

Review of Economic Impact Study: Nam Theun 2 Hydroelectric Project

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Note: The original version of this review was issued 1 August 1997. Subsequently Louis Berger International issued a revised edition of the report dated 28 July 1997, and Mr. Scott Thomas, Team Leader of the Economic Impact Study, issued a letter in response to our review. This revised version of the review includes consideration of the revisions to the Study, and Mr Thomas' letter.

All original content has been retained, superseded items are set off in brackets, additions and changes are given in italicized type.

I. Overview

The scope of this report, in accordance with its terms of reference, is to critically review the Economic Impact Study of Nam Theun 2 Dam Project prepared by Louis Berger International, Inc. dated June 12, 1997, *revised and reissued dated July 28, 1997.*

This review finds the Berger study, while in many ways adequate in its application of conventional analytical methods, has shortcomings which affect the legitimacy and utility of its conclusions. In contrast, an economic analysis that accurately reflects the full range of issues surrounding hydropower development as a means of poverty alleviation and sustainable development, would have best served the Lao people.

A significant weakness of the Berger study is in fulfilling its charge to, as part of the project evaluation, construct "realistic scenarios for...pessimistic conditions." The Berger study presents what it alternately terms a "pessimistic" or "nightmare" scenario, yet this *economic* calculation, for example, excludes any consideration of sedimentation in the reservoir, limits its worst case construction cost overrun to 20 % [15%], and does not consider single or multi-year construction delays. Familiarity with international hydropower projects demonstrates that these factors are not only pessimistically possible, they are typical. For this reason, the statement contained in the study: "Sensitivity analysis of the model indicates that the net present value of the project remains positive under all but the most pessimistic of scenarios" may be technically correct, but is fundamentally misleading.

The study is relatively even more selective in calculating project benefit to the Lao government than it is in calculating overall project return. As the report states (Annex 1, para. 48) "the flow of benefits to the GOL is distributed more heavily to the later periods in project life." The later periods of project life are precisely when sedimentation effects will be felt in diminished production and/or need for capital reinvestment to maintain operation. The later periods of project life also carry a greater risk of Thailand turning to cheaper alternate sources of power. [By using a lower discount rate for GOL analysis (7%) than project analysis (9%), and given the high distribution to the government in later periods, the Berger calculation further favors an optimistic net present value for the government. Further, the fact that the study uses a base Thai inflation rate of 3%, and a worst case of 4%, when the present inflation rate in Thailand is 6%, has a strong impact in bringing the supposed earnings in later periods to a present value.] (*The subsequent version of the study does rationalize discount rates at 7%, and*

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utilize a base inflation rate for Thailand of 6%. More on this below.)

We also find the study to have assumptions which systematically raise the "optimistic" and "pessimistic" case projections. The base electrical tariff rate used is, in our opinion, high. [The Thai inflation rate assumption also presents a systematic bias.]

II. Review of assumptions

Scoping the IRR calculation. We agree with the statement (page 3, para. 7) that cost overruns, demand shortfalls and hydrological variations are among the most obvious sources of risk. We cannot agree that they can be downplayed, simply because private sector, project finance may be employed. The presumption that "market signals" demonstrate viability, when appearing in an economic study that should help the Lao government evaluate the developer proposals, is tautological at best. The existence of BOT finance does not change, in the case of hydrology, the performance of the weather.

The presumption in the "market signal" discussion by Berger seems to be that if shortfalls do occur, the project developers, NTEC, will absorb any losses and the government will be not only fully protected, but continue to receive full dividend, royalty and tax payments--this is not at all a safe assumption, not before the contracts are negotiated and signed, and quite probably not after they have been either.²

Even if losses were limited to NTEC, this affects the GOL as an equity participant.

Responsible characterization of these risks, however, would provide invaluable background information to the Lao negotiating team as they enter into the next round of negotiations--assuming the project proceeds to that point.³

Discount rate. [The study uses a 9% discount rate for project analysis. It uses a 7% rate for the GOL case, a lower rate which increases the calculated present value of the projected GOL earnings far in the future. The study uses (Appendix 1, page 1) a discount rate of 10% for calculating the present value of lost future forestry earnings from the Nakai Plateau, a rate higher than the 7% or 9% decreases the calculated present value of lost sustainable forestry earnings.]

The subsequent version of the study does rationalize the discount rate at 7%. The revised calculations, however, do not show the present value of lost forestry earnings increasing as would be expected, but rather decreasing! This was accomplished by lowering the unit value of wood in the calculation. (See Annex 2, para. 40) The June version shows the range of forestry present value from a low of \$22million, to a high of \$45mil. For a period of 50 years, the present worth factor at 10% is 9.915, and at 7% is 13.801, so we would correspondingly expect

²The Berger contention is in contrast to the observation in Engineering and Economic Aspects of Planning, Design, Operation and Construction of Large Dam Projects by Engelbertus Oud and Terence Muir (p. 4) that "the increasing role of private sector development leads to...off-loading of as much risk as possible onto other parties, particularly onto the Government."

³During the negotiations, if the developers offer extraordinary protection from cost overruns, it may be because they are willing to rely on their construction management skills, as well as any built in hedges, to a high degree. With respect to shouldering risk for demand and hydrology, however, if the developers' offer seems too good to be true, it probably is.

the forestry present value to be about 39% higher at the 7% discount rate, therefore \$31 mil. low, \$63 mil. high. Instead the July version of the study cites values of \$20 mil. low, \$38 mil. high.

Similarly, the Land Opportunity Cost used in the nominal dollar calculation of Cost/Benefit (Annex 1, pages 28, 29) fell from \$311.4 million to \$134.5 mil. between the two studies, despite the change in interest rate which trended the opposite direction!

Inflation rate. [The study uses a base rate for Thai inflation of 3%, with 2% as "rosy" and 4% as "nightmare;" the current rate of inflation in Thailand is 6%.⁴ As the study says (Annex 1, p.16, para. 62) "lower inflation works to the advantage of NT2." The study does not adequately represent the worst case for inflation.] *The study now uses a base case Thai inflation rate of 6%.*

The study's sensitivity test for inflation shows the project net present value to the Lao government at the end of 30 years falling by \$51 million with inflation rate only 1percentage point higher than the 3% base case, and by \$82 million when carried out to 2050. It is beyond the scope of this review to calculate a true worst case including the higher inflation scenario, but an inflation assumption of 5% would in itself lower the net present value to the GOL by a further tens of millions of dollars. *The earnings to the Lao government are shown to drop in the later report, which combines the effects of higher inflation, lower tariffs, and other factors in the calculation.*

Construction cost estimates. We maintain that it was a positive and appropriate development for the government to employ "an outside general engineering consultant" (page 4, para. 10) for tasks including generating "independent cost estimates." It is appropriate for Berger to utilize Lahmeyer cost estimates as a construction cost basis.

We do feel that Berger responsibly should have subjected the Lahmeyer-generated base construction costs to more realistic scenarios for cost overruns and construction delays.

By application of the [9%] 7% real discount rate to the Lahmeyer projected construction cost schedule, we derive a construction cost of [US\$995 million] *US\$931 million* in the first year of project operation. As a statement of construction costs excluding construction delays and other cost overruns, it is roughly consistent with previous estimates.

Construction cost (US\$millions, 1996 dollars)

	Expenditure	Carryover debt @ 9% real discount rate	Annual Sum
1998	\$17.40		\$17.40
1999	\$117.55	\$18.97	\$136.52
2000	\$231.63	\$148.80	\$380.43
2001	\$231.63	\$414.67	\$646.30
2002	\$120.55	\$704.47	\$825.02
2003	\$14.00	\$899.27	\$913.27
2004		\$995.46	\$995.46

⁴We do recognize that the Berger study is referring to average inflation over a number of years.

Construction cost (US\$millions, 1996 dollars)

	Expenditure	Carryover debt @ 7% real discount rate	Annual Sum
1998	\$17.40		\$17.40
1999	\$117.55	\$18.62	\$136.17
2000	\$231.63	\$145.70	\$377.33
2001	\$231.63	\$403.74	\$635.37
2002	\$120.55	\$679.85	\$800.40
2003	\$14.00	\$856.43	\$870.43
2004		\$931.36	\$931.36

Berger utilizes a base case with no cost overrun, and a worst *economic* case of a [15%] 20% cost overrun, 30% in the *financial risk calculation*. According to the 1996 World Bank Technical Paper No. 325, Estimating Construction Costs and Schedules: Experience with Power Generation Projects in Developing Countries,⁵ hydropower projects supported by the World Bank have an "average cost overrun of 27 percent." Based on the experience elaborated in that document, it would have been appropriate for Berger to have used no-cost-overrun only for the best case scenario, a 27% cost overrun for the base case, and a 50 to 100% cost overrun⁶ for the "nightmare" or "worst case."

As factors leading to possible construction delays and cost overruns, we note geological uncertainty, which will affect tunnelling operations, and possibly require structural shoring or 'plugging' of the hills which will form the basin rim as the reservoir begins to fill. The Berger study has noted (page 41, para. 8) "In regard to cost over-runs, a preliminary review of the contract indicates that NTEC would be exposed to additional costs related to ground conditions outside of a 'Defined Work Area,' for Force Majeure events, and for lack of adequate water during acceptance testing." We do note the relatively good transportation access to the site, yet we feel that logistics will present a very real challenge.

The study (Annex 1, page 18,19) presents a comparison of the projected cost of electricity from NT2 in comparison with many other Asian hydropower projects. This information indicates that the calculated cost for NT2 is markedly lower than the average value of projects in Laos, and in Southeast Asia. What is not confirmed yet is whether this comparison demonstrates that, a) NT2 is a low cost hydropower project, or b) the NT2 cost is being appreciably underestimated.

Ecosystem preservation. The study makes its assumption clear (page 4, para. 12) to accept the argument that project development will favor protection of a conservation area, while failure to develop the project will mean the would-be conservation area goes unprotected while the

⁵Bacon, Robert W., John E. Besant-Jones, Jamshid Heidarian, World Bank Technical Paper No. 325, Energy Series, Estimating Construction Costs and Schedules: Experience with Power Generation Projects in Developing Countries, World Bank, 1996.

⁶see Figure 5.4 of Bacon et al.

reservoir site gets degraded anyway. We must note that this stance is seen as arbitrary and unsupported by some interested parties. Arguments against this stance would point out that it ignores the question of reversibility, that greater logging of the Nakai Plateau to a certain point does not rule out future ecosystem recovery while a reservoir would. Also, it could be argued, what is the source of confidence that the watershed of the reservoir won't be clearcut after construction, resulting in both environmental chaos and massive sedimentation of the reservoir? Expenditures for preservation do not ensure results. Would the regional development company, really have an interest in the medium term of protecting the watershed rather than cashing in on the timber?

Without the reservoir, we would find it economically rational for the government to pursue, and donors to support, programs of sustainable forestry.

The calculation of the lost future timber harvests (Appendix 1, page 2) ignores the rising real value of timber in international markets, especially the Tokyo Exchange, *in addition to the concerns mentioned above under 'Discount rate.'*

Environmental and social cost mitigation. We would like to stress that mitigation relies not only on the amount developers are willing to spend (page 5, para. 13) but the efficacy of their efforts. Annex 2 of the report provides an excellent enumeration of possible environmental and social impacts, and makes observations that would facilitate mitigation planning. Without careful assignment of authority and meaningful conditionality in the contractual agreements, however, the unmitigated costs will reach 100% despite any mitigation spending.

We support the study for the assumption (page 5, para. 14) that 50% of the environmental and social costs will not be mitigated as a factor in this economic analysis, as a more realistic and less conservative assumption than might have been used, without in any way endorsing the reality which this reflects. We also note the corollary to the assumption that 50% of the environmental and social costs will not be mitigated: that watershed degradation will lead to some heightened degree of sedimentation, and that some citizens will experience a diminution in living standard, in violation of World Bank policy.

Reinvestment. We note and find appropriate the discussion (page 5, para. 16) of the ability of the Lao government to re-invest project earnings; the study is correct to term NT2 an 'enclave' project. Such reinvestment is a necessary component if development of the NT2 project is to contribute to poverty alleviation in Laos. We believe that for net capital within the Lao economy to have experienced a net increase at the end of service life is a key criteria in assessing NT2 as a vehicle of sustainable development.

We note, however, that within the project analysis earnings to the GOL are taken as a proxy for benefit to the Lao economy, functionally assuming perfect reinvestment in that context. Although the study purports to analyze "institutional capacity constraints" and present a "strategy for their mitigation," such discussion is not equivalent with implementing successfully a program that achieves perfect reinvestment capability.

Hydrological risk. [The calculation uses (page 9, para. 6) a monte carlo simulation to represent hydrological constraints to power generation. Our apprehension is that the monte carlo simulation expresses hydrological variation, but does not adequately address the possibility of hydrological shortfall.] *The monte carlo simulation has been removed from the primary benefit/cost calculations, which now carry constant annual generation estimates. The possibility*

of any hydrological variation is now treated only within the sensitivity analysis. The project hydrological models are built upon rainfall measurements taken in too few locations over too short a span of time to provide a high level of confidence. By its nature, modelling from inadequate data "inherently results in a lower variability in the estimated flows than occurs during the observed sequence."⁷ Limitations included "an extremely poor network of rainfall stations."⁸

Again, generation rates of the so-called 'base case' 'most likely scenario' are now set at idealized constant levels in the calculation.

Tariffs. The Berger study cites (Annex 1, para. 53) the tariff given in the now expired power purchase agreement, which was 4.55 cents/kWh escalated at 3% during construction and 35% of the rate of inflation during operation. The study then goes on to note that Thailand's avoided cost of power is lower than this amount and falling, therefore "the new tariff can be expected to be lower than the previous agreement." The study then goes on (para. 54) to use a base rate of "5.75 cents/kWh in 2004" increasing "at 35% of inflation during operation as in the previous agreement." Please note that an amount of 4.55 cents in 1996, raised by 3% a year inflation for eight years, is equivalent to 5.76 cents in 2004.

To summarize the previous paragraph, Berger uses a base rate tariff in its calculations which it states (in para. 53) is artificially high. In explaining its use of this number it cites "conversations with NTEC and the World Bank."⁹

The study now uses a tariff of 5.70 cents which it holds constant in nominal terms with no inflation factor.

In 1995, the average tariff at which the Lao utility exported electricity was 3.2 cents per kWh.¹⁰ Raised for inflation by the referenced amount, this is equivalent to 3.3 cents/kWh in 1996, only 72% of the referenced 4.55 cents/kWh. *It is equivalent to 4.05 cents in 2003, or 71% of the 5.70 cent tariff.*

Berger also recognizes a scenario in which combined cycle gas plants in Thailand create a competitive tariff price of 4.0 cents/kWh in 2003, or thirty percent cheaper than the assumed base case. The study (Annex 1, para. 70) notes "It is very possible that both the capital costs of combustion turbines and the production cost of natural gas will stay flat or decline in real terms in the near future." Yet the study marginalizes the significance of low gas-fueled tariffs by citing natural gas scarcity. We do not feel that the natural gas scarcity argument is conclusive, and that the study should have given much more credence to a scenario of continued downward tariff price pressure.

Sedimentation. We agree that (Annex 1, para. 9) sedimentation "may pose a risk to future NT2 generation output and therefore the revenues and benefits associated with NT2." We do not feel

⁷Lahmeyer International in Association with Worley International, Nam Theun 2 - Study of Alternatives: Review of NT2 Hydrology, p. 3.

⁸Ibid, p. 9.

⁹Annex 5, para. 42 states "tariff assumptions used were those supplied by the World Bank."

¹⁰Lao PDR: Public Expenditure Review, February 1997, p. 150.

that it was appropriate to perform this study and reach conclusions without factoring in any sedimentation scenarios.

The report states that, "no comprehensive data nor studies were available to the project team at the time of the report." SMEC made an assessment of sediment loads in 1991; the SMEC data has also been the foundation for an assessment of sedimentation in Nam Theun 2- Study of Alternatives by Lahmeyer in February of this year, and A Review of Nam Theun 2 Project Economics by White in July 1996.

We feel that data exists from a variety of reservoirs in Asia under similar geological and hydrological conditions that could have been used to generate at least approximate assumptions for sedimentation rates and the resulting economic impact. Further, regional experience indicates a true worst case scenario would consider extreme watershed degradation.

If the study had generated a sedimentation scenario for a watershed protection worst case, and carried it through to a Lao government project return calculation, it would have provided a valuable service in demonstrating to the Lao government its self interest in watershed protection if the project is built.

III. Review of conclusions

Returns. The Berger study finds (page 9, para. 4) that under the "most likely" scenarios, the economic internal rate of return for the project from a project ('global') perspective, and GOL perspective, is not less than [14%] 16%, and the net present value of an initial \$100 million GOL investment is more than [\$300 million] \$345 million. It goes on to say "Sensitivity analysis of the model indicates that the net present value of the project remains positive under all but the most pessimistic of scenarios."

The objective of this study (page 1, para. 1) "is to provide the Government of the Lao People's Democratic Republic (GOL) with a comprehensive and well balanced analysis of the economic viability of the proposed Nam Theun 2 hydroelectric project." From the indicated returns it would be logical for the GOL to perceive that the project is not only viable but attractive, with negligible risk.

A well balanced analysis should point out the real possible downside of project development, as disappointing and unwelcome as that news may be. Clearly, the implications of tariff revenues being 20 to 30 percent lower than assumed in the study, and a cost overrun of even 40 percent or less, even if not combined with hydrological shortfall and diminished project life, present a very real possibility of the project having a negative NPV, subjecting the GOL to loss of its total investment while incurring environmental, social, and opportunity costs.

The July version of the study has lower project benefits in terms of project revenues, yet presents a higher net present value and rate of return, especially for the Lao government. It is able to do so because it greatly reduced its tabulation of land opportunity cost including forestry, which increases the doubt as to the appropriateness of the calculation.

As for the reasoning that the project developers will shield the GOL from critical cost overruns or earnings shortfalls, it is a given that the developers are not interested in losing tens or hundreds of millions of dollars. They will, under such conditions, find a way of passing along losses, or they will find a pretext for abandoning the project.

Diverging outcomes. The GOL should note (page 14, para. 19) that under the "nightmare" scenario, which for reasons given above we do not at all consider to represent the worst case, in the first 30 years the GOL loses [\$95 million] \$69 million, while the project over all retains a positive net present value. The study cites the current draft of the Concession Agreement (page 41, para. 9) to point out that not only is the GOL being asked to accept diminished royalties in the event of hydrological shortfall, but also if the developers simply have not achieved their 'hurdle' rate of return.¹¹ The discussion further points out (para. 10) ways in which the GOL is being exposed to greater risk than the developer, as the resource levy holiday "significantly exposes the GOL to the risk of a renegotiated tariff structure in the later operating phase of the project," and because the developer is seeking "2-to-1 reimbursement of development costs" by the commercial operation date.

Alternatives. The Berger study does not, we believe, sufficiently present the no-build option in its conclusions. We do not believe that the proposed Nam Theun 2 project, even were it to be of net benefit, is the only vehicle by which the Lao PDR can pursue its national development

¹¹It would have been helpful to the GOL for the study to have built and calculated a financial scenario which demonstrates the importance of these contract provisions.

objectives.

A GOL development strategy of sustainable forestry of the Nakai Plateau has many advantages over the NT2 scheme. It does not require a US\$100 million investment. It could begin today. It does not carry a risk that the GOL could lose \$95 million or more. It has a net present value from timber sales alone of between \$45 and \$275 million. It would not carry a cost of \$95 million for combined environmental and social costs and mitigation measures, although it would require some fraction of that for management and protection measures. It could provide employment for Lao citizens, especially if combined with wood products processing and ecotourism development. It does not carry the same risks for increased prostitution and accompanying public health concerns, nor waterborne diseases such as Schistosomiasis. It is compatible with Lao macroeconomic development needs including enhanced rural development, farm to market roads, agricultural extension, and education.

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