Hydropower units transfer that energy into an electrical form. The electricity generating units that execute this task perform best under certain operating conditions. The optimal operating conditions for each unit may differ based on design or other variables. By determining the optimal operating conditions for each unit – and trying to match up the actual operation of the units with their optimal operation point – an operator can increase the total electricity generation from the same amount of water flowing under the same conditions. This is especially true when you calculate the optimal generation scenario for multiple generating units using all the available data including likely weather conditions, reservoir capacity, head, and other variables.

Two to ten percent increases in electricity generation have been realized for example in the reasonably well managed operations in Manitoba Hydro (Canada) and Idaho Power (USA) simply by implementation of a Decision Support system to better manage water resource decision making.[1]

Decision Support Tools are designed to calculate the optimal use of the generating capacity of a hydro generating unit or a series of hydro generating units by taking advantage of all the controllable factors (head, reservoir capacity, spillage, time of use, etc.) and best available information. If the Decision Support Tool is able to increase electricity generation from existing hydro units it is, in most circumstances as per calculations of combined margin in ACM002, able to displace electricity generated from thermal sources and eliminate the combustion of fossil fuels. This will result in CO2 emission reductions.

To measure the impact of a Decision Support System, a project developer can look at optimizing the cumulative energy (measured in kWh) generated for each m^3 of water that moves through the generating units or cascade of generating units. In order to eliminate the key factor outside the control of the Decision Support System- the timing and quantity of natural water supply – a normalized baseline is established in which the weekly energy output for the system is established for various points corresponding to a total flow index. For example in the baseline *period* if 60,000MWh are produced in a week which averages 20,000 cubic feet per second (about 56m3 per second) this would be compared to the actual electricity generation in the post-optimization project year at the same flow index.

---

[1] For additional examples and technical papers please see
http://www.synexusglobal.com/product_generators_vista_papers_sched.html and

http://www.synexusglobal.com/product_generators_vista_success.html

The total flow index, which in projects with reservoirs includes spillage, can be the flowrate, total flow volume from all hydro stations, or the total flow from a representative point such as the most downstream plant if run of the river. The total flow index will be measured consistently between the baseline period and the project years.

The flow index is determined using the industry standard method as follows:

- MW output is measured at each unit and plant on a continuous basis
- Headwater level is also measured as above
- Tailwater level is measured
- Gross head is the difference between the last two bullets
- Flow through each generating unit is determined for each hour, based on the unit performance "hill diagram" provided by turbine manufacturer and/or commissioning test, which defines the three dimensional relationship between power output, head and flow (and associated efficiency). Flows are aggregated at all units and all plants in the cascade to yield the flow index.

The meters associated with measuring MW output and water levels are extremely accurate. River flow gauges will not be used since their accuracy is not high enough. Using the QA/QC measures outlined in calibrating the meters, there should be little inaccuracy in any of these measurements. However, it should be noted that for the methodology to reach accurate and conservative results, the measurement of the flow index does not have to be accurate, as long as it is 100% consistent in the before and after cases. To demonstrate this point, assume that a particular unit performance curve before DSS implementation is in error by x%, which implies that the calculated flow will also be in error. It should be noted that after DSS implementation, for the same flow, the error will be exactly the same, since the unit performance curve is the same. Therefore, the flow index will be 100% consistent between the before- and after-DSS cases providing an accurate and conservative flow measurement. This measurement approach is an internationally recognized as the industry standard.

<u>Baseline Emissions:</u> The baseline generation in kWh at a particular flow index observed during a week in the project year would be compared with the actual kWh generated in the same week in the project case. The difference would yield the additional electricity generated. This will be converted into CO2 emission reductions using the combined margin approach to develop a carbon emissions factor.

In a very simplistic example the Decision Support Tool might inform an operator currently running all the generating units at between 50-75% of capacity 24 hours a day that more electricity can be generated by using fewer units to produce less electricity during off-peak hours. This would allow the head to build in the reservoir, which could then allow each generating unit to operate at optimal levels for shorter periods of time but producing a greater quantity of electricity.

Another very simplistic example is how the Decision Support Tool collects weather data to determine water flows in a river. If the hydro operator knows that a good deal of rain is occurring upstream and it will take several days to reach the dam, it can increase generation and temporarily lower reservoir levels. That could avoid spillage when the increased flows reach the dam, and what would have been spillage can now be used as useful electricity. In these two cases, this increased level of output would typically displace fossil-fuel units as calculated using the combined margin approach outlined in ACM002, reducing CO2 emissions.

In summary, in order to calculate the additional generation due to the Decision Support System the project developer will:

1. Measure the weekly total flow index (sum of the water flow through each generating unit and flow over each spillway) in the baseline *period* and the corresponding total electricity generation. The flow index will not include water consumption and irrigation/other return flows.
2. Measure the weekly total flow index in the project year and the corresponding total electricity generation.
3. For each weekly flow index level in the project year, use the measurements taken in the baseline *period* to identify the baseline total generation for that flow index. (For weekly flow index data points in the project year that are higher or lower than the limits of baseline data set, the project developer will not seek to claim emission credits.)
4. Total all the actual weekly generation in the project year.
5. Total all the expected weekly generation using the baseline generation data that corresponds to the actual project year total flow index.
6. Subtract 5 from 4 to determine the total additional electricity generated using the Decision Support Tool
7. Determine the Carbon Emission Factor for the project year using the Combined Margin Approach outlined in ACM002.
8. Multiply the number from step 6 by the Carbon Emissions factor to determine the total emissions reduction.

Choosing the baseline scenario: Step # 1: First, the project developer must identify all alternatives to deliver the additional kWh that would likely occur in the absence of this project.

Step #2: The methodology then requires the project developer to utilize the barrier analysis outlined in the EB-approved Additionality Tool to assess the likelihood of each alternative coming to pass. The baseline scenario will be the alternative that appears the most likely to occur in the absence of the project.

Demonstrating additionality: This project uses the EB-approved Tool for the Demonstration of Additionality.

Calculating Project Emissions: There is expected to be no project emissions as described in Section G.

Calculating leakage: No leakage is anticipated from this project, as described in Section H below.

Calculating emission reductions: The CO2 emissions reductions for year x is the difference between actual electricity generation for year x and the baseline electricity generation for year x which is then multiplied by the carbon emissions factor for the electricity in year x being displaced by the extra generation.

$$(\text{Actual Electricity Generation}_x - \text{Baseline Electricity Generation}_x) * CEF_{yearx} = \text{Emission Reductions}_x$$

If this methodology is a based on a previous submission, please state the previous reference number (NMXXXX/AMXXXX) here:

This is a new methodology

SECTION B. Applicability/ project activity

Methodology procedure:

This methodology applies:

- Only to existing hydropower generation units and reservoir capacity. The methodology can include multiple units linked in a cascade including both run of the river and reservoir-based units.
- The data required to determine the efficiency of the existing hydro units and the total flow index is reliable and readily available
- To hydropower systems that lack advanced Decision Support System optimization controls and modeling required to optimize generation potential
- To electrical power systems where additional hydropower would offset fossil fuel based generation
- Only includes optimization of generation units that were online as of the baseline period
- Only to those power generation units that have not undergone significant upgrades beyond basic maintenance, which would affect the expected operational efficiency levels during the duration of the project.
- Only where accurate data is available to measure and document the additional energy generated by existing hydro stations beyond the baseline case
- Only where no dam height is added as a result of the project to increase reservoir size

To cascades where

- No additional hydro power units are located down river from the last unit within the project boundary, or
- The first hydro unit down stream from the final hydro unit within the project boundaries has the capacity[2] to regulate at least 24 hours of maximum flow from upstream.
- As per the suggestion of the Methodology Panel, where appropriate data exists for[3]:
- Three complete years or more, the project developer must use the three years of data prior to project implementation to determine the baseline or

---

[2] 24 hour capacity in m3 = Mean annual flow m3/s *24 hr*3600 s/hr

[3] *For the purposes of this methodology therefore the baseline period will be defined as typically three years of data and only in cases where the project developer can document that appropriate data does not exist, the project period will consist of two or at least one complete year of data.*

- Less than three complete years the project developer uses at least one complete year (two when it exists) and must demonstrate to the data does not exist. This will predominately cover cases where the project developer is installing or upgrading meters and/or data collection systems as part of the project.

This project corresponds to Sectoral Scope #1: Renewable Energy.

Explanation/justification:

These applicability criteria provide the boundaries and conditions in which this methodology can be utilized. If the conditions above do not apply or the data is not available, then this methodology cannot be accurately used to determine the baseline and emission reductions.

SECTION C. Project Boundary

Methodology procedure:

The project boundary is the sum of all of the hydro generation units using the Decision Support Tools. If various units do not share a connected water source, they will need to be calculated separately (i.e. if the project developer is working on with two hydro dam cascades on two non-connected rivers.). The electricity grid to which the hydro units are delivering their output constitutes the system boundary.[4]

Emissions sources included in or excluded from the project boundary [add/delete gases and sources as needed]

	Source	Gas	Included?	Justification / Explanation
Baseline	Electricity generated from the grid	CO_2	Yes	CO2 is emitted when fossil fuels are burned to generate electricity. This project activity would displace those fossil fuels with enhanced hydropower capacity.

[4] Note the following project conditions from A3 that relate directly to project boundaries:
The methodology applies to cascades where
- No additional hydro power units are located down river from the last unit within the project boundary, or
- The first hydro unit down stream from the final hydro unit within the project boundaries has the capacity to regulate at least 24 hours of maximum flow from upstream.

Project Activity	Emissions from the CDM project	CO_2	Yes	In terms of monitoring emission reductions, CO2 will be the gas since fossil fuels emitted in the baseline scenario are reduced as a result of additional hydropower. In terms of project emissions, the project is enhancing the use of existing hydropower capacity to generate additional hydropower. No fossil fuel emissions will be used to generate this additional electricity and thus there will be no project emissions.

Explanation/justification:

It is reasonable to include only CO2 as is the case with other renewable energy methodologies. The additional renewable energy will be displacing electricity generated by fossil fuels, which emit CO2.

D. Baseline Scenario

Methodology procedure:

How the methodology determines the baseline scenario:
Step # 1: First, the project developer must identify all alternatives to deliver the additional kWh that would likely occur in the absence of this project.

Step #2: The methodology then requires the project developer to utilize the barrier analysis outlined in the EB-approved Additionality Tool to assess the likelihood of each alternative coming to pass. The baseline scenario will be the alternative that appears the most likely to occur in the absence of the project. This will based on a clear analysis of the impact of the various barriers on each alternatives performed by the project developer. Supporting documentation and evidence demonstrating the barriers each of the non-baseline alternatives faces will need to be presented to the DOE. In cases where there are two equally likely alternatives, the project developer may be able to demonstrate that the baseline calculation will not likely change regardless of which of the two alternatives would actually come to pass. For example, it may make no difference for the calculation of the baseline scenario whether the existing scenarios continues or additional fossil fuel based capacity is added. Since the carbon emissions factor is measured for each year based on the combined margin approach presented in ACM002, the baseline calculations may represent the continuation of the current situation and added fossil fuel based capacity equally well.

In addition to continuation of the current situation, likely alternatives for this type of project include:

Alternative #1: Additional Generation Capacity Would be Built or Imported: If the proposed project were not implemented, it is possible that additional capacity would be needed immediately (in a supply-constrained environment) or in the future. If the capacity expansion were likely to be from fossil fuels-fired plants, the project could still be considered additional, because the additional hydropower would displace

fossil fuels. The project developer would need, however, to provide evidence that additional power would not come from zero-emitting resources, including other hydro (unless it creates reservoirs and thus submerges biomass which will release CH4) and other renewable resources. Among the reasons why zero-emitting resources would not be built include: they are too costly and not the least cost option, lack of renewable resources, the utility does not have access to financing, etc. If the project developer can show that zero-emitting resources would not likely be built, it can be assumed that the current condition is the baseline scenario.

In addition to additional capacity, the project developer should consider whether electricity imports from another country or another grid could be another scenario. If there are imports from other grids, particularly if those grids are dominated by hydropower, the project developer will need to provide evidence that these imports are not likely to increase over the crediting period or else make sure to incorporate them in the calculation of the combined margin. Likely reasons for non-inclusion would include transmission constraints or other policy/cost barriers that prohibit the importation of additional hydro or other zero-emitting electricity.

As mentioned above, if this alternative is deemed most probable, the methodology will still apply based on the annual calculation of the carbon emission factor using the combined margin approach.

Alternative #2: The utility or hydro-operator would try to undertake this project without the involvement of CDM or CDM project developers. This alternative can be shown to be unlikely be using the barriers and common practice described below. If it can be ascertained that this project faces many technological, financial and other barriers – and has not been implemented in other locations in the same region or country – it is not likely to happen without the involvement of CDM. If this case is determined to be the most likely scenario, the project will not be eligible for CDM.

If each of these alternatives and any others identified are not likely to occur, the current water management and generation system by default is the baseline scenario.

National/Sectoral Policies: In cases where actively enforced laws mandating the use of Decision Support Tools are in place, the project will be considered the baseline scenario and thus not eligible for CERs.

Explanation/justification:

This methodology strives to calculate the emissions that would have occurred if current practices of hydro generation were maintained in the years covered by this project. In order to get a realistic picture of what would happen every year, the baseline calculation will change each year based on the total flow available to produce electricity. Specifically, each week in the project year, both the total flow index and the actual electricity generation will be calculated. The corresponding baseline will be calculated for that same week based on the electricity generated under the same total flow index conditions during the baseline *period*. The baseline calculations therefore capture the changing hydrological conditions that would also change annually in a business as usual scenario.

SECTION E. Additionality

Methodology procedure:

The project will be demonstrated as additional using a version of the EB's additionality tool that has been enhanced with further details on how to implement the tool considering the specific project type proposed by this methodology. The sections in which details have been added are represented below, while the sections that remain unmodified from the tool are not included as per instructions in the Methodology Panel report from January 26-28, 2005.

Step 0. Preliminary screening based on the starting date of the project activity:

Step 1. Identification of alternatives to the project activity consistent with current laws and regulations. The potential alternatives – and the process for determining their likelihood of being implemented – are described in D.1. As per the Additionality Test tool, the project developer would assess these alternatives and assure their compliance with local laws.

(Note: In accordance with guidance by the Executive Board, consistency is to be ensured between "baseline scenario" and "baseline emissions"
Define realistic and credible alternatives3 to the project activity(s) that can be (part of) the baseline scenario through the following sub-steps:

Sub-step 1a. Define alternatives to the project activity:
1. Identify realistic and credible alternative(s) available to the project participants or similar project developers that provide outputs or services comparable with the proposed CDM project activity5. These alternatives are to include:

- The proposed project activity not undertaken as a CDM project activity;
- All other plausible and credible alternatives to the project activity that deliver outputs and or services (e.g. additional electricity generation capacity) with comparable quality, properties and application areas. In this project case, could there be additional electricity generation from other, zero-emitting resources (hydro, wind, etc.) that could reduce the carbon impact of the project?
- If applicable, continuation of the current situation (no project activity or other alternatives undertaken).

Sub-step 1b. Enforcement of applicable laws and regulations:
Proceed to Step 2 (Investment analysis) or Step 3 (Barrier analysis). (Project participants may also select to complete both steps 2 and 3.)

Step 2. Investment analysis (as Per Additionality Tool)

Step 3. Barrier analysis: The barriers test below will have to show that the project faces barriers that:
(a) Prevent the implementation of this type of proposed project activity; and
(b) Do not prevent the implementation of at least one of the alternatives.

The project developer should follow the substeps, as per the Additionality Test tool.

Sub-step 3a. Identify barriers that would prevent the implementation of type of the proposed project activity:

1. Establish that there are barriers that would prevent the implementation of the type of proposed project activity from being carried out if the project activity was not registered as a CDM activity. Such barriers may include, among others:

Investment barriers. Although cheaper than building a new power plant, optimization is still an expensive undertaking. Would the utility be able to finance it? Would outside financiers be willing to lend for a project that is so unique? Are there other investment priorities that will take precedent? The project developer can look at all of these factors to show a substantial investment barrier.

Other than the economic/financial barriers in Step 2 above*, inter alia*:
- Debt funding is not available for this type of innovative project activities.
- No access to international capital markets due to real or perceived risks associated with domestic or foreign direct investment in the country where the project activity is to be implemented.
-Subsidies exist that inhibit investments in energy efficiency
-there is no cost recovery at the electricity utility that inhibits major investments (lack of access to credit due to poor revenues, management inability to dedicate resources, etc.)

Technological/lack of familiarity barriers: The optimization technology is in fact rarely used in developed countries. The penetration rate is very light in North America and Europe (about 5% of utilities that own substantial hydroelectric facilities). The key problem is that utility managers are unfamiliar with the concept of hydro-optimization and are never sure if it will work until it is installed and the investment is made. Most hydro operators are unwilling to take the risk for an unfamiliar technology. The project developer should show that the lack of familiarity and the fact that this may be a first-of-its-kind project hinders the ability to move forward. The implementation of this technology requires extended advanced training and advanced computer equipment, which may not be available at the selected utility.

Other technology barrier discussions could include:

- Skilled and/or properly trained labor to operate and maintain the technology is not available and no education/training institution in the host country provides the needed skill, leading to equipment disrepair and malfunctioning;
- Lack of infrastructure such as appropriate meters and communications links for implementation of the technology.

Barriers due to prevailing practice, *inter alia*:
- The project activity is the "first of its kind": No project activity of this type is currently operational in the host country or region.

The identified barriers are only sufficient grounds for demonstration of additionality if they would prevent potential project proponents from carrying out the proposed project activity if it was not expected to be registered as a CDM activity.

2. Provide transparent and documented evidence, and offer conservative interpretations of this documented evidence, as to how it demonstrates the existence and significance of the identified barriers.
Anecdotal evidence can be included, but alone is not sufficient proof of barriers. The type of evidence to be provided may include:
(a) Relevant legislation, regulatory information or industry norms;
(b) Relevant (sectoral) studies or surveys (e.g. market surveys, technology studies, etc) undertaken by universities, research institutions, industry associations, companies, bilateral/multilateral institutions, etc;
(c) Relevant statistical data from national or international statistics;

(d) Documentation of relevant market data (e.g. market prices, tariffs, rules);
(e) Written documentation from the company or institution developing or implementing the CDM project activity or the CDM project developer, such as minutes from Board meetings, correspondence, feasibility studies, financial or budgetary information, etc;
(f) Documents prepared by the project developer, contractors or project partners in the context of the proposed project activity or similar previous project implementations;
(g) Written documentation of independent expert judgments from industry, educational institutions (e.g. universities, technical schools, training centers), industry associations and others.

Sub-step 3 b. Show that the identified barriers would not prevent the implementation of at least one of the alternatives (except the proposed project activity):
3. If the identified barriers also affect other alternatives, explain how they are affected less strongly than they affect the proposed CDM project activity. In other words, explain how the identified barriers are not preventing the implementation of at least one of the alternatives. Any alternative that would be prevented by the barriers identified in Sub-step 3a is not a viable alternative, and shall be eliminated from consideration. At least one viable alternative shall be identified.

If both Sub-steps 3a – 3b are satisfied, proceed to Step 4 (Common practice analysis)
If one of the Sub-steps 3a – 3b is not satisfied, the project activity is not additional.

Step 4. Common practice analysis

The above generic additionality tests shall be complemented with an analysis of the extent to which the proposed project type (e.g. technology or practice) has already diffused in the relevant sector and region. This test is a credibility check to complement the investment analysis (Step 2) or barrier analysis (Step 3).

As mentioned in the section above, the penetration rate for this technology is low in the developed world and extremely rare in the developing world. The project developer should interview utilities in the selected country or region and with the manufacturers of this software/optimization technology to show that this project is not common practice. If the project has not been implemented in the country (or region for large countries), if the relatively few companies that make this technology have done minimal business in this country, and if the utility managers are unfamiliar with this type of project, it can be assumed that the common-practice test has been met. As per the tool, if the optimization has taken place somewhat frequently elsewhere in the country or region, the project developer would need to show the extenuating circumstances that made that project happen and how it would not be replicable.

Identify and discuss the existing common practice through the following sub-steps:

Sub-step 4a. Analyze other activities similar to the proposed project activity:
1. Provide an analysis of any other activities implemented previously or currently underway which are similar to the proposed project activity. Projects are considered similar if they are in the same country/region and/or rely on a broadly similar technology, are of a similar scale, offer similar outcomes, and take place in a comparable environment with respect to regulatory framework, investment climate, access to technology, access to financing, etc. Other CDM project activities are not to be included in this analysis. Provide quantitative information where relevant.

Sub-step 4b. Discuss any similar options that are occurring:

2. If similar activities are widely observed and commonly carried out, it calls into question the claim that the proposed project activity is financially unattractive (as contended in Step 2) or faces barriers (as contended in Step 3). Therefore, if similar activities are identified above, then it is necessary to demonstrate why the existence of these activities does not contradict the claim that the proposed project activity is financially unattractive or subject to barriers. This can be done by comparing the proposed project activity to the other similar activities, and pointing out and explaining essential distinctions between them that explain why the similar activities enjoyed certain benefits that rendered it financially attractive (e.g., subsidies or other financial flows) or did not face the barriers to which the proposed project activity is subject.

3. Essential distinctions may include a serious change in circumstances under which the proposed CDM project activity will be implemented when compared to circumstances under which similar projects where carried out. For example, new barriers may have arisen, or promotional policies may have ended, leading to a situation in which the proposed CDM project activity would not be implemented without the incentive provided by the CDM. The change must be fundamental and verifiable.

If Sub-steps 4a and 4b are satisfied, i.e. similar activities cannot be observed or similar activities are observed, but essential distinctions between the project activity and similar activities can reasonably be explained, please go to step 5 (Impact of CDM registration).

If Sub-steps 4a and 4b are not satisfied, i.e. similar activities can be observed and essential distinctions between the project activity and similar activities cannot reasonably be explained, the proposed CDM project activity is not additional.

For the investment, barriers and common practice tests, the Project Developers should provide the following evidence to the DOE:

- Letters from the utility indicating their unfamiliarity with the hydro-optimization technology before this project.

- Letters from one or more developers of the technology that indicate average penetration rates in developed markets and the fact that no similar project has been developed in the country or region.

- Financial statements indicating the revenue losses and overall financial health of the utility.

- Any least-cost planning or feasibility studies (if done) that show examination of potential capacity expansion projects – this would indicate the focus of the utility. This could include a list of priority investments for the utility. If the list does not include hydro-optimization but includes other projects, it shows that the CDM project is having an impact in bringing this investment to the “front burner.”

- Existing tariff rates or other information that show the income received from additional hydropower would not translate into additional income for the hydropower

operator, thus making the investment in optimization not cost-effective (investment test only).

Step 5. Impact of CDM registration: As per the Additionality Test tool.

If Step 5 is satisfied, the proposed CDM project activity is not the baseline scenario.
If Step 5 is not satisfied, the proposed CDM project activity is not additional.

Explanation/justification:

The additionality tool, which has been used for many other CDM methodologies, can adequately be used to assess the additionality for this type of project. There is nothing especially unique about this project activity, although some modifications of the tool are suggested.

SECTION F. Baseline emissions

Methodology procedure:

The project is designed to increase the generation of electricity from existing hydro units by optimizing their operations. The formulae are designed to calculate the total increase in generation in MWh from either a single hydro station or a series of hydro stations in a cascade. The project developer will have to calculate separately any geographically separated units (ie on a different unconnected river).

The baseline for year x will be determined by first measuring the pre-project efficiency of generation in the project area in total kWh produced at particular weekly[5] total flow index. This means in practical terms that in the baseline *period*, for each week, the total flow of water through the project area will be calculated and the total kWh generated will also be recorded. The relationship between the flow index and the actual aggregate generation will be established, as seen graphically below. A best-fit line using a polynomial trend equation (like that typically found using Excel 'TREND' function) will be established. This relationship will be used to define the baseline energy production for a given weekly flow index.

The form of the flow-generation curve (power vs flow and head) is very well represented by a third order, 12-coefficient polynomial, the derivation and discussion of which is included in the attached document. This corresponds directly to the mentioned 'Trend' function on Excel.

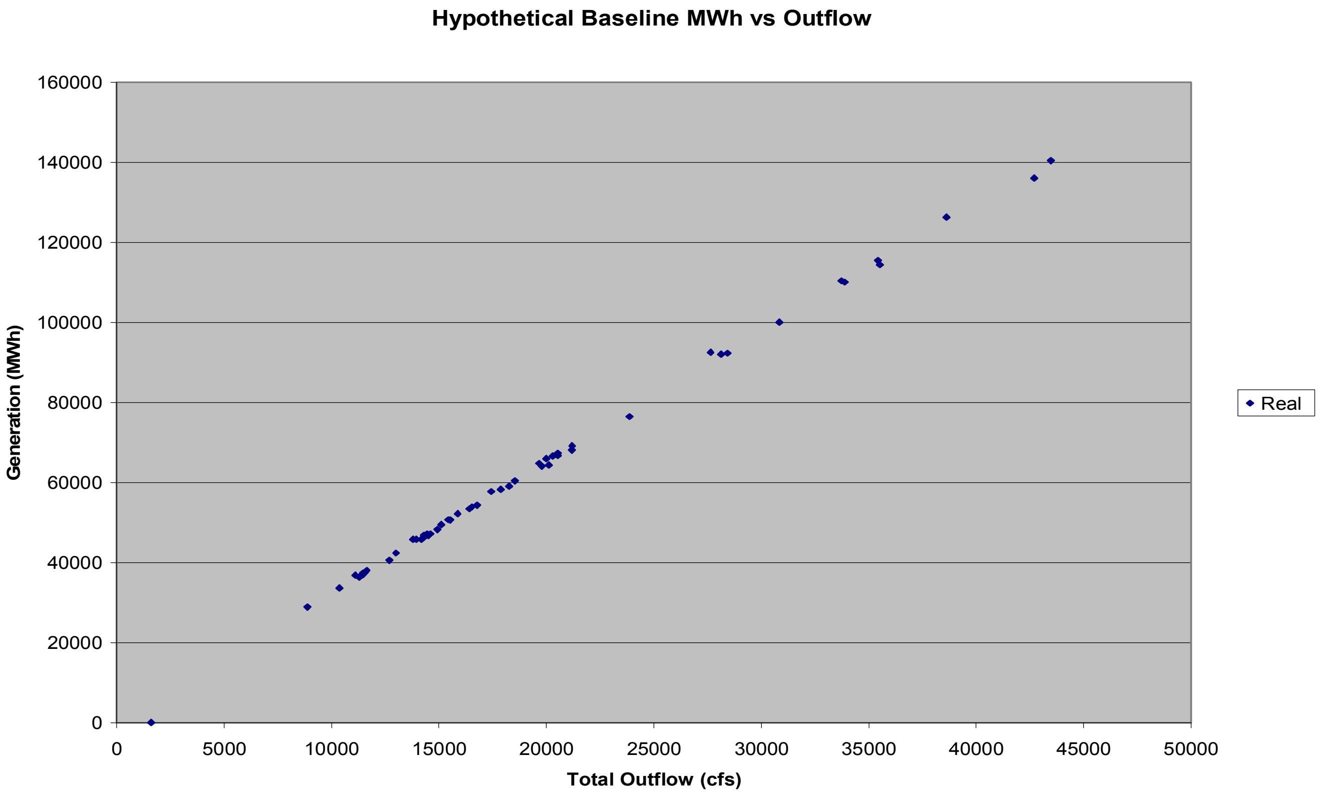
The accuracy of the power determination is usually within a fraction of one percent, and is verifiable by the comparison of the measured relationship versus the values determined with the best-fit relationship.

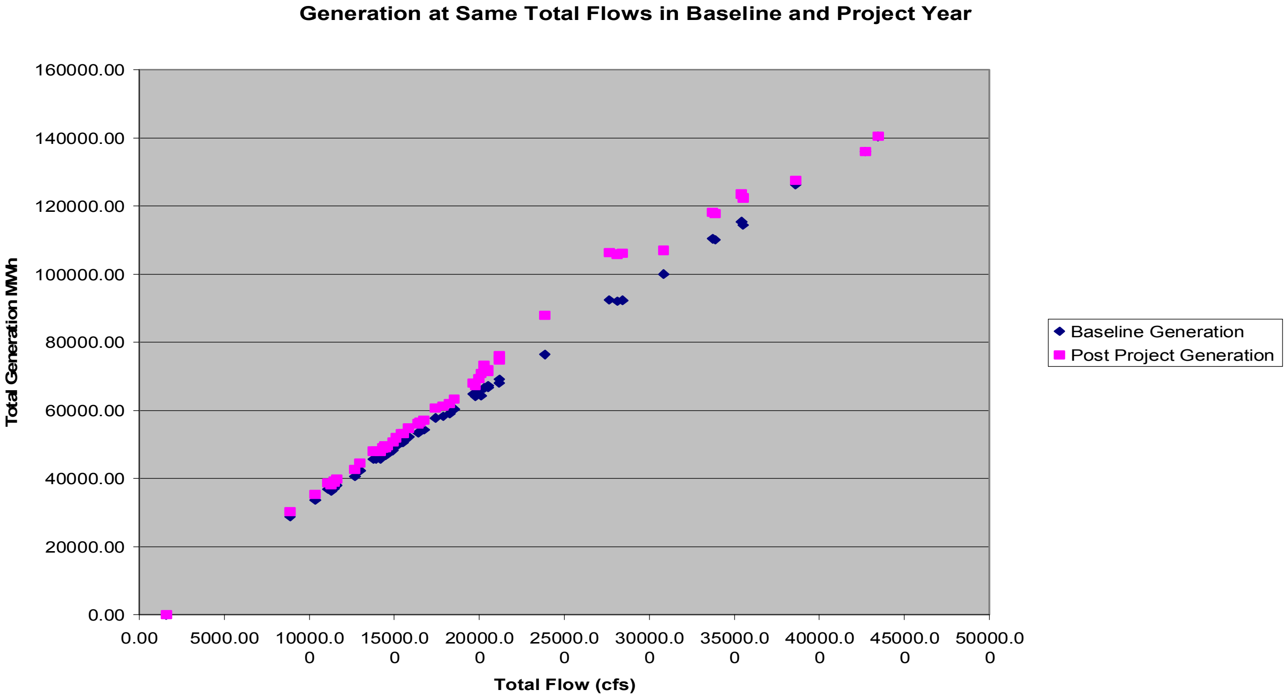
[5] The time period of a week was selected as the default because unlike a day or hour it should capture all of the various usage peaks that typically fall within a week (weekend versus weekday). It also is preferable to longer periods such as a month, since an average flow over this longer period would mask the hydrologic variability. In specific cases, the project developer can propose a different time period to the DOE by demonstrating and documenting how a different timeframe produces a more accurate result.

A Data Book will be prepared prior to DSS implementation, which will contain all functional relationships utilized, including flow-generation functions. These will be reviewed by the DOE to assure their appropriateness, accuracy, and transparency.

Each project year, the baseline generation and the actual generation will be calculated by determining the actual weekly flow index and using the measured electricity production for that flow index in the baseline period to determine what the generation of electricity would have been for that week if the hydro system had not been optimized. The total baseline electricity generation will simply be a sum of all the weekly calculations, and the total actual generation will be the sum of all the actual weekly figures. These two values will then be compared, to determine the additional electricity generated through optimization.

In order to be conservative, the project developer will not seek to claim credit for any weekly project year results in which the flow index falls outside the recorded boundaries of the baseline data. This means that if the baseline data does not extend to extremely high or low flow weeks found in the project year, the project developer will not look to claim carbon credits for that week. This gives the project developer incentives use as many years of baseline data as possible. It also allows the baseline to conservatively and accurately normalize data in changing climates and in different withdrawal regimes.





For example, in the baseline *period* the measured outflow in week 18 of 20,000 cubic feet per second (566 m3 per second) produced 60,000 MWh from the hydro generating units in the project boundary. If in the project year after optimization, the same measured outflow produced 62,000 MWh the project developer could claim credit for an additional 2000 MWh produced for that particular week.

Once the total additional electricity generation is determined by subtracting the baseline generation from the actual generation, it will be multiplied by a carbon emissions factor for the entire electricity grid determined using the combined margin approach approved in ACM002.

In developing the data set for both the baseline and the project year, the project developer must identify and eliminate outlying data points that represent atypical circumstances such as blackouts, major equipment malfunction and repair. For the baseline, this will simply mean eliminating these data points from the data set. In the project year, the project developer will not be able to claim any emission reductions in weeks where these types of major abnormalities occur since it would be too hard to calculate the baseline generation in those same abnormal conditions.

Additionally, the project developer will measure electricity generation at each generating unit and total the output for the week. This is needed since any major post-project upgrades to existing generating units or any new units added will need to be factored out of the calculations since the optimization project will not be directly responsible for the increase in generation. This means that if two years after the optimization project a 50MW generating unit is overhauled and upgraded to a more efficient 75MW, from that point on the generation output of this unit will be factored out both in the baseline calculation and in the post project calculation.

Baseline Electricity Generation in year x equals or BEgen
(note two caveats listed above which may change slightly the actual formula (i.e. only 51 weeks are tabulated since a major blackout occurred during one week)

$$\sum_{week_x=1}^{52} \left(\sum_{HPU=1}^{\Psi g} kWh_{hpu} \text{ produced in year}_0 \text{ at } Q(\text{index})\text{week}_x \right)$$

Where
Year x= given project year being compared to baseline
HPU= Hydro power unit
ψg= total number of hydro power generation units that existed in the baseline *period*
Q(index)= total of all generation flows and spill flows during the week (as calculated below)
Week_x = week in the year x (1-52)
Year 0= baseline period

The Weekly flow index which is used to identify the corresponding total electricity generation figure from the *baseline period*, Q(index), is calculated by cumulating all project releases (generation flow and spill flow) during the week, as follows.

$$Q(\text{index}) = \sum_{hour_x=1}^{168} \left(\sum_{HPU=1}^{\Psi g} m3_{hpu} \right) + \sum_{hour_x=1}^{168} \left(\sum_{s/w=1}^{\Psi s} Qspill \right)$$

Where
HPU= Hydro power unit index in m3
S/w = spillway
ψg= total number of hydro power generation units that existed in the *baseline period*
ψs= total number of spillways that existed in the *baseline period*
Qspill= total m3 of spillage for given time period and spillway

Note: The flow index will not include water consumption and irrigation/other return flows.

<u>List of Data Sources:</u> Data for carbon content of fossil fuel sources will use IPCC data unless more accurate scientific studies exist outlining the carbon content of specific fuel used. The data acquisition

system used to operate the Decision Support tool will supply the data required to monitor the impacts of the project.

Vintage and spatial level of data: Baseline efficiency data for each generation unit in kWh at each flow index will be recorded weekly the year prior to the project's commencement. If possible, multiple years of data should be included into the baseline calculations to provide a more robust depiction of baseline conditions. The rest of the data will be gathered weekly and compiled on an annual basis. The spatial level of data will be gathered using local data for each generation unit. The carbon emissions factor will be derived from national level or grid level data.

Uncertainty Assessment of Key Parameters/Conservative Nature of Values: New hydro units installed or major upgrades to existing hydro units that occur after the project commences will not be included in the emissions reduction. If additional generation capacity is added to a system after the Decision Support System is put in place, the efficiency of operation of each of the other generation units may be affected. The new units are likely to be the most efficient, least cost option and will be operated as much as possible. This may reduce the efficiency of generation of other units that are operated less often and/or at lower, more inefficient production levels. While the addition of new generation capacity may add a significant layer of uncertainty to the project results, the error will almost always be on the conservative side since the generation units included in the project are much more likely to have their post-project efficiency levels reduced.

In addition, as with any project relying on metered data, there are some uncertainties concerning the inaccuracies in the meters. While the types of meters used in this project are typically very accurate, to redress this issue and ensure consistency and accuracy of data, the project developer will annually test and calibrate meters as appropriate.

Data is collected and calculated in a transparent manner. The Decision Support System will provide clear and highly accurate data. As mentioned above the approach to mitigate the key uncertainty of the affect of new hydro units added after the project takes place by removing them from consideration of carbon credits will likely make the data more conservative. New generation units or major upgrades to existing units after the initiation of this project will not be counted under this methodology.

Explanation/justification:

This approach allows the project developer to determine – on a weekly basis – what the hydropower output would have been without the project activity. It does this for each week during each project year. It is therefore a conservative and accurate approach.

SETION G. Project activity emissions

Methodology procedure:

There will be no emissions that result form the project activity. The activity will generate more electricity from an existing renewable source.

Explanation/justification:

The project is enhancing the use of existing hydropower capacity to generate additional hydropower. No fossil fuel emissions will be used to generate this additional electricity and thus there will be no project emissions.

SECTION H. Leakage

Methodology procedure:

There is no leakage expected from the installation of a Decision Management System. Installing software and meters will not lead to additional emissions.

Explanation/justification:

Installing the software and the overall DSS does not require a large amount of equipment or any other type of activity that would contribute to additional emissions.

SECTION I. Emission reductions

Methodology procedure:

The CO2 emissions reductions for year x is the difference between actual electricity generation for year x and the baseline electricity generation for year x which is then multiplied by the carbon emissions factor for the electricity in year x being displaced by the extra generation. [6]

(Actual Electricity Generation$_x$ - Baseline Electricity Generation$_x$) * CEF $_{yearx}$ = Emission Reductions$_x$

CEF= kgCO2/kWh=Carbon emissions factor determined either by using the combined margin approach outlined in ACM002.

To determine the actual electricity

Total actual generation energy, Egen is the sum of the generation in all the weeks in year x

$$\text{Egen} = \sum_{week_x=1}^{52} E(x)$$

To determine the actual electricity generation in week x or, E(x) equals[7]

[6] While not likely, it should be noted that if the actual generation is less than the baseline for a certain week, it will be treated as a negative value and deducted from the total annual savings.

The flow index as determined in the project year for calculating the baseline will not include water consumption and irrigation/other return flows.

[7] Note the following two caveats which may affect the implementation of the formula either reducing the number of weeks or reducing the number of HPUs-

- In developing the data set for both the baseline and the project year, the project developer must identify and eliminate outlying data points that represent atypical circumstances such as blackouts, major equipment malfunction and repair. For

$$E(x) = \sum_{hour_x=1}^{168} \left(\sum_{HPU=1}^{\Psi g} kWh_{hpu} \right)$$

where
$E(x)$ = total electricity generated in week x
$hours_x$ =total hours in week x
HPU= Hydro power unit
ψg= total number of hydro power generation units that existed in the baseline *period*
KWh_{hpu} =total kWh generated by the given hydropower unit (HPU) for a given time frame

Note : The flow index as determined in the project year for calculating the baseline will not include water consumption and irrigation/other return flows.

Explanation/justification:

By comparing enhanced hydropower output in the project year with what the hydro output would have been in the absence of this project, it is realistic to determine emission reductions by multiplying that additional output by the CEF as determined by the combined margin. This is because if a hydroplant can produce more electricity, it would displace the higher-cost, more marginal sources of electricity – the fossil fuel plants.

SECTION J. Changes required for methodology implementation in 2nd and 3rd crediting periods (if relevant / optional)

Methodology procedure:

No changes will be required in the 2nd or 3rd crediting periods.

Explanation/justification:

N/A

the baseline, this will simply mean eliminating these data points from the data set. In the project year, the project developer will not be able to claim any emission reductions in weeks where these types of major abnormalities occur since it would be too hard to calculate the baseline generation in those same abnormal conditions. This may mean the actual data calculations for the year involves fewer than 52 weeks.

- Additionally, the project developer will measure electricity generation at each generating unit and total the output for the week. This is needed since any major post-project upgrades to existing generating units or any new units added will need to be factored out of the calculations since the optimization project will not be directly responsible for the increase in generation. This means that if two years after the optimization project a 50MW generating unit is overhauled and upgraded to a more efficient 75MW, from that point on the generation output of this unit will be factored out both in the baseline calculation and in the post project calculation.

SECTION K. Selected baseline approach from paragraph 48 of the CDM modalities and procedures

Choose One (delete others):

X Existing actual or historical emissions, as applicable;

☐ Emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment;

☐ The average emissions of similar project activities undertaken in the previous five years, in similar social, economic, environmental and technological circumstances, and whose performance is among the top 20 per cent of their category.

Explanation/justification of choice:

Existing practice is the most obvious baseline approach given that the project is a modification in the management of an existing system, rather than a capacity-intensive investment in new generation capacity. The project developers will be able to accurately calculate the gains in efficiency from the project and translate those gains into emissions reductions using the combined margin approach. The data to make this approach work including the total flow index and total electricity generation will be readily available through the metering system required to operate the Decision Support Tool.

SECTION I. Other Information

Explanation/justification:

Strengths

The methodology is simple. It provides a clear transparent overview of the increase in generation due to optimization of the existing generating units. The methodology eliminates the impact of year-to-year generation variability due to changes in water availability by annually recalculating the baseline using actual weekly water flow and determining what the baseline generation would have been by looking at what the actual generation was in the baseline period at the same level of flow. The typical baseline period of three years should also capture any inconsistencies, however highly unlikely they may be, in year to year data. While projects that use a shorter time period for the baseline will have the advantage of having new, highly accurate metering and data collection systems in place prior to the start of baseline collection activities. The methodology will conservatively determine what the generation would have been under the baseline scenario regardless of how much water is actually available in any specific project year. The methodology is set up to ensure that any discrepancies in emissions reduction accuracy err on the conservative side. It also has a heavy reliance on monitoring using very accurate data and therefore avoids reliance on making ex-ante projections and estimates. To translate the additional electricity generation from hydro units into CO_2 reductions, the methodology utilizes the combined margin approach, which has already been refined and approved by the CDM Executive Board (i.e., ACM0002). Once the methodology calculates the additional hydro output, the project essentially becomes like a zero-emission, renewable electricity project, of which there are many examples for the Clean Development Mechanism.

Weaknesses

Because of the complexity of hydro systems, the methodology cannot interpret the project's impact on from new generation capacity added during the course of the project. Any new generating units added during the course of the project will be excluded. Also, it cannot hope to quantify any improvement that the Decision

Support Software would enable during major abnormal operational situations (blackouts, major equipment repairs, etc.).

-.-.-.-