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Bangkok, Thailand 10120

Mr. Ian C. Porter
World Bank Country Director
Lao PDR and Thailand
East Asia and Pacific Region

Dear Mr. Ian C. Porter,

Re: flawed assumptions and false statements in NT2 economic appraisal

Thank you for your letter dated 8 April.[1] It helps resolve one issue (apparent post-2014 natural gas price increase), and helps clarify others. Most of your answers reinforce our concerns that key assumptions used in the *Nam Theun 2 Hydro Power Project Regional Economic Least-Cost Analysis: Final Report*[2] (RELC) and the *Lao PDR Nam Theun 2 Hydroelectric Project: Project Economic Analysis*[3] are flawed in ways that strongly favor a positive appraisal of NT2.

We have calculated[4] the contribution of the *RELC's* erroneous assumptions towards the RELC'claimed present value US$188 million economic "savings" in the "with NT2" scenario (Table 1). Including only the flaws whose impacts we were able to calculate, and using techniques that understate the economic contributions of the erroneous assumptions, we estimate that these errors in the *RELC* account for at least present value US$220 million of the "with NT2" scenario's claimed present value US$188 million savings. We are concerned that correcting the economic appraisal may show that the project is not economically least-cost. The key problematic assumptions we have identified are summarized below in Table 1. The remainder of this letter discusses in greater detail the erroneous assumptions and other problematic aspects of the economic appraisal of NT2.

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1 All correspondence in this dialogue (now 5 letters) is available at http://www.palangthai.org/docs/RemarkableAssumptions.pdf

2 Robert Vernstrom, 2005. *Nam Theun 2 Hydro Power Project Regional Economic Least-Cost Analysis: Final Report.* March. url: http://siteresources.worldbank.org/INTLAOPRD/Resources/RELC-2005-final.pdf. In earlier letters we referred to this report as *Final.* In this letter we adopt the Bank's abbreviation of *RELC.* Similarly, we adopt the Bank's abbreviation of *Nam Theun 2 Hydro Power Project Regional Economic Least Cost Analysis: Draft Final Report* as *RELC/2004.* Previously we had referred to this as *Draft Final.*

3 World Bank, 2005. *Lao PDR Nam Theun 2 Hydroelectric Project: Project Economic Analysis,* March 14. url: http://siteresources.worldbank.org/INTLAOPRD/Resources/Annex_11A.pdf

4 The spreadsheet containing these calculations can be downloaded from our website at: www.palangthai.org/docs/NT2EconMalfeas.xls

Description of assumption erroneous assumption / false claim	**Contribution towards "$188 million savings" in "with NT2" scenario.**	**Notes**
Inflation of variable O&M costs for natural gas CCGT and GT in final *RELC* (released just 1 week before World Bank approval of NT2)	US$150 million to US$156 million	CCGT inflated 1240% GT inflated 1000%. Final O&M values far in excess of international benchmarks. Inflation is discernable only in small changes between the *RELC* and *RELC/2004* versions of tables printed in 6- or 5.5- point font.
Unfair unequal valuation of loss of firm Theun Hinboun electricity generation caused by NT2 water diversion	US$51 million to US$63 million	NT2 power valued at Thai consumer "willingness to pay" of US cents 7/kWh. Theun Hinboun electricity is indistinguishable from NT2 to Thai consumers, but valued at less than one third this amount.
Findings of Bank-commissioned NT2 study on economically superior alternatives are 100% omitted from NT2 economic appraisal calculations.	Difficult to calculate without appraisal spreadsheets. Omitted DSM would delay optimal commissioning 9 months and reduce of ERR from 16.3% to 14.6%.	Additional 1225 MW DSM and 216 MW renewable energy are less costly than NT2. 4000+ MW cogeneration also ignored
Omission of 4 committed EGAT CCGT power plants totaling 2800 MW	US$19.5 million (Economic impact from omission of just Songkla (700 MW) which has been approved by Cabinet.	These omissions falsely provide flexibility that the *RELC* relies upon to minimize economic losses from over-capacity due to NT2 in "low demand" scenarios. Omission discernable only through comparison with actual EGAT PDP2003.
Total	**US$220 million to US$236 million**	**Exceeds $188 million savings in "with NT2" scenario**
False claims that risk analysis considers only "downside risks" to NT2.	US$51 million (not included in total above[5])	*RELC* repeatedly claims that "low construction cost" scenario is excluded from risk analysis. *RELC* Tables S-1 & 24 show these claims to be false.

Table 1: Summary of key erroneous assumptions in the *RELC* and their contribution towards the Bank's positive economic appraisal of NT2.

[5] Not included in total because this is a case of misrepresentation of study methodology rather than an erroneous assumption *per se*.

1. ***Escalation of O&M costs for CCGT and GT***

In the *RELC* variable operations and maintenance (VOM) costs for combined cycle gas turbines (CCGT) and gas turbines (GT) increased 1240% and 1000%, respectively, over the values in the *RELC/2004*. The only evidence for this change was minor adjustments in *RELC* Tables 13 (written in 6 point font) and table 15 (written in 5.5 point font).

Table 2 below shows CCGT[6] VOM and Fixed O&M (FOM) assumptions in the draft *RELC/2004* and final *RELC* versions compared with benchmark CCGT O&M costs from regulatory bodies and utilities in Thailand and other countries. In order to mitigate the comparability problem that groups apportion costs differently to FOM and VOM we normalized each set of figures by calculating the annual O&M costs per kW in the case in which the generator is operated at 80% capacity factor[7] (typical for CCGT).

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6 We focus on CCGT because CCGT is determined by the *RELC* to be the most likely economic alternative to NT2 (*RELC,* p 29 & p 31). As noted above, GT O&M costs also escalated radically over *RELC/2004* values

7 Using the formula: (Total O&M = VOM * 8760 hours/yr * capacity factor/1000) + FOM. See worksheet "benchmark VOM" in www.palangthai.org/docs/NT2EconMalfeas.xls. There is little sensitivity to changes in capacity factor. Even at capacity factors as low as 30%, *RELC* figures are more than twice the highest benchmark.

CCGT VOM ($/MWh)	CCGT FOM ($/kW-yr)	Annual O&M costs ($/kW-yr)	Country	Notes
7	18	67.06	Thailand	RELC 1/
0.564	16.8	20.75	Thailand	RELC/2004 2/
0.5358	15.96	19.71	Thailand	EGAT 3/
2.55	10.61	28.48	USA (Cal)	CPUC MPR 4/
1.36	13.57	23.10	USA (Cal)	CPUC merchant-owned CCGT 5/
1.36	13.57	23.10	USA (Cal)	CPUC utility-owned CCGT 5/
2	11.00	25.02	USA (Wash)	Puget Sound Energy 6/
1.26	10.25	19.09	Ireland	Ireland Commission for Electricity Regulation 7/
3.14	2.60	24.58	Australia	New South Wales Regulatory Tribunal 8/

1/ RELC Table 13

2/ RELC/2004 Table 13

3/ EGAT assumptions used in *Strategist* expansion planning modeling. *Strategist* is the updated version of *Proscreen II* software used in the RELC modeling. Price Waterhouse Coopers (2004). Thailand: Electricity Power Tariff Energy Planning and Policy Office -- Inception Report -- Annexes C, table C.6.-E. Bangkok, Thailand.

4/ CPUC CCGT avoided cost. California Public Utilities Commission (CPUC) Electric Avoided Cost Calculation. ver. 21, Prepared by E3, Inc. for the California Public Utilities Commission. 2005. Avoided cost spreadsheet available at: http://www.ethree.com/cpuc_avoidedcosts.html. Assumptions based on *Revised 2004 Market Price Referent (MPR) Staff Report*, February 10, 2005.

5/ CPUC Electric Avoided Cost Calculation. ver. 21, Prepared by E3, Inc. for the California Public Utilities Commission. 2005. Avoided cost spreadsheet available at: http://www.ethree.com/cpuc_avoidedcosts.html.

6/ Navigant Consulting. 2003. LCP Conservation Integration Results, Methodology, & Assumptions. Prepared for Puget Sound Energy. 31 July. Page 22. http://www.pse.com/account/pdfs/lcp_2003_08_29_appendix_b_lcp_conservation_presentation.pdf.

7/ Ireland Commission for Electricity Regulation (1999). Best New Entrant Pricing: A Consultation Paper. Url: http://history.cer.ie/cer9908i.pdf. 1999 exchange rates to US$: http://www.eh.net/hmit/exchangerates/

8/ Intelligent Energy Systems (2004). The Long Run Marginal Cost of Electricity Generation in New South Wales: A Report to the Independent Pricing and Regulatory Tribunal. http://www.ipart.nsw.gov.au/documents/Pubvers_Rev_Reg_Ret_IES010304.pdf. Exchange rate of $Aus = 0.7839 $US from http://www.ssga.com/library/povw/lawrencedrydenausdollarin200420050218/page.html

Table 2: comparison of O&M costs for CCGT between *RELC* values and international benchmarks.

Perhaps the most startling feature in Table 2 (graphed in Figure 1) is that the *RELC* O&M values are by far the highest values in the table. Though we conducted an extensive internet search of CCGT O&M costs, *we were unable to find O&M costs anywhere in the world that were even half as high* as those assumed in the RELC. To the best of our knowledge, these cost estimates all include insurance, inspection and maintenance. In addition, the international benchmark values are generally *commercial* O&M costs, and therefore overstate *economic* costs because they do not include profits or taxes. They cover the spectrum from utility-owned generation to independent power producers. In our international search, the highest assumptions we encountered (besides the *RELC* figures) were those used in avoided cost calculations by the California Public Utilities Commission (CPUC). Consider that California has extremely high labor costs and some of the strictest environmental regulations for power plant emissions in the world. We are surprised that the Bank believes that O&M costs for CCGT in Thailand, which has fairly low labor costs, would be more than twice as high as CPUC cost estimates.

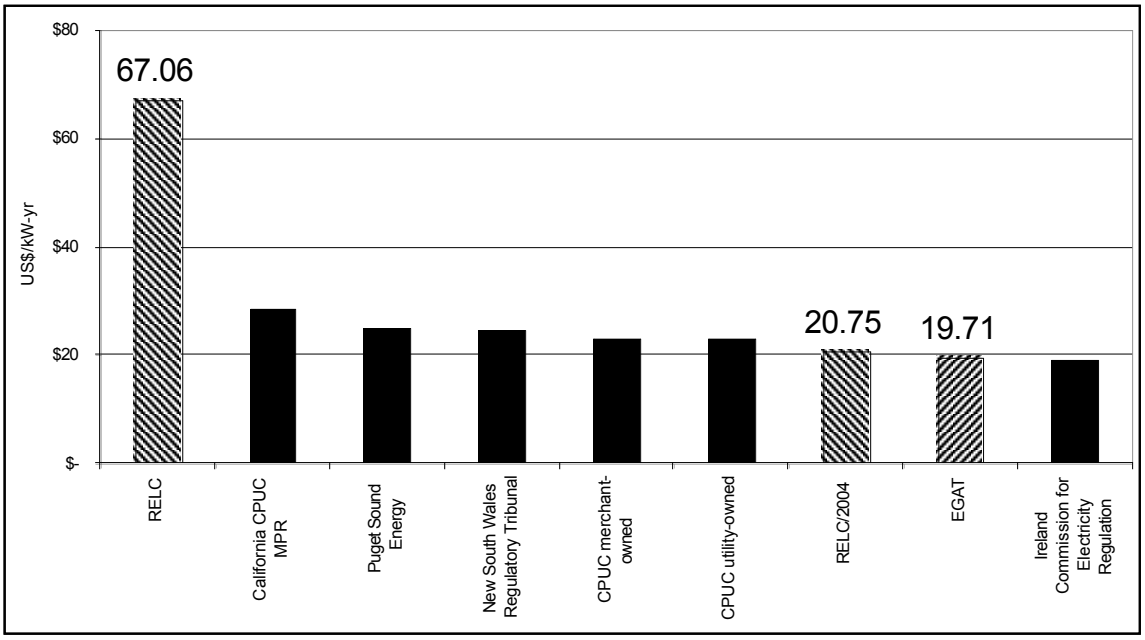

Figure 1: *RELC* assumptions for annual CCGT O&M costs compared with Thai and international benchmarck values. (Graph of data in Table 2). Notice that *RELC/2004* costs were similar to Thai and international benchmark figures, but *RELC* costs are more than twice as high as the highest benchmark.

Perhaps more important than the international benchmark values are the Thai EGAT values. The *RELC* cost estimates for total O&M are 340% as large as EGAT total O&M cost estimates. EGAT has an extensive record running CCGT in Thailand. For new EGAT plants, it seems appropriate to use EGAT O&M costs.[8] At the same time, one would not expect EGAT costs for CCGT O&M in Thailand to be *that* different from private sector costs. EGAT typically has a larger workforce per plant than private sector Independent Power Producers (IPPs), but IPPs may pay somewhat higher salaries -- these two effects would tend to compensate for each other. Our research finds evidence that insurance costs for utility and IPP CCGT are similar and account for a fraction of total O&M costs.[9]

What can possibly explain the huge differences between *RELC* assumptions and benchmark O&M figures?

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[8] Historically it has been government policy that 50% of new generation is built by EGAT. Cabinet has approved the EGAT Sonkla CCGT project. These contradict the *RELC* presumtion that "*all* future capacity will be developed by the private sector." (*RELC,* page 59).

[9] See, for example, CPUC Electric Avoided Cost Calculation. ver. 21, Prepared by E3, Inc. for the California Public Utilities Commission. 2005. http://www.ethree.com/cpuc_avoidedcosts.html. IPPs and utilities insurance is estimated to be equal at US$9.24/kW-yr, out of a total of US$23.10/kW-yr O&M costs.

In response to our inquiry about the escalation of CCGT VOM in the economic appraisal, you claimed in your 8 April letter that "US$0.002 of every kWh is charged in variable cost for generation associated transmission".

There is no mention of this figure anywhere in the *RELC* or *Project Economic Analysis* reports. What are the details of the basis for this charge? Thailand's extensive natural gas pipe network provides considerable flexibility in locating CCGT close to load centers – at least much closer than the Lao border is to load centers. If costs for reinforcing the Thai 500 kV transmission system for CCGT are included in CCGT VOM, it would it would only be fair to require that these costs be included for NT2 as well. But the *RELC* reports that these are excluded for NT2 (*RELC*, footnote 47, page 59).

Strangely, distributed cogeneration (which has very low – or often negative -- associated transmission costs) was excluded from the terms of reference of the study on alternatives to NT2. This is discussed later on in this letter in our response concerning DSM and renewable energy.

Even if the US$0.002/kWh transmission charge for CCGT and GT is legitimate (which remains to be proven), it only explains US$14.02/kW-yr of the *RELC* US$67.06/kW-yr CCGT O&M costs in Table 2 above. *We note that even after subtracting $0.002/kWh, RELC values for CCGT O&M costs are still 186% of the value of the highest international benchmark values we encountered in our search, and 269% of the value of EGAT O&M costs.*

Given these irregularities, we respectfully ask that you provide:

1. A detailed justification for the exceptionally high economic cost estimates for O&M of CCGT. Given the importance of this variable, and the radical escalation of its value in the *RELC* it deserves more than the 6-point font footnote to Table 13. Specifically, the justification should include a discussion of the conditions in Thailand that lead to O&M CCGT costs that are far above international levels and published EGAT figures.
2. An explanation of why published EGAT figures are not relevant for the *RELC* analysis.
3. An explanation for why there was no discussion in the text of the *RELC* of the 1240% escalation in CCGT and 1000% escalation in GT VOM values. We find this omission astounding considering that this change accounts for more than half of the "with NT2" savings and that the values assumed are exceptionally high by international standards.

The domestic (EGAT) and international benchmark values and the discussion above suggest that the *RELC/2004* values for natural gas O&M are more realistic than the more recent *RELC* figures. We calculate[10] that inflating CCGT and GT VOM costs from the

[10] www.palangthai.org/docs/NT2EconMalfeas.xls, worksheet "Inflated gas VOM"

RELC/2004 values to the *RELC* values accounts for present value US$150 to $156 million of the *RELC's* "with NT2" economic savings of US$188 million.

This is sufficient to offset the present value US$101 million base-case *increase* in NT2 capital costs from *RELC/2004* to *RELC* indicated by changes in Table 17,[11] and removal of an unwarranted[12] present value $20 million NT2 greenhouse gas credit.[13]

Because these *RELC* O&M assumptions in question are apparently also used in the commercial analysis, our calculations hold for this case as well. That is, US$150 to US$156 million of the *RELC's* "with NT2" commercial savings of US$145 million are attributable to the *RELC* escalation in CCGT and GT O&M costs.

2. Irregularities in transmission cost assumptions

In response to our inquiry about the escalation of CCGT VOM in the RELC, you stated that "for NT2, the associated transmission charge is US$0.006 [per kWh] because of the high voltage and long length of that particular line." (8 April, 2005)

Can you help us understand this $/kWh transmission cost figure better? We do not want to be accused again of misconstruing your statements, but we find it especially difficult to reconcile your US$0.006/kWh NT2 transmission claim with what is published in the RELC.

There is no mention of "$0.006/kWh" NT2-associated transmission costs anywhere in the chapters related to the economic appraisal in the *RELC* or the *Project Economic Analysis*. The only relevant figure we can find in the *RELC's* economic assessment is that the total NT2-associated transmission costs are estimated to be (present value) US$82.4 million (RELC, page 44, Table 17)[14]. Taking the *RELC's* assumptions about discount rate and NT2 annual energy production, present value US$82.4 million is equivalent[15] to a

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11 In *RELC/2004* the present value of capital cost of NT2 is US$499.0 million (Table 17, page 42). In the *RELC* this raises to US$599.9 million (Table 17, page 44).

12 The Bank-commissioned study Laplante, B. (2005). *Economic analysis of the environmental and social impacts of the Nam Theun 2 Hydroelectricity Power Project* states: "reduced emissions may be partially or totally offset by the production of GHG [greenhouse gases] from the [NT2] reservoir", page 55. http://siteresources.worldbank.org/INTLAOPRD/147273-1092045101973/20377067/e-s_economic_analysis.pdf

13 *RELC/2004* page 44 includes $1.91 million/yr in carbon credits. This text dropped in the RELC.

14 There is no detailed breakdown of what this US$82.4 million comprises. Correct practice would be to compute and state the incremental transmission costs for the pure NT2 addition, including the towers, wire, telecommunications, protection, substations, special equipment (series or shunt compensation), changes to SCADA/AGC databases and displays, commissioning costs, project management, and the present value of the associated O&M costs for the line. Without these details it is difficult to determine whether or not RELC's figure of $82.4 million is reasonable.

15 See worksheet "levelized NT2 econ trans" in www.palangthai.org/docs/NT2EconMalfeas.xls

transmission charge of $0.00314/kWh, a little bit more than half of the $0.006/kWh you claim in your letter.

It is only *RELC Chapter 6: Commercial Assessment* that mentions the "US$0.006/kWh" cost you cite. However, it does so in such a way that we can only conclude that this cost was *not included* in the *RELC's* economic assessment, but was added in the transition from economic assessment to commercial assessment:

> "In the commercial analysis… the cost of each kWh is increased by US$0.00615, the estimated levelized cost of incremental transmission investments required to deliver all planned Lao hydro purchases from the Thai border to the nearest 500 kV line (for transmission to the Bangkok metropolitan area)" (*RELC* page 59)

We are concerned that *even* the $0.006/kWh *commercial* transmission cost figure may be considerably underestimated. The *RELC* terms of reference explicitly instructs study authors that, "The project-associated incremental transmission costs for Thailand need to be determined … on a basis that does not include any other future hydro exports from Laos to Thailand, because of their uncertainty." (*RELC*, page 74) But the *RELC* appears to have violated the TOR by sharing the commercial cost of NT2-associated transmission with thousands of MW of Lao hydropower that does not exist: "the levelized cost is based on transmitting 3,300 MW from agreed border crossing points to Tha Tako (near Nakhorn Sawan), the closest 500 kV connection point." (*RELC* footnote 47, page 59). NT2 accounts for 920 MW[16] of this 3,300 MW, but where do the remaining 2,380 MW come from?

Why did the commercial assessment of transmission costs fail to follow the directive specified in the TOR? Clearly the levelized commercial transmission costs would be substantially higher than $0.006/kWh if they were not able to share transmission resources with phantom Lao hydropower plants.

We remain puzzled how to reconcile a corrected estimate of commercial transmission costs with the US$0.00314/kWh economic costs discussed above.

Considering these apparent irregularities, and the questions raised above regarding CCGT transmission cost assumptions, can you provide us with a clear explanation of how transmission costs for CCGT and NT2 are accounted for in the *RELC* economic appraisal, how they are different in the *RELC* commercial analysis, and how they comply with directives specified in the TOR? A key component of this would be a transmission plan showing what line(s) are to be built, and a breakdown of economic and commercial transmission costs.

3. Regarding the valuation of Firm Power from Theun Hinboun

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16 NT2 is considered a 995 MW plant, comprising 920 MW to Thailand and 75 MW to Laos. See *RELC* footnote 8, page 9.

In our previous letters we noted that water used to produce electricity at NT2 will cause the Theun Hinboun (THB) dam 40 kilometers downstream to lose a significant amount of energy production. The World Bank NT2 economic appraisal values NT2's firm energy at US cents 7 per kWh[17] but values Theun Hinboun's loss of (firm) electricity at less than one third this amount.

First and foremost, this assumption defies the basic economic concept that perfect substitute goods have equal economic value. Valuation of NT2's firm electricity is based on Thai consumer's willingness to pay (*Project Economic Analysis*, page 20). To Thai consumers, a unit of firm electricity from THB is indistinguishable from a unit of firm electricity from NT2. We do not mean this merely in the broad sense that no one can tell exactly where their electricity comes from. But rather in the very rigorous sense that electricity from Theun Hinboun and Nam Theun 2 are as close to perfect substitutes as any energy economist could hope for. Firm electricity from THB and NT2 share the following properties: (a) both are sold under "firm" contract to deliver power at guaranteed times and quantities at the times when Thai consumers need it most; (b) both are derived from hydropower from neighboring locations in Laos and therefore subject to the same risks in terms of droughts, political risk, and other contingencies and (c) both have essentially identical impact on the Thai transmission system. Since electricity from these two sources are perfect substitutes, we must assign them the same value.

However, your prior letters to us indicate that you believe it more appropriate to frame the valuation of THB electricity loss in terms of capacity (kW) and energy (kWh) components that make up commercial firm energy contracts. You argue that the water diversion leads to "no reduction" in capacity (kW) at Theun Hinboun, and therefore Theun Hinboun is correctly valued by considering only the incremental cost of replacing the lost energy (kWh).

We think this "capacity/energy" framing is arbitrary and inconsistent given the identical characteristics of the two goods discussed above and the economic principle of equal value for perfect substitutes. But even framed this way, the assertion that capacity from THB "is not reduced or lost" as a result of water diversion from NT2 is unfounded.[18] If it were true that water diversion from THB to NT2 results in no capacity loss, one could in theory divert 100% of the water from THB until all that was left of this "firm" project is a dam and a dry reservoir. THB would still have "no reduction in capacity" in the sense that its generators would retain their original nameplate capacity. But this capacity would be worthless from the utility's perspective without adequate water to power the turbines. In order to justify the claim of "no reduction in capacity" one must show (using engineering and hydrology studies) that the water diversion in question in no way affects the capacity Theun Hinboun to generate power -- even in drought years -- at times, in quantities and durations that it was able to generate before NT2.

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17 *Lao PDR Nam Theun 2 Hydroelectric Project: Project Economic Analysis*, March 14. Page 20. http://siteresources.worldbank.org/INTLAOPRD/Resources/Annex_11A.pdf

18 Your letter to us, 8 March.

Another argument posited in your 30 March letter in defense of unequal valuation of THB firm power is the claim that "the Theun Hinboun project was predicated on the knowledge that the NT2 project – once constructed – would draw water from THB, which has used the incremental water available as a result of the delayed implementation of NT2 to generate additional power for export to Thailand." This argument turns appropriation water rights conventions upside-down by essentially arguing that historic users of water have fewer rights than do newcomers. Regardless, it is a grossly insufficient basis for valuing THB power at distress prices. From an economic perspective, what matters is the technical capacity of Theun Hinboun to generate benefits to society, not some claim that a project was predicated on a particular expectation.

Indeed, if the claim is correct that Theun Hinboun's construction was predicated on the expectation water diversions to NT2, then in a "without NT2" scenario Theun Hinboun may have options available to expand dam crest height or turbine capacity to fully exploit the available water flows. These options would obviously be precluded with construction of NT2. This option value should have been counted against NT2's economic "savings".

We calculate that the Bank's misvaluation of power from Theun Hinboun is worth present value US$51 to US$63 million of NT2's calculated present value US$188 million economic "savings".

4. ***Accounting for Additional DSM/RE***

Your April 8 letter states that Dr. Peter Du Pont's Bank-commissioned assessment of DSM/RE is incorporated in the *RELC* risk analysis. How is this possible when the risk analysis numbers were not changed between the *RELC/2004* (released before the DSM/RE impact study) and the final *RELC* report?

Let us review when each study was released and what each said with respect to DSM potential and demand forecast scenarios.

June 2004: The *RELC/2004* is released. The forecast of electricity demand used in the risk assessment (Table 9, page 22) concludes that demand in the base case will rise to 38,590 MW by 2016. In a high case the 2016 peak load is forecast at 53,652 MW, and in a low case forecast at 26,280 MW. The DSM assumption that informed this assessment is 982 MW of DSM by 2011 as projected in the Thai Load Forecast Subcommittee (TLFS) August 2002 load forecast (see Table 3, page 16).

24 March 2005: The World Bank releases Dr. Du Pont's study, *Nam Theun 2 Hydropower Project (NT2): Impact of Energy Conservation, DSM and Renewable Energy on EGAT's Power Development Plan (PDP)* [19]. The study heavily discounts both commercial DSM potential and government programs to conclude that 1,225 MW *of*

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[19] du Pont, P. (2005). Nam Theun 2 Hydropower Project (NT2) Impact of Energy Conservation, DSM, and Renewable Energy Generation on EGAT's Power Development Plan. Bangkok, World Bank. 24 March. http://siteresources.worldbank.org/INTLAOPRD/Resources/DSMmarch2005.pdf

additional DSM and 274 MW of renewable energy are achievable by 2011 and are economically and commercially lower cost than electricity from NT2.

24 March 2005: The *RELC* is released. Its risk assessment of electricity demand (also Table 9, page 24) is figure-for-figure 100% identical to the *RELC/2004* version of Table 9. The DSM assumption that informs this assessment is *still* 982 MW (Table 3, page 18).

If Dr. Du Pont's findings were included in the risk analysis, then Table 3 of *RELC* would show 2207 MW of DSM by 2011, not 982 MW. Table 9 base-case figures in the *RELC* would therefore be shifted 1225 MW downward by year 2011. Following the report's methodology regarding demand scenarios, these revised base-case figures would then be subject to the +/- 25% variation in the high and low demand cases.

Without the spreadsheets used by the *RELC* author, and without re-running the economic models it is difficult to calculate the economic impact of the DSM omission, but it is certainly significant. Your own analysis indicates that including omitted DSM reduces the base case ERR from 16.3% to 14.6%[20].

Regarding the treatment of renewable energy in the *RELC*, there is a similar failure to incorporate Dr. Du Pont's findings. The treatment of renewable energy in the *RELC/2004* and the Final *RELC's* treatment are word-for-word identical. Each version of the study includes 197 MW of Small Power Producer (SPP) renewable energy as committed plant additions (*RELC* page 27), dispatched without regard to cost (*RELC* p. 36). Contrary to your assertion that "only firm capacity that is economically superior to NT2 needs to be accounted for the purpose of the economic analysis", there no was requirement in either the *RELC/2004* or the *RELC* that this renewable energy generation had to be less costly than NT2, it was simply part of the 2003 EGAT PDP. The inclusion of these plants reflects EGAT's expectation that these plants will be coming on-line because they were approved as of March 2003 under the Thai government's subsidized renewable energy SPP program (*RELC,* page 26).

The 274 MW of commercially and economically superior (to NT2) renewable energy in Dr. du Pont's study included 216 MW of biogas-based electricity which is clearly *additional* because it is expected to come online under the (unsubsidized) VSPP program, not the SPP program. Together with the 1225 MW of additional DSM discussed above, this accounts for 1441 MW of clean energy identified by a World-Bank commissioned study as economically and commercially superior to NT2, that was omitted from the NT2 economic appraisal.

The discussion of renewable energy in the *Project Economic Analysis* largely ignores the analysis of Dr. Peter du Pont's study, and essentially dismisses all renewable energy as too expensive. The section on biomass is particularly striking: "Based on discussion with EGAT the biomass potential that can be supported from the annual availability of raw material is about 700 MW… and the generating cost is about THB 3/kWh (over US cents

[20] Your letter to us, 30 March 2005, page 3.

7/kWh, based on an EGAT pilot project.)"[21] However, the author's source at EGAT failed to recognize that there is already 861 MW (capacity) of biomass generators online as SPP generators. 32 out of 41 of these are non-subsidized, and the vast majority sell power at 1.77 baht/kWh (US Cents 4.425/kWh)[22]. Dr. du Pont's study includes a comprehensive review of a number of government-commissioned studies of renewable energy potential, as well as interviews with industry experts, and concludes that about 2400 MW of additional biomass are commercially viable. The Thai Ministry of Energy estimates biomass electricity generation potential in Thailand, based on availability of raw material, at 7000 MW; an order of magnitude higher than the estimate provided by the author's EGAT informant.[23]

The reason these existing biomass generators can be viable at such low tariffs is that they are generally built as cogeneration (combined heat and power) installations, which vastly increases overall efficiency and provides valuable steam to industry.

An even more significant omission is the unfortunate fact that consideration of fossil-fuel fired cogeneration was not included in the Terms of Reference (TOR) of the *DSM/RE* study (and were also excluded/ignored as least-cost competitors in the *RELC* and *Project Economic Assessment*). Notwithstanding the omission from the TOR, Dr. Peter Du Pont noted the following in his study:

> "This study has also not considered energy savings from cogeneration — although this may be a considerable omission. Cogeneration is a large source of potential energy efficiency savings because the combined production and utilization of heat and power for industrial processes can raise the efficiency of the power plant output by as much as two-fold and reduce the need for electricity supply. The SPPs noted in Table 40 that have been submitted but not contracted by EGAT represent more than 4,000 MW of power, approximately half of which would be consumed on site and half sold to the grid. Since most of these projects were submitted prior to the economic crisis, it is likely that there is significant additional cogeneration potential for on-site generation as well as sale to the grid. While this report did not investigate the cogeneration potential in detail, it is noted that the number of submitted projects represents a large, as yet untapped, resource." (*NT2 Impact of DSM/RE*, page 55)

Clearly, the results of Dr. Dupont's DSM/RE study are the tip of the iceberg of available true economic least-cost alternatives.

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21 *Project Economic Analysis*, page 8

22 du Pont *NT2 Impact of DSM/RE,* page 34.

23 Thai Ministry of Energy. (2003). *"Renewable Energy: New Opportunities for Thailand"*. (Thai language). Presented at the Energy Strategy for Competitiveness workshop. 28 August 2003. http://www.eppo.go.th/admin/moe-workshop1/energystrat2.zip

Contrary to your claims, we never asserted that EGAT was obligated to provide 8 percent of *incremental capacity* as renewable energy. We wrote (page 3, 31 March) that Thailand has adopted a target of 8% of *total (commercial) energy* come from renewable energy by year 2011. This target is one of the pillars of Thailand's current energy strategy. The strategy (and the 8% policy) are clearly discussed, in English, in one of Thailand's key energy policy documents: "Energy Strategy: Energy for Thailand's Competitiveness". The document was released at 28 August 2003 at a workshop held by the Ministry of Energy, and presided over by Prime Minister Thaksin Shinawatra. It is available online from the website of the Thai Energy Planning and Policy Office (EPPO).[24] If you are not aware of this key energy sector document, as your response to our letter seems to indicate, then this is both tragic and astonishing given the role of the World Bank in energy in Thailand.

As discussed in Dr. Du Pont's study there are a number of policies that will be used to achieve this 8% target, including (but not limited to) the EGAT's 5% renewable portfolio standard. Other key measures for electricity include feed-in tariffs, capacity subsidies, and tax reductions. In addition, significant measures are planned for transportation and industrial heating. We note that the government has allocated US$412 million to meet the 8% target.

Finally, you state that "capacity that requires programming and subsidies is generally – by definition – uneconomic, and this is, after all, an economic analysis." We wonder how you consider NT2 in light of this comment. Do not the World Bank political risk guarantees and grants valued at up to US$270 million for NT2 constitute a subsidy?

5. Omission of Committed Plants and Overestimation of Plant Retirements

In our previous letter we explained that the April 2003 version of the *Power Development Plan (PDP)* upon which the NT2 economic appraisal is based was never approved by the Thai government. The official *2004 PDP*, which calls for 4,098 MW more capacity additions than NT2 version, provides a much more realistic basis for assessing Thailand's power plant investment decisions. The *2004 PDP* was issued in August 2004 – plenty of time for inclusion in the *RELC* (released in March 2005). We are still awaiting an explanation of why the *RELC* ignored an officially approved PDP in its "revisitation of all major assumptions".

But, as we have pointed out before, the *RELC* does not follow even the *April 2003 PDP* that it purports to follow. The *RELC* omits, without explanation, plants that are clearly identified in the *April 2003 PDP*[25]. These plants comprise Songkla CCGT[26] (700 MW, to be commissioned in 2008), North Bangkok CCGT (700 MW commission 2009), South Bangkok CCGT (700 MW, commission 2009) and Bang Pakong CCGT (700 MW,

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24 See: http://www.eppo.go.th/doc/strategy2546/strategy.html

25 EGAT 2003. Power Development Plan (in Thai). April. p 41.

26 identified in April PDP 2003 as "Southern"

commission 2010). These omissions are beneficial to a positive economic appraisal of NT2 because they open up (false) demand for new generation that NT2 conveniently fills.

We have spoken with a number of planners at EGAT who assure us that EGAT considers all of four of these plants "committed", not "candidates". The Songkla plant has been approved by the Thai Cabinet, and construction is scheduled to start this year and to be completed in 2008.[27]

You argued in your 8 April letter that "Were [Songkla] to be included, it would reduce both the with and without NT2 Base Case additions by 700 MW; in other words there would be no effect on the net benefits of NT2."

This statement is true but of little relevance. The *RELC* positive economic appraisal of $188 million "savings" from NT2 is a risk-adjusted result. Your study methodology requires you to include a 25% weighted probability of a Low Demand scenario. The relevant question is not "what will the impact be on the Base Case" but obviously, "what will the impact be on the study's final result – the probability-weighted real cost-risk analysis of the "savings" of the "with NT2" scenario."

In the event that future demand for electricity in Thailand is low, constructing NT2 would mean that these power plants lie idle for longer than they would if NT2 were not built, accruing costs but not providing benefits. The Bank's economic appraisal of NT2 considers a scenario in which electricity demand is low, but it fails to include these power plants. Including just one of these "omitted but committed" power plants, Songkla, would reduce overall NT2 economic savings by another US$20 million.[28] The calculations also hold for the commercial assessment: $20 million of the projected "with NT2" US$145 million commercial savings is due to omitting Songkla in a low demand scenario.

Similarly, your response regarding the plant retirements is unacceptable. The *RELC* claims to follow the April 2003 PDP, but *RELC* treatment of plant retirements is not consistent with their treatment in this same PDP. The 2003 PDP treats all "plants planned for reconditioning" as "plants planned for reconditioning", not as "retirements and *candidates* for reconditioning". The distinction is important because interpreting the 2003 PDP as the *RELC* does creates false opportunities to retire more plants to make way for NT2 capacity.

Note – the impact of these omissions would increase substantially if the *RELC* did not also ignore the additional achievable DSM and renewable energy discussed above in section 3 of this letter.

6. False claims about analyzing only downside risks

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[27] Bankok Post. (2005). "Gas-fired power plant gets cabinet approval" 8 June. Page 5.

[28] Calculations and references at: www.palangthai.org/docs/NT2EconMalfeas.xls on the worksheet "Omitted Songkla"

We must also register a complaint concerning false claims in the presentation of the methodology and results of the Final RELC. The executive summary states, "It was decided to focus the cost-risk analysis for the current study only on the *downside risks to NT2* [emphasis in original]. Specifically, the analysis was limited to the base case and those cases which could be expected to pose the greatest test to project viability, i.e., conditions of lower than expected demand, lower than expected fuel prices, and *higher than anticipated NT2 capital costs* [emphasis added]." (*RELC,* page iii) The executive summary concludes that "The economic evaluation, based on a probability-weighted real cost-risk analysis of *downside risks* [emphasis added], indicates a real savings… on the order of US$188 million will accrue to the region over the lifetime of the plant." (*RELC,* page vii)

Reference was made to the "*downside risks*" claim 15 times throughout the study, with five of these claiming that cost-risk assessment modeling was *limited to consideration of the downside risks to the NT2 project*[29]. There are five explicit statements that the analysis considers only NT2 capital costs that are base case values or higher than anticipated (*RELC* page iii, page 40, page 48, page 54, page 68). The statements are integrated into the text in a variety of locations and demonstrate rephrasing in different words.[30]

Yet Table S-1 (*RELC* page v) and Table 24 (*RELC* page 55) clearly shows that the Bank based its risk assessment on the assumption that construction costs could be "low", yielding an economic windfall for the "with-NT2" scenario. Low construction costs are applied in 9 of the *RELC's* 27 scenarios, and in each case they lead to a $205 million greater "savings" than base case construction cost scenarios. Because the study methodology assumes that the probability of "low construction cost" occurrence is 25% this means that US$51.25 million of the US$188 million "risk adjusted NT2 savings" is attributable to this upside "risk".

This is particularly relevant when one considers that the assumption of a 25% probability of a "30% lower than expected construction cost" scenario conflicts with most published research on this topic. One of the most cited studies is a World Bank study performed by Bacon et al (1996). The comprehensive study investigates 70 hydropower projects financed by the World Bank between 1965 and 1986 and finds that the estimated values for costs were significantly biased below actual amounts, and that average cost underestimation for hydropower projects was 27 percent.[31]

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[29] These occurrences are easily verified by doing a search of the *RELC* document in Adobe Acrobat using the keyword "downside".

[30] See for example differences in wording between references to claimed understatement of NT2 benefits due to omission of low construction cost scenarios on *RELC* pages iii, 40, 48 and on pages 54 and 68.

[31] Bacon R.W. et al (1996) "Estimating construction Costs and Schedules. Experience with Power Generation Projects in Developing Countries" World Bank Technical Paper No.325, WB, Washington D.C. Page 53. Available at: http://www-wds.worldbank.org/servlet/WDS_IBank_Servlet?pcont=details&eid=000009265_3961219094408

The World Commission on Dams report (2000) cites a number of other studies with similar (and generally more pronounced) results: large dam projects usually have cost overruns, and seldom come in under cost. The WCD study calculates that an aggregation of the results of all of the studies yields an average cost overrun for 248 large dam projects of 54%.[32] Specifically regarding construction cost estimates in the economic appraisal of NT2, a 1999 World Commission on Dams draft study notes, "Indeed, it could be argued that 30 percent cost overruns should be the base case and pessimistic scenarios assume even higher cost overruns."[33]

Given the historical record, we think that it is very questionable to have included this windfall "low construction cost" scenario as having a 25% probability of occurrence in the modeling. But it is much worse to have included it in the *RELC* modeling while repeatedly claiming it was excluded.

The *Project Economic Analysis* is guilty of similar treatment of scenarios. Its list of "downside risk cases" include one in which NT2 construction cost is low and all other assumptions are at their base-case values (*Project Economic Analysis*, page 16). At the same time, the considered "downside cases" inexplicably omits scenarios like "high construction cost, low demand, high gas price" which by inspection are highly likely to yield negative results. In the commercial analysis, the report contains a mathematical error that results in understatement of project commercial risk (100% - 12.5% - 6.3% "=" 87%.) (page 17). We note that fixing these errors would be futile without first addressing the erroneous assumptions discussed in the rest of this letter, since correct values for these will substantially increase the number of negative outcome scenarios for NT2.

In a related issue, the repeated claims in the *RELC* of "understating NT2 benefits" by leaving the "high demand" scenario out of the modeling are over-advertised. Comparison of "high demand" and "base case demand" scenarios in the *RELC/2004* show limited increased economic savings from NT2 in a high demand scenario. Results from the high demand scenario in the *RELC/2004* show a modest increased savings of US$22 million over the base case.[34] This translates into a barely noticeable $5.5 million increase in the "with NT2" risk-adjusted result. By comparison, the low demand case (even ignoring Songkla and other omitted committed EGAT plants) is very costly for the "with NT2" scenario in the *RELC* and *RELC/2004*. The difference between the *RELC* low demand

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[32] World Commission on Dams (2000). Chapter 2: Technical, Financial and Economic Performance. *The Report of the World Commission on Dams*. WCD. London, Earthscan Publications Ltd. Page 41. Available at: http://www.dams.org/report/contents.htm

[33] McKenney, B., M. Manion, et al. (1999). World Commission on Dams: Thematic Review III.1: Economic and Financial Issues Financial, Economic and Distributional Analysis: Version 1 – Draft. Page 40. http://www.dams.org/docs/kbase/thematic/drafts/tr31_draft_ver1.pdf

[34] Present value US$299 million savings in high demand case vs. US$277 million savings in base case demand. *RELC/2004* page 49.

and base case demand is $242 million.[35] Considering the 25% probability of this scenario in the *RELC* modeling, impact on the *RELC* final result is US$60 million – eleven times higher than the projected impact of high demand scenario.

This extreme difference between the impact of low and high demand scenarios arises because NT2 is fully utilitized in the base case and there is limited opportunity for further benefits due to increased load in the high demand case. In the low demand case, however, NT2 leads to considerable (and costly) excess generation capacity. The *RELC* does admit this, but only once, on page 54. This does little for readers who only get as far as the executive summary, where they are exposed to three statements (page vi footnote 6, page vii footnote 7, and page viii) that proclaim that leaving out the high demand scenarios understates the economic advantage of NT2. At the very least, the author of the *RELC* should have added a caveat in the executive summary that explains that symmetrical inputs in the high and low demand scenarios yield highly asymmetrical outputs, and that high demand scenario NT2 savings are nearly equal to base case numbers.

7. *On the cost of natural gas after year 2014*

Thank you for clarifying (in your 8 April 2005 letter) the use of the US$3.65/mmbtu natural gas price in the *RELC* version of the study. Needless to say, a better job could have been done with the treatment of this crucial[36] variable in the text of the report. It was particularly confusing that the value of this variable used in the economic least cost analysis is *not* shown in any table in the entire report. Yet a value for the variable *not* used in the economic least cost analysis *is* shown in a table (Table 15) in the Chapter titled "System Supply Assumptions".

The fact that the values of key variables for natural gas (the capital costs for both CCGT and GT) stated in the text of the final *RELC* were wrong[37] further eroded our confidence in the mention in the text of the post-2014 natural gas values on page 90 and the somewhat elliptical mention on page 30.

8. Gas assumptions

We are concerned about assumptions behind calculation of economic costs of natural gas. We find it inconsistent that profits to natural gas companies selling Burmese natural gas to Thailand are included in the economic cost of natural gas, whereas profits to the NTPC hydroelectricity company selling Lao hydropower to Thailand are excluded from the economic cost of NT2 electricity. In other words, the definition of "region" in the

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35 See *RELC* page 64. Present value economic savings of $24 million in low demand case versus $266 million savings in base case. *RELC* page 49. The difference is even more pronounced in the commercial analysis which concludes that savings "with NT2" are negative would come at a present value $32 million *cost* in a low demand scenario, compared with $266 million savings in the base case scenario.

36 We calculate that a 61% increase in post-2014 natural gas prices would be worth present value $148 million to $153 million of "savings" in a "with NT2" scenario.

37 The text of the Final *RELC* erroneously refers to capital costs of natural gas CCGT and GT at their *RELC/2004* values and never at their escalated *RELC* values. *RELC*, page 28.

"regional analysis" is inconsistent, resulting in higher natural gas cost estimates, which in turn support a positive NT2 appraisal. We also find it strange that PTT's marketing margin is also included in the economic cost of natural gas, since this appears to be a transfer rather than a cost.

Conclusions

The *RELC* and *Project Economic Analysis* contain a number of erroneous assumptions and false statements. All in all, our calculations show that the erroneous assumptions contribute at least present value US$170 million towards the RELC calculated present value US$188 million economic savings in a "with-NT2" scenario. The false statement accounts

Erroneous assumptions

- Massive escalation O&M costs for CCGT in Final *RELC* (released just one week prior to Bank approval of NT2)
  - more than double highest international benchmark values
  - no discussion in text
  - discernable only through inspection of tables written in 6-point and 5.5-point font
  - accounts for $99 to $111 million of "NT2 savings"
- Unequal valuation of NT2 & Theun Hinboun firm electricity
  - Violates economic principle of equal valuation for identical substitutes
  - No mention of this variable or its value in *RELC*.
  - Accounts for $51 to $63 million of "NT2 savings"
- 0% inclusion of results from World Bank-commissioned study on DSM/RE in Final RELC
  - Final *RELC* tables showing DSM assumptions and demand assumptions unchanged from *RELC/2004* values even after DSM/RE study finds substantial additional DSM and renewables are achievable at lower cost than NT2.
  - Difficult to assess impact without access to study spreadsheets. World Bank calculates substantial ERR reduction.
- Omission of Committed Plants and Overestimation of Plant Retirements
  - Failure to use PDP approved by government despite official release 7 months before *RELC* submitted
  - Omission of 2800 MW of committed EGAT generation from *outdated 2003 PDP* in NT2 "version" of PDP.
  - Omission includes Songkla 700 MW, which has already been approved by Cabinet
  - Accounting for "omitted committed" Songkla alone accounts for $19.5 million of "NT2 savings". Others would be more.

False statements

- The *RELC* claims a dozen times that economic cost-risk assessment modeling was *limited to consideration of the downside risks to the NT2 project*. Four of these occurrences explicitly state that analysis considers only NT2 capital costs that are

base case values or "higher than anticipated". These claims are shown to be false by inspection of Table S-1 and Table 23 (both in 6.5-point font) which show that inclusion of "low construction cost" scenario adds US$51.25 million to risk-adjusted NT2 economic "savings".

As we have done from the start, we urge you to consider an independent investigation into the irregularities in the NT2 economic appraisal, and to reconsider the role of the World Bank in the NT2 project. It is not too late to correct these errors and evaluate the project on its true merits. If this results in a cancellation, it is still likely to be better than committing Thai ratepayers to paying for an economically inferior choice. Investors are affected as well, as many of these assumptions strongly inflate the commercial appraisal of the project.

Sincerely,

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