CDM: Proposed new methodology expert form (version 04)

(To be used by methodology experts providing desk review for a proposed new methodology)

Name of expert responsible for completing and submitting this form	John Frank Fazio
Related F-CDM-NM document ID number	NM0112

Note to those completing this form, as applicable: Please provide recommendations on the proposed new baseline and monitoring methodologies based on an assessment of CDM-NMB and CDM-NMM and of their application in sections A to E of the draft CDM-PDD, desk reviews and public input. Please ensure that the form is entirely filled and that arguments and expert judgements are substantiated.

A. Evaluation of the proposed new methodologies by desk reviewers:

I. Evaluation of the proposed new baseline methodology:

Title of new baseline methodology:>>Increased electricity generation from existing hydropower stations through Decision Support System (DSS) optimization

i. Conditions under which this methodology is applicable to other potential projects (e.g. project type, region, data availability):

>>This methodology should be applicable to other hydroelectric systems worldwide. In fact the documentation references two examples of this methodology being used to successfully improve the efficiency of systems in Idaho (U.S.A.) and Manitoba (Canada).

ii. Strengths and weaknesses of the methodology:

>>Strengths: 1) This methodology is simple and easy to implement.

2) It is easy to understand and explain.

3) By establishing a relationship between flow and generation for each hydroelectric unit, this methodology eliminates any complicated "calibration" to assess gains in energy production.

Weaknesses:

1) no incentive to upgrade the system because any upgrades would immediately be removed from the calculations for emission reduction. 2) Not a great deal of historical data, especially at the newest project. 3) Must wait until the operating year is complete before credit can be estimated. 4) Cannot estimate long-term benefits (i.e. averaged over many years of implementation).

iii. Any changes needed to improve the methodology:

a. Minor changes:>>Be more explicit regarding the actual computation of benefits. For example, state specifically that weekly average flows (or volumes) and weekly average generation at each dam will be used to assess benefits. The weekly gains (and losses) relative to a DSS operation will be summed up over an entire year to yield a net annual benefit.

b. Major changes:>>No major changes are required.

II. Evaluation of the proposed new monitoring methodology:

Title of new monitoring methodology: >> Increased electricity generation from existing hydropower stations through Decision Support System optimization

i. Conditions under which this methodology is applicable to other potential projects (e.g. project type, region, data availability):

>> This methodology should be applicable to other hydroelectric systems worldwide. In fact the documentation references two examples of this methodology being used to successfully improve the efficiency of systems in Idaho (U.S.A.) and Manitoba (Canada).

ii. Strengths and weaknesses of the methodology:

>>Please see my response to the baseline methodology.

iii. Any changes needed to improve the methodology:

a. Minor changes:>>

b. Major changes:>>

B. Details of the evaluation of the proposed new methodology by the desk reviewer:

I. Proposed new baseline methodology *(specify title here):* >> Increased electricity generation from existing hydropower stations through Decision Support System optimization

(1) Short description of the methodology, including an assessment of which approach from paragraph 48 of the CDM modalities and procedures was used:

a) Describe the methodology:

>>The purpose of the baseline methodology is to establish a point of reference to assess how much more energy a hydroelectric system will produce when operated under a Decision Support System (DSS). The methodology identifies the historical relationship between river flow (or volume) and generation (prior to the implementation of the DSS operation). The actual generation under the DSS operation for a given flow is then compared to the generation under the historical operation, for the same flow. This difference in generation is summed over each week of the year to establish the total amount of additional energy generated (in megawatt-hours). This energy is assumed to displace the operation of thermal resources and decrease the overall emission of greenhouse gases.

b) State the approach selected:

>>The suggested approach is the most appropriate, i.e. implement the DSS operation with involvement of the CDM and funds acquired through credits for reducing the production of greenhouse gases.

c) Indicate (in summary form) why the approach selected is the most appropriate. Please provide your expert judgement on the appropriateness of the selected approach to the project category:

>> By not implementing a more efficient operation for the hydroelectric system, additional thermal resources may be needed or existing resources may have to be run at higher capacity factors in order to serve existing and future electricity demands. In either case, the total amount of greenhouse gases released to the atmosphere will increase. Without the involvement of the CDM, it appears that this project would not be implemented due to lack of capital. Thus, the most promising approach is to implement the DSS operation with the involvement of the CDM (and funds acquired by reducing greenhouse gas emissions).

(2) Basis for determining the baseline scenario:

a) State whether the documentation explains how the baseline scenario is to be chosen and identified:

>>The documentation does a satisfactory job of defining the baseline and how it can be established with historical data.

b) State the basic underlying rationale for algorithms/formulae used (e.g. marginal vs. average basis) (see also section 4 below):

>>Generation from a hydroelectric unit is equal to the flow passing through the turbine times the head (forebay elevation minus tail-water elevation) times a "power" factor (which includes the efficiency of the turbine). Generally, turbine efficiency curves (that is, generation as a function of flow for a particular head) are not linear. The head can also vary non-linearly with flow. Thus, a flow vs. generation relationship should be non-linear. In addition, under high flow conditions, exceeding hydraulic capacity has the effect of "flattening" out a generation vs. flow curve, which adds more non-linearity to the relationship. However, over normal operating ranges, a linear approximation for the relationship between flow and generation is not a bad assumption. This is especially true over time periods when non-power constraints remain constant (such as minimum or maximum elevation limits or flow limits or discretionary spill requirements). For example, the Columbia River hydroelectric system (U.S.A.) shows a very linear relationship between flow and generation on a monthly basis in spite of numerous non-power constraints placed on the operation (please see the attached reference material). For this methodology to work, however, the relationship between flow and generation does not have to be linear; it simply has to be well understood. It also must not have a level of error (i.e. standard deviation) that would make it difficult to assess real gains in energy production due to an alternative operation. I have not seen the historical data that will be used to compute the baseline flow/generation relationship, however, I would be surprised if a linear approximation would not be an appropriate assumption for this project.

c) State whether the documentation explains how, through the use of the methodology, it can be demonstrated that a project activity is additional and therefore not the baseline scenario. If so, what are the tools provided by the project participants?

>>The documentation explains in detail how additional generation provided by implementing a DSS operation could be calculated.

d) State whether the basis for determining the baseline scenario and for assessing additionally is appropriate and adequate:

>>In my opinion, the basis for determining the baseline and the method to assess additional generation is appropriate and adequate. There are some weaknesses to this approach, which I elaborate on in other sections, but for the most part, I believe that this method will work satisfactorily.

(3) Assessment of the description of the proposed methodology and its applicability

a) State whether the methodology has been described in an adequate manner:

>>This methodology has been described adequately in the documentation. There are a few minor points that should be emphasized, however. It should be stated more clearly that the "benefits" of implementing the DSS operation must be computed over an entire year. There will be times when the generation under a DSS operation will be less than that under the baseline (i.e. cases when the reservoir is drawn down in weeks prior to an expected increase in natural flows). These negative results imply that additional thermal units may have to be dispatched, which would lead to higher levels of emission during those weeks. Thus, these negative results must be summed up along with the positive weekly results to yield an accurate annual benefit.

b) State whether the proposed methodology is appropriate for the referred proposed project activity and the referred project context (described in Sections A - E of the draft CDM-PDD and submitted along with CDM-NMB):

>>The proposed methodology is appropriate for the referred proposed project activity.

c) State whether the application of the methodology could result in a baseline scenario that

reasonably represents the anthropogenic emissions by sources of greenhouse gases that would occur in the absence of the proposed project activity.

>>This methodology should yield a reasonable estimate of reduction in greenhouse gas emissions.

Please explain:

>> It is appropriate to assume that any additional hydroelectric generation will displace thermal generation. For one thing, the marginal cost of producing hydroelectric generation is almost always much less than the marginal cost of producing electricity from a gas or coal fired unit. Therefore, any marginal increase in hydroelectric production translates directly into a decrease in thermal production and a consequent decrease in green house gas production.

(4) Assessment of algorithms/formulae and type of data needed:

a) State whether the description of the methodology includes algorithms and generic formulae that can be applied to other potential project activities (if not, the proposed new methodology will be considered as a project-specific methodology):

>>The methodology described for this project is generic in that it can be used for any hydroelectric system. For some systems, the flow/generation relationship may not be as linear or may include larger uncertainties. This would be especially true for systems where non-power constraints are constantly changing. I am not familiar with the DSS but based on my naïve understanding, it appears to be just a method to optimize the use of stored water in reservoirs. Thus, for any given hydro unit, the *relationship* between flow, head and generation will not change because of a DSS operation. What will change is the distribution of flow and of reservoir elevations over a given time period. This is why it is so important to measure the benefits of a DSS operation over an entire year. Almost by definition, there will be periods when the head will be lower under a DSS operation relative to the baseline. For these cases, a negative benefit may be observed but it should presumably be overwhelmed by the positive benefits computed over other time periods. (We certainly hope that a DSS operation will yield a net generation increase over the course of a year). It is also intuitive to assume that there will be conditions (i.e. years) when operating under a DSS case yields very little or no effective increases to annual generation. The documentation states that improvements of two to ten percent have been realized in the two referenced cases. The amount of additional generation is very likely a function of weather and other conditions and will undoubtedly change from year to year.

b) Explain the spatial scope of data used to determine the baseline and whether the scope is appropriate:

>> The special scope of the data to be used for the baseline determination is appropriate. I would recommend developing a flow/generation relationship at each dam (see below for my explanation).

c) Explain the vintage of data used (in relation to the duration of the project crediting period) and whether the vintage of data is appropriate, indicating the period covered by the data:

>> The data to be used for the baseline determination is appropriate but unfortunately is limited in size. Because of the low number of historical operating years to draw from, it would be preferable to compute a baseline relationship for flow/generation at each dam. The Shamkhir project was completed in 1982, the Mingechaur in 1955, the Varvara in 1958 and the Yenikend in 2000. It would be inappropriate to use a single flow value (say below the most downstream project) to develop a flow/generation relationship because there are only five years of operating data for the four-set dam system. In fact, the fourth unit on the Yenikend dam was not completed until 2003. The better alternative would be to develop a flow/generation relationship for each dam. The relationship between flow and generation at each dam is obviously a function of head. The head at each project for each time period depends on the operating strategy and non-power constraints. If the operating strategy and/or non-power constraints have changed significantly over the historical period, then the flow/generation relationship may show non-linear tendencies. It is still appropriate to use the relationship but the DSS operation will be compared to an "average" historical operating strategy. More importantly perhaps is that it is more difficult to trend a non-linear relationship and it will likely introduce greater error.

(5) Definition of the project boundary related to the baseline methodology:

a) State how the project boundary is defined in terms of:

i) Gases and sources

>>The project boundary may extend beyond the borders of Azerbaijan if energy is imported to serve local demand. In this sense, optimizing the operation of the hydroelectric system should reduce emissions outside of Azerbaijan but that is perfectly acceptable. Whether gas emissions are reduced within or outside of Azerbaijan doesn't matter under the objective of this project.

ii) Physical delineation

>>

b) Indicate whether this project boundary is appropriate:

>>I believe the project boundary is appropriate.

(6) Key assumptions/parameters (including emission factors and activity levels) and data sources:

a) List the implicit and explicit key assumptions. Identify those, if any, which are problematic and explain:

>>1) the flow/generation relationship is linear (this is implied by the sample data provided in the document), 2) the implicit assumption that implementing a DSS operation will increase every week's generation relative to the baseline (this assumption is not valid but it doesn't matter as long as the total benefit of the DSS operations is estimated over the course of an entire year), 3) the assumption that good historical data is available (no evidence was provided that such data is available and is reliable), 4) the implicit assumption that during times when the DSS operation would produce less energy from the hydro system (i.e. during off-peak hours) that sufficient other resources would be available to serve demand, 5) the implicit assumption that demand will grow and thus new resources or other sources of energy will be needed, 6) the explicit assumption that thermal resources would be used for demand growth (either within the country or imported energy from neighbouring countries (what about the viability of conservation or other renewable resources? How much will it cost to implement the DSS? Are other renewable resources cost effective relative to DSS?), 7) the assumption that there exists sufficient data to yield robust flow/generation curves (except for one dam). The data would have to be examined but I believe a satisfactory relationship can be established with the available data.

b) State whether the key assumptions are arrived at in a transparent manner:

>>Major assumptions were identified well in the documentation but some (see above) were not discussed at all.

c) Give your expert judgement on whether the assumptions/parameters are adequate:

>>The relevant assumptions are adequate.

d) Indicate which data sources are used and how the data are obtained (e.g. official statistics, expert judgement):

>>For this method to be viable, historical flow and generation data must be available at all four hydro facilities. Weekly average flows below each dam, taking into account both turbine flow and spill, will be used along with average weekly generation to establish a flow/generation relationship at each dam. I believe weekly time steps are appropriate.

e) Give your expert judgement on whether the data used are adequate, consistent, accurate and reliable:

>>Since I have not seen the data, I cannot determine whether the data is adequate, consistent, accurate or reliable. One thing to consider is whether the same techniques were used to measure flow and generation over the historical period. Earlier data recordings may have had higher levels of measuring errors. It is impossible to determine without examining both the measuring technique or the data itself.

f) State possible data gaps:

>>The historical data for the Yenikend dam is very limited. In spite of the limited number of historical operating years for this project, I believe a satisfactory flow/generation curve can be developed.

(7) Assessment of uncertainties:

a) State whether the methodology includes an assessment of uncertainties regarding:

i) The basis for determining the baseline scenario:

>>The methodology does not include a specific explanation of how uncertainties will be dealt with. See my response to question 9b.

ii) Algorithms/formulae:

>>The only algorithms involved should be those imbedded in Excel to compute the trend equations for flow and generation. These should be sufficient.

iii) Key assumptions:

>>One of the key assumptions is that implementing a DSS operation will (always) improve hydroelectric output. Overall, this may be true but two issues must be made clear 1) that the annual average improvement will vary due to hydrologic and weather conditions (i.e. there may be years when the DSS operations does not increase production over historical operation) and 2) that weekly operations under a DSS may actually produce less energy (so that more can be produced later). The uncertainties surrounding these assumptions could be explored in more depth.

iv) Data:

>>No mention of data uncertainty was made but it was implied that historical data is available and is reliable.

b) State whether the uncertainties presented are reasonable:

>>There was little discussion of uncertainties. It would strengthen the document if this issue were dealt with more explicitly. Again, please see my response to question 9b.

(8) Leakage:

a) State how the baseline methodology addresses any potential leakage due to the project activity:

>>There is no leakage in either the baseline or optimized operation because we are dealing with a hydroelectric system.

b) Indicate whether the treatment for leakage is appropriate and adequate:

>>This question does not apply (see above response).

(9) Transparency and "conservativeness":

a) Indicate whether the baseline methodology was developed in a transparent way:

>>The baseline methodology is very simple and easy to understand. The proposal could be made stronger by specifying that the flow/generation relationship should be computed at each dam for each week of its historical operation. The total increase in generation due to a DSS operation should be assessed annually and can vary from year to year depending on conditions.

b) State whether the baseline methodology is conservative:

>>Using a flow/generation relationship based on historical data to assess the baseline generation for a given flow level is not necessarily conservative or liberal. By looking at the data (which I have not) one can determine the standard deviation for the fitted (linear) regression. The standard deviation can be used to compute a confidence interval for the data. For example, a spread (plus or minus from the mean) of 1.96 times the standard deviation (for a normal distribution) yields a 95 percent confidence interval. In other words, there is a 95 percent chance that the "true" value will lie in this range. To incorporate a level of conservatism into the method, one could "adjust" the expected historical value by some fraction of the standard deviation. This would assure that the method would not overstate the amount of increased generation due to the DSS strategy. More careful consideration is required to assure that this adjustment is

not overly conservative.

(10) Potential strengths and weaknesses of the proposed baseline methodology *(please explain)***:**

>> Strengths: 1) This methodology is simple and easy to implement.

2) It is easy to understand and explain.

3) By establishing a relationship between flow and generation for each hydroelectric unit, this methodology eliminates any complicated "calibration" to assess gains in energy production.

Weaknesses:
1) no incentive to upgrade the system because any upgrades would immediately be removed from the calculations for emission reduction. 2) Not a great deal of historical data, especially at the newest project. 3) Must wait until the end of the operating year to assess credits. 4) Cannot estimate long-term benefits (i.e. averaged over many years of implementation).

(11) Other considerations, such as a description of how national and/or sectoral policies and circumstances have been taken into account *(please explain)***:**

>>There was very little mention of the relationship between Azerbaijan and its neighbouring countries. Are there downstream hydroelectric projects to consider? Are there treaties or other constraints that might hamper the implementation of DSS?

(12) Applicability of the proposed methodology across project types and regions *(please indicate)***:**

>>In my opinion, this methodology will work well for any region with a hydroelectric system that serves some portion of that region's total electricity demands. It may be possible to modify this methodology to consider the "optimization" of thermal units, that is, to determine a dispatch of thermal resources that produces the least amount of green house gases. It appears to me that one good use for this methodology is to consider funding conservation programs. Determine how much thermal generation would be displaced by conservation measures and compute the resulting decrease in green house gas production. Or for that matter, any other renewable resource (ones that don't produce green house gases) can be credited in the same way.

(13) Any other comments:

a) State whether any other source of information (i.e. other than documentation on this proposed methodology available on the UNFCCC CDM web site) has been used by you in evaluating this methodology. If so, please provide specific references:

>>An analysis of the Columbia River hydroelectric system was used to examine the flow/generation relationship. A spreadsheet summarizing that analysis is attached. (NM0112 Fazio Additional Analysis.xls)

b) Indicate any further comments:

>>Further comments can be found in the attached document containing additional questions regarding this proposed project. (NM0112 Fazio Additional Comments.doc)

II. Proposed new monitoring methodology *(specify title here):* >> Increased electricity generation from existing hydropower stations through Decision Support System optimization

In respect of the proposed new monitoring methodology, evaluate each section of CDM-NMM to the draft CDM-PDD. Please provide your comments section by section:

(1) Brief description of new methodology:

Describe new methodology:

>> The purpose of the monitoring methodology is to establish a procedure to measure hydroelectric generation gains from implementing a Decision Support System (DSS). The methodology proposes that weekly average flows and generation under a DSS operation be measured and then compared to the historical generation produced under the same flow conditions. This difference in generation is summed over each week of the year to establish the

total amount of additional energy generated (in megawatt-hours). This energy is assumed to displace the operation of thermal resources and decrease the overall emission of greenhouse gases.

(2) Key assumptions/parameters:

a) List the implicit and explicit key assumptions. Identify those, if any, which are problematic and explain:

>>Please see my response to the baseline methodology.

b) State whether the key assumptions are arrived at in a transparent manner:

>> Please see my response to the baseline methodology.

c) Give your expert judgement on whether the assumptions/parameters are adequate:

>> Please see my response to the baseline methodology.

(3) Data sources and data quality:

a) Indicate which data sources are used and how the data are obtained (e.g. official statistics, expert judgement):

>> Please see my response to the baseline methodology.

b) Give your expert judgement on whether the data used are adequate, consistent, accurate and reliable:

>> Please see my response to the baseline methodology.

c) *State possible data gaps:*

>> Please see my response to the baseline methodology.

(4) Assessment of the description of the proposed methodology and its applicability:

a) State whether the proposed methodology has been described in an adequate manner:

>>The assumption is that weekly flow and generation will be measured in the same way that historical data was obtained. It is important that similar methods be used. If improvements in measuring flows are made, then some adjustments may have to be done to the computation of benefits.

b) State whether the proposed methodology is appropriate for the referred proposed project activity and the referred project context (described in Sections A - E of the draft CDM-PDD and submitted along with CDM-NMM):

>> Please see my response to the baseline methodology.

c) State whether this proposed monitoring methodology is compatible with the proposed baseline methodology described in CDM-NMB of the draft CDM-PDD:

>>This methodology is compatible with the proposed baseline methodology.

(5) Leakage *(please elaborate, if appropriate)***:**

>>Not applicable.

(6) Quality assurance and control procedures *(please explain)***:**

>>The measuring techniques used to obtain flow and generation data must be clearly defined, along with any information regarding embedded uncertainties. Should changes in the measuring method or devices change, the procedure for calculating benefits should be revisited to assure that it still provides the same level of conservatism.

(7) Potential strengths and weaknesses of the proposed monitoring methodology *(please explain)***:**

>> Please see my response to the baseline methodology.

(8) Applicability of the proposed methodology across project types and regions *(please indicate)***:**

>> Please see my response to the baseline methodology.

(9) Any other comments:

a) State whether any other source of information (i.e. other than documentation on this proposed methodology available on the UNFCCC CDM web site) has been used by you in evaluating this methodology. If so, please provide specific references:

>> Please see my response to the baseline methodology.

b) Indicate any further comments:

>> Please see my response to the baseline methodology.

Signature of desk reviewer …John Frank Fazio…………………………………………..

Date: 5 / 25 / 2005

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