

**Technical Review**  
**of**  
**The World Bank's**  
*Nam Theun 2 Hydro Power Project Regional Economic Least-Cost Analysis*  
*Draft Final Report*<sup>1</sup>

**And**  
*Nam Theun 2 Project Economics Interim Summary Report*<sup>2</sup>

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According to World Bank guidelines, the World Bank must demonstrate that the Nam Theun 2 Hydro Power Project is Thailand's and Lao's least-cost option for expanding power supply, in order for the project to be eligible for World Bank's financial assistance.<sup>3</sup>

This technical review examines the assumptions, methodology and findings of the World Bank's economic analyses using updated information obtained from the World Bank studies, the Electricity Generating Authority of Thailand, and the Government of Thailand. Based on my review, **the Nam Theun 2 project fails to pass the least-cost test.**

The review finds five main flaws with the World Bank's economic analysis of NT2 project, each of these is biased towards overestimating the economic attractiveness of the NT2 project:

1. the least-cost economic analysis failed to consider cleaner and cheaper supply options, such as demand-side management (DSM), energy efficiency, renewable energy and co-generation;
2. the study omitted a large amount of Thailand's committed domestic capacity addition from the analysis and used information that is now outdated;
3. the study imprudently adopted demand projections that have a high risk of over-estimating the actual demand;
4. the NT2 project cost used in the analysis is outdated; and
5. the assumption that the NT2 project would receive carbon credits worth \$1.91 million per year is not justified given that a separate study by the World Bank concluded that the NT2 project's green house gas benefits "may or may not be positive".

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Section I below discusses these flaws in detail. Section II presents the results of the least-cost analysis under corrected assumptions. Section III discusses findings from Section II in relation to the World Bank’s suppressed study of competitive alternatives to NT2.

**Section I. Five main flaws of the World Bank’s Economic Analysis**

***1. The analysis failed to consider cleaner and cheaper supply options***

The World Bank’s least-cost analysis considers only oil-fired thermal, coal-fired thermal, combined cycle and gas turbine as candidate alternatives to NT2. The analysis excludes demand side management, energy efficiency, renewable energy and co-generation (combined power and heat) which have been shown to be cost-effective, environmentally friendly and/or efficient ways to meet electricity demand.

A simple comparison of the price to EGAT of different electricity sources based on available information shows that these alternative options are very competitive and should NOT be excluded from the analysis. Table 1 below indicates that Nam Theun 2 is not least-cost. In fact, the price of Nam Theun 2 power is 290% more than the cost of EGAT’s program to reduce demand through energy conservation measures and 14 percent higher than the most commercially attractive and fuel-efficient fossil-fuel alternative: gas-fired combined cycle plants.

**Table 1: Price Comparison of Thailand’s Power Supply Alternatives**

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1. Agreed price for NT2 power	4.7* US cents per kilowatt-hour <sup>4</sup> 1.97 Thai baht/kW-h
2. Agreed price for power from newest gas-fired combined cycle plants	4.0 US cents per kilowatt-hour 1.7 Thai baht/kW-h <sup>5</sup>
3. Cost of reducing electricity demand via energy conservation programs implemented by EGAT	1.2 US cents per kilowatt-hour 0.5 Thai baht/kW-h <sup>6</sup>

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\* Note: Despite the high commercial cost of NT2 electricity, the *Interim Summary Report* claims that the *economic* cost of NT2 electricity is only 2.7 US cents per kWh (1.08 Thai baht/kWh) whereas they estimate economic costs of natural gas combined cycle at 3.8 US cents per kWh. The Bank’s justification of NT2 rests primarily on its claim of low *economic* cost electricity relative to other options. How can NT2’s economic costs be so much lower than natural gas when its commercial costs are considerably higher? We doubt the validity of these numbers. Unfortunately the World Bank has failed to provide details of these calculations despite repeated requests.

## ***2. The study omits committed capacity additions and is based on an outdated Power Development Plan***

The World Bank's *NT2 Regional Economic Least-Cost Analysis* compares two supply expansion scenarios: one with Nam Theun 2, one without Nam Theun 2. This comparison should be straightforward.

Instead, the World Bank inexplicably omits from its analysis 2,100 MW of committed upgrades at EGAT's existing power plants which were included in EGAT's April 2003 Power Development Plan (PDP). The World Bank analysis claims that it is based on this same April 2003 PDP.<sup>7</sup> By omitting EGAT's planned upgrades from the expansion scenarios, the World Bank presents a significant shortfall of capacity thereby exaggerating the need for the addition of 995 MW Nam Theun 2.

Furthermore, the government has since approved EGAT's new investment plan, PDP 2004<sup>8</sup>, with even more committed plants to be commissioned before 2010, the year that NT2 is planned to come on line. EGAT's planned capacity retirements have also changed (See Table 2 and Table 3). Though the PDP 2004 was issued in July 2004, a month after the least-cost study was completed, the World Bank did not release the study until October 2004. Due to the significant difference between PDP 2003 and PDP 2004, it would be expected that the World Bank would note or examine the impact of this new expansion plan on the economic analysis of NT2. The World Bank's *Interim Summary Report* which was dated 21 August 2004 fails to mention EGAT's new plan. In my analysis presented below in Section II, I both correct the World Bank's capacity omission and update the capacity addition and retirement plan according to EGAT's PDP 2004.

**Table 2: EGAT's Committed Plant Additions (after March 2003)**

As Assumed in NT2 Economics Study*			Actual (EGAT PDP 2004)**		
Plant	Capacity (MW)	Comm'n Yr (FY)	Plant	Capacity (MW)	Comm'n Yr (FY)
<b>1 EGAT Projects</b>	<b>1,307</b>		<b>1 EGAT Projects</b>	<b>3,762</b>	
Lam Takhong pumped storage	500	2003-04	Lam Takhong pumped storage	500	2003-04
Krabi Thermal #1	300	2003-04	Krabi Thermal #1	340	2003-04
Lan Krabu GT	122	2003-04	Lan Krabu GT	122	2003-04
Khanom CC	385	2007	Songkhla CC #1	700	2007
			South Bangkok CC #3	700	2009
			North Bangkok CC #1	700	2009
			Bangpakong CC #5	700	2010
<b>2 IPP Contracts</b>	<b>3,446</b>		<b>2 IPP Contracts</b>	<b>5,066</b>	
BLCP - Unit 1	673	2007	BLCP - Unit 1	673	2007
BLCP - Unit 2	673	2007	BLCP - Unit 2	673	2007
Gulf Power	700	2008	Gulf Power	1,400	2007-08
Union Power - Unit 1	700	2008	Ratchaburi Power - Unit 1	700	2008
Union Power - Unit 2	700	2009	Ratchaburi Power - Unit 2	700	2008
			Nam Theun 2	920	2010
<b>3 SPP contracts</b>	<b>197</b>	2003-05	<b>3 SPP contracts</b>	<b>220</b>	2003-07
<b>TOTAL</b>	<b>4,950</b>		<b>TOTAL</b>	<b>9,048</b>	
			<b>TOTAL without NT2</b>	<b>8,128</b>	

**Table 3: Schedule of Retirements (after March 2003)**

As Assumed in NT2 Economics Study*			Actual (EGAT PDP 2004)**		
Fiscal Year	Plant	Capacity Retired (MW)	Fiscal Year	Plant	Capacity Retired (MW)
2003			2003	Ratchaburi CC 1-3 (derated)	130
2004			2004		
2005			2005		
2006	South Bangkok 1	200	2006		
	South Bangkok 2, Khanom				
2007	TH	350	2007		
2008	Bang Pakong CC 1	380	2008		
2009	Bang Pakong CC 2	380	2009		
2010	South Bangkok 3	310	2010		
2011	South Bangkok 4	310	2011	Khanom TH 1	75
2012			2012		
2013	South Bangkok 5	310	2013		
2014	Bang Pakong TH	550	2014		
<b>TOTAL</b>		<b>2790</b>	<b>TOTAL</b>		<b>205</b>

Source: \* NT2 Hydro Power Project Regional Economic Least-cost Analysis: Draft Final Report, June 2004

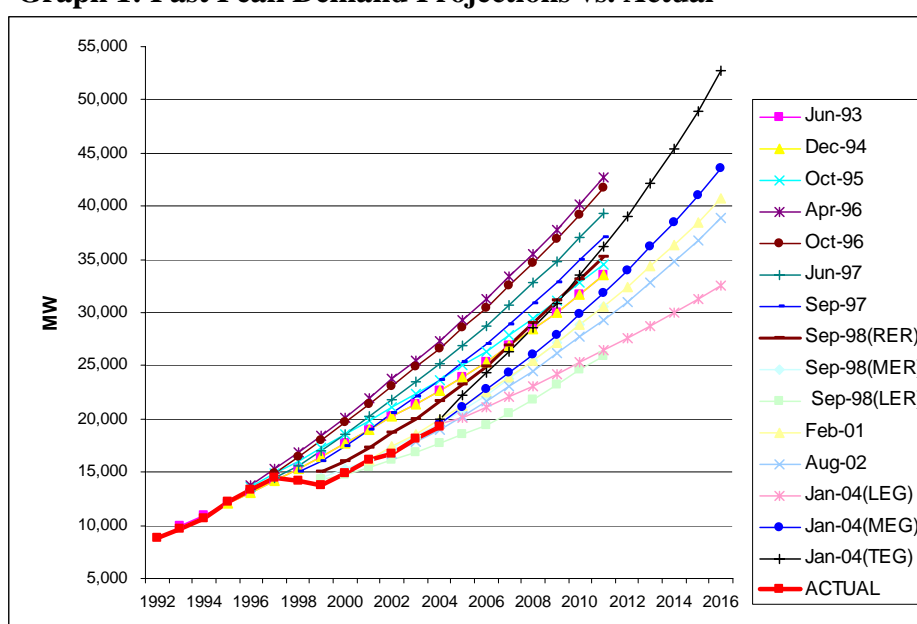
\*\* EGAT Power Development Plan (PDP2004), July 2004

### 3. The World Bank's study imprudently adopts demand projections that have a high risk of over-estimating the actual demand

The Bank's decision whether or not to support Nam Theun 2 requires making prudent assumptions about future electricity demand in Thailand. When demand forecasts are too high the considerable cost of unnecessary expansion or unnecessary power purchase commitments are passed on to consumers.

EGAT/the Thai government has a long history of making unreliable projections of future electricity demand, based on the government's overly optimistic predictions about economic growth (See Graph 1). This has meant increased costs passed on to consumers. Table 4 shows that in the utility's past 11 forecasts, 10 have overestimated demand, sometimes by as much as 40 percent.

**Graph 1: Past Peak Demand Projections vs. Actual**



**Table 4: Comparison between 2004 Actual and Projected Peak Demand under Different Forecasts**

Forecast name	Years elapsed since forecast	Forecast (MW)	2004 Actual - Forecast (MW)	Over-estimation (%)
Jun-93	12	22,690	3365	17.4%
Dec-94	10	22,690	3365	17.4%
Oct-95	9	23,654	4329	22.4%
Apr-96	9	27,330	8005	41.4%
Oct-96	8	26,645	7320	37.9%
Jun-97	8	25,171	5846	30.3%
Sep-97	7	23,685	4360	22.6%
Sep-98 (Base case)	6	19,611	286	1.5%
Feb-01	4	19,913	588	3.0%
Aug-02	2	19,029	-296	-1.5%
Jan-04	1	19,600	275	1.4%

Source of data: Thailand Load Forecast Subcommittee, *Report of Revised Demand Forecast*, January 2004

EGAT's latest 2004 forecast predicts high electricity demand growth that average 7 percent annually over the next 13 years. This figure is based on an optimistic prediction of Thailand's sustained economic growth of 6.5 percent annually for the next 13 years, as shown in Table 5.

**Table 5: EGAT's Latest Demand Forecast (January 2004) and Its Assumed GDP as Compared to Actual Historical Records**

Year	GDP growth rate (% per year)	Demand Growth		
		MW	Increase/year	
			MW	%
2004	6.5%	19,600	1,479	8.2
2005	6.5%	21,143	1,543	7.9
2006	6.5%	22,738	1,595	7.5
2007	6.5%	24,344	1,606	7.1
2008	6.4%	26,048	1,704	7.0
2009	6.4%	27,852	1,804	6.9
2010	6.6%	29,808	1,956	7.0
2011	6.5%	31,844	2,036	6.8
2012	6.5%	33,945	2,101	6.6
2013	6.5%	36,173	2,228	6.6
2014	6.4%	38,515	2,342	6.5
2015	6.5%	40,978	2,463	6.4
2016	6.4%	43,558	2,580	6.3
<b>Average (2004-2016)</b>	<b>6.5%</b>	<b>-</b>	<b>1,957</b>	<b>7.0</b>
<b>A c t u a l</b>				
<b>Avg. past 10 yrs (1995-2004)</b>	<b>3.3%</b>	<b>-</b>	<b>862</b>	<b>5.2</b>
<b>Avg. past 15 yrs (1990-2004)</b>	<b>5.2%</b>	<b>-</b>	<b>873</b>	<b>7.4</b>
<b>Avg. past 20 yrs (1985-2004)</b>	<b>6.2%</b>	<b>-</b>	<b>789</b>	<b>8.8</b>

A more prudent assumption about annual GDP growth would be 5.2 percent annually given that this was the actual average GDP growth rate for the past 15 years.<sup>9</sup> For year 2005 the Thai government has already backed away from its 6.5 percent prediction. The National Economic and Social Development Board of Thailand – generally the most upbeat source of economic projections -- expressed concern on March 8, 2005 that economic growth may fall below 6 percent in 2005<sup>10</sup>.

The World Bank's economic analysis was based on an earlier forecast (August 2002) which has the same forecasting methodology as the latest 2004 projections. My review uses the most recent forecast to be consistent with EGAT's PDP 2004 but revised the underlying economic assumption to be more realistic. In addition, because the Jan-04 forecast has already over-estimated the 2004 peak, I re-based the forecast to match the actual level and take into account the impact of EGAT's Peak Cut program in accordance with EGAT's PDP 2004. The results are shown in Table 6 (Please note that the demand presented here is EGAT's gross generation requirement.)

**Table 6: Revised Demand Forecast**

Year	Jan 04 Forecast		Recommended adjustments to Jan 04 forecast (MW)				Forecast (adjusted)
	Assumed per annum GDP growth rate	Peak demand (MW)	Use actual 2004 peak as base (19,326)	GDP growth = 5.2% (average past 15 yrs)	Peak Cut (according to EGAT's PDP 2004)	Total (MW)	Revised peak demand (MW)
2004	6.5%	19,600	-274	0	0	-274	19,326
2005	6.5%	21,143	-296	-304	0	-600	20,543
2006	6.5%	22,738	-318	-637	-500	-1455	21,283
2007	6.5%	24,344	-340	-990	-500	-1830	22,514
2008	6.4%	26,048	-364	-1361	-500	-2225	23,823
2009	6.4%	27,852	-389	-1771	-500	-2661	25,191
2010	6.6%	29,808	-417	-2278	-500	-3195	26,613
2011	6.5%	31,844	-445	-2804	-500	-3750	28,094
2012	6.5%	33,945	-475	-3367	-500	-4341	29,604
2013	6.5%	36,173	-506	-3983	-500	-4989	31,184
2014	6.4%	38,515	-538	-4626	-500	-5664	32,851
2015	6.5%	40,978	-573	-5348	-500	-6421	34,557

#### ***4. The NT2 project cost used in the analysis is outdated***

The June 2004 *Least-Cost Economic Analysis* was done based on the NT2 US\$1,069 million<sup>11</sup>. The August 2004 *Interim Summary Report* noted a US\$116 million (11%) increase of project cost but did not update the analysis.<sup>12</sup> The current figure stands at US\$1.3 billion<sup>13</sup>, representing an accumulated project cost increase of 22% that has not been accounted for in the Bank's economic analysis of NT2.

#### ***5. Adding carbon credit for NT2 is unjustified***

According to the *Least Cost Economic Analysis*, "the World Bank has requested that an environmental benefit – a "carbon credit" of \$3 per tonne Carbon of gas substitution – should be given to NT2 for its contribution to global greenhouse gas reduction". This "request" by the World Bank is not justified given that a separate study by the Bank, *Economic Analysis of the Environmental and Social Impacts of NT2*, concluded that the present value of these benefits "may or may not be positive"<sup>14</sup>. The annual \$1.91million carbon credit treated as a decrease in NT2's annual O&M cost should thus be removed.

## **Section II. Least-Cost Analysis under Revised and Updated Assumptions**

To remove the bias in the World Bank’s economic analysis of NT2, I re-did the World Bank least-cost base-case analysis (with and without NT2) based on the following revised assumptions:

**Table 7: Summary of revised assumptions in updated Least Cost Analysis**

<i>Flaw in World Bank economic analysis</i>	<i>Revised assumption</i>
Failure to consider cleaner and cheaper supply options	Insufficient data – unable to address this problem. World Bank assumptions retained.
Omitted committed capacity additions and use of outdated plan	Use committed capacity additions and retirements as per EGAT’s PDP 2004 but treat NT2 as a candidate supply option (consistent with the World Bank’s least-cost analysis framework)
Adoption of demand projections that have a high risk of over-estimating the actual demand	Use the adjusted Thai government/EGAT demand forecast as discussed above. <sup>15</sup>
NT2 project cost used in the analysis is outdated	Increase the NT2 capital cost (pro rata) to reflect the project cost increase to \$1.3 billion.
Addition of unjustified carbon credit for NT2	Remove carbon credit.

Because the World Bank has not made public the models and spreadsheets used in their calculations, it was necessary to make the following general assumptions in my calculations:

- NT2 is commissioned in FY2010 in the “with NT2” scenario
- Candidate plants are gas combined cycle (700 MW) and gas turbine (230 MW) with the same cost assumptions as in page 30 of the *Least Cost Economic Analysis*
- Planned capacity is added to maintain a minimum reserve margin of 15% through the planning horizon that ends in FY2014
- NT2 displaces gas-fired combine cycle generation at constant 5,357 GWh/year for 25 years
- The variable production cost of NT2 is its annual O&M cost while that of a gas combine cycle include fixed and variable O&M and fuel costs (page 30, *Least Cost Economic Analysis*)
- The comparison between the “with NT2” and “without NT2” scenarios focus on the difference between the capital costs of planned capacity additions of the two scenarios and the difference between the variable production costs of NT2 and gas combine cycle.
- The discount rate is 10% (consistent with the World Bank’s NT2 economic analysis framework)

The results of the revised base case expansion scenarios are presented in Table 8. It is worth noting that under the revised demand scenario and updated expansion plan (PDP 2004) Thailand would have a reserve margin of 27.9% in 2010 without Nam Theun 2. This means Thailand does not need the dam to maintain the minimum requirement of 15%



reserve. Adding the dam to the grid would thus be a burden, not a benefit, to Thai consumers.

**Table 8: Revised Least-Cost Analysis (Base Cases with and without NT2)**

Revised and updated assumptions				Revised base case with NT2					Revised base case without NT2				
Fiscal Year	Demand MW	Committed Plant		Installed MW	Planned additions			Reserve Margin	Installed MW	Planned additions			Reserve Margin
		Addition	Retirem't		CC	GT	NT2			CC	GT	NT2	
2003	17,350	8	(134)	25,422					25,422				
2004	18,809	989		26,352				40.1%	26,352				40.1%
2005	19,990	20		26,372				31.9%	26,372				31.9%
2006	20,702			26,372				27.4%	26,372				27.4%
2007	21,947	2,210		28,582				30.2%	28,582				30.2%
2008	23,283	2,800		31,382				34.8%	31,382				34.8%
2009	24,667	1,400		32,782				32.9%	32,782				32.9%
2010	26,186	700		34,477			995	31.7%	33,482				27.9%
2011	27,684		(75)	34,402				24.3%	33,407				20.7%
2012	29,210			34,402				17.8%	33,637		230		15.2%
2013	30,808			35,802	1,400	-		16.2%	35,737	2,100			16.0%
2014	32,491			37,432	1,400	230		15.2%	37,367	1,400	230		15.0%
<b>Total</b>					<b>2,800</b>	<b>230</b>	<b>995</b>			<b>3,500</b>	<b>460</b>		

The World Bank’s “regional economic least-cost analysis” concludes that the “with Nam Theun 2” scenario represents an economic “savings” of US\$277 million. With corrected assumptions, my analysis shows that the “with Nam Theun 2” scenario represents a net economic burden of US\$116 million. (Annex 1 shows the details of the calculations.)

<b>Cost Savings Due to Selecting Nam Theun 2</b>	
<b>Difference in Accumulated Present Value (US\$ million)</b>	
<b>According to <i>NT2 Regional Economic Least-Cost Analysis</i></b>	<b>277</b>
<b>Revised assumptions based on updated information</b>	<b>-116</b>

### **Section III. The World Bank’ Suppressed Analysis of Competitive (and Environment-Friendly) Alternatives to Nam Theun 2**

The World Bank’s disclosure policies apparently do not apply to information that would weaken its case for financing Nam Theun 2. A 2004 report commissioned by the World Bank to compare the cost and potential of renewable energy and energy conservation options to NT2 has been suppressed for months by the World Bank, despite requests by citizens groups for its disclosure.

A leaked draft<sup>16</sup> indicates that the potential from these available alternative sources is more than triple the capacity of NT2 and could be financed and installed for 25 percent less cost. See Table 8 below. At Baht1.56/kWh, DSM/EE/RE is also cheaper than electricity from gas-fired combined cycle plant (Baht1.70/kWh). NT2 would displace cleaner and cheaper DSM/EE/RE, not gas combine cycle.

NT2 is NOT the least-cost option, even when evaluated in the flawed framework of the WB economic analysis (NT2 displaces gas-fired combined cycle plants and other alternative options excluded). If alternative options are considered, the economic burden of building NT2 greatly exceeds \$116 million.

**Table 9: Comparison of Resource Availability and Price of Different Electricity Sources**

Resource Type	Amount of resource in 2011		Weighted avg cost (THB/kWh)
	Energy (Gwh/yr)	Peak (MW)	
<b>NT2</b>	<b>5,636</b>	<b>995</b>	<b>2.06</b>
<b>Natural Gas Combined Cycle</b>	N/A	N/A	<b>1.70*</b>
DSM/EE	11,468	2,259	1.25
Renewable Energy	5,400	1,380	2.21
<b>Total DSM/EE/RE</b>	<b>16,868</b>	<b>3,639</b>	<b>1.56</b>
<b>Amount of DSM/EE/RE not included in PDP2004</b>	<b>6,264</b>	<b>1,990</b>	<b>1.56</b>

**Source:** All data, unless otherwise noted, is taken from *NT2 Impact of Energy Conservation, DSM and Renewable Energy Generation on EGAT's PDP*, 28 August 2004

\*EGAT official (equal to the levelized price of power purchase from gas IPP)

## References

- 1 RV Consulting Economist, June 2004. <http://siteresources.worldbank.org/INTLAOPRD/491761-1094074854903/20251513/Economic.pdf>
- 2 Mark Segal, 21 August 2004. [http://siteresources.worldbank.org/INTLAOPRD/Projects%20and%20Operations/20246496/Consultations\\_2004\\_Economics.pdf](http://siteresources.worldbank.org/INTLAOPRD/Projects%20and%20Operations/20246496/Consultations_2004_Economics.pdf)
- 3 World Bank subsidies would include a partial risk guarantee to protect the Nam Theun 2 Power Company's international shareholders and investors from certain financial risks associated with investing in Lao PDR, and a series of soft loans to cover a portion of the project's resettlement and environmental costs.
- 4 Segal, *Interim Summary Report*, 2004, page 11.
- 5 Equal to EGAT's avoided cost or the levelized purchase price of electricity from a recently negotiated gas-fired IPP.
- 6 Phumaraphand, N. (2001). Evaluation Methods and Results of EGAT's Labeling Programs. Lessons Learned in Asia: Regional Conference on Energy Efficiency Standards and Labeling. Organized by Collaborative Labeling and Appliance Standards Program (CLASP) and the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP). Bangkok, Thailand. Download from: [http://www.un.org/esa/sustdev/sdissues/energy/op/clasp\\_egatppt.pdf](http://www.un.org/esa/sustdev/sdissues/energy/op/clasp_egatppt.pdf)
- 7 RV Consulting Economist, page. 23.
- 8 EGAT Power Development Plan 2004-2015 (PDP 2004), July 2004.
- 9 For years prior to 2003, see: Bank of Thailand (2005). Key Economic Indicators. [http://www.bot.or.th/bothomepage/databank/EconData/Thai\\_Key/Thai\\_KeyE.asp](http://www.bot.or.th/bothomepage/databank/EconData/Thai_Key/Thai_KeyE.asp). Year 2004 growth was 6.1%. Theparat, C. and P. Chitsomboon (2005). NESDB warns of under-6% GDP, Bangkok Post. March 8.
- 10 Theparat and Chitsomboon (2005). NESDB warns of under-6% GDP, Bangkok Post. March 8.
- 11 Derived from Segal, *Interim Summary Report*, pages 5-6.
- 12 Ibid., page 5.
- 13 The US\$1.3 billion figure is the most recent estimate of the project's cost reported in the media (See for example, Kevin Rafferty, "Green Light for Nam Theun 2" *Business Day*, 27 February 2005; and Amy Kazmin and Andrew Balls, "Dam Project in Laos Acts as Test Cast for the World Bank" *Financial Times*, 17 February 2005.
- 14 Dr. Benoit Laplante, 7 February 2005, page 8. [http://siteresources.worldbank.org/INTLAOPRD/147273-1092045101973/20377067/e-s\\_economic\\_analysis.pdf](http://siteresources.worldbank.org/INTLAOPRD/147273-1092045101973/20377067/e-s_economic_analysis.pdf)
- 15 to be consistent with the World Bank's least-cost analysis framework I converted the gross demand to net demand and added 75 MW Lao load
- 16 *Nam Theun 2 Hydropower Project (NT2) Impact of Energy Conservation, DSM and Renewable Energy Generation on EGAT's Power Development Plan (PDP) Final Report prepared for the World Bank*, 28 August 2004

## **Annex 1**

Details of calculations of

- Capital costs of “with NT2” and “without NT2” scenarios
- Variable production cost of NT2 vs. gas combined cycle plant

Capital cost of NT2				PV of Total Capital Cost		
Unit: US\$ million				Unit: US\$ million		
Source/Date	Total project cost	% Increase	Total PV of cost	PV of Capital Cost	With NT2	Without NT2
Regional Least-cost Analysis (Jun04)	1,069	-	581.40	CC & GT	536	697.51
Interim Summary Report (Aug04)	1,185	10.9%	644.77	NT2	707	-
News e.g. FT (Feb05)	1,300	21.6%	707.27	Total	1,244	697.51
				Savings due to selecting NT2		(546.11)

Pro-rata increase based on total project cost

Assumption: NT2 total PV cost is increased pro rata to reflect the increased project cost

Capital Cost of GT & CC															
MW Cap cost	GT	CC	With NT2						Without NT2 (gas)						
	2012	2012	GT1-2012	GT1-2014	CC2-2013	CC3-2014	Total	PV	GT-2012	GT-2014	CC-2013	CC-2014	Total	PV	
	230	700	0	230	1400	1400			230	230	2100	1400			
	250	450	0	57.5	630	630			57.5	57.5	945	630			
	\$/kW	\$/kW	\$ mill	\$ mill	\$ mill	\$ mill	\$ mill	\$ mill	\$ mill	\$ mill	\$ mill	\$ mill	\$ mill	\$ mill	
2009		16.6%													
2010	41.6%	34.4%			104.58		104.58	51.11	23.92		156.87		180.79	88.36	
2011	49.6%	37.9%			216.72	104.58	321.30	142.75	28.52		325.08	104.58	458.18	203.57	
2012	8.8%	11.1%		23.92	238.77	216.72	479.41	193.63	5.06	23.92	358.16	216.72	603.86	243.90	
2013				28.52	69.93	238.77	337.22	123.82		28.52	104.90	238.77	372.19	136.66	
2014				5.06		69.93	74.99	25.03		5.06		69.93	74.99	25.03	
							Total	1,317.50	536.35				Total	1,690.00	697.51

**Variable Production (Energy) Cost**

**Assumptions:** 1. NT2 displaces gas-fired CC generation at constant 5,357 GWh for 25 years  
 2. Remove \$1.91 million/yr carbon credit from NT2's O&M cost  
 3. Gas CC energy costs include fixed and variable O&M and fuel costs

**Unit: USD million**

NT2			CC		
Output/yr	5357	GWh	FOM	16.8	\$/kW/yr
Commission yr	2010			995	MW
O&M	16.28	\$million/yr	VOM	0.0004	\$/kWh
CO2 credit	1.91	\$million/yr	heat rate	7000	btu/kWh
Total O&M	18.19	\$million/yr			

PV of Total Energy Cost	
NT2	88.76
CC	519.03
NT2 Savings	430.26

Unit: USD million		NT2		CC					
Year	Discount	O&M	PV(O&M)	FOM	VOM	Fuel price	Fuel cost	Total	PV total
<b>Total</b>			<b>88.762912</b>						<b>519.02569</b>
2003	1.05								
2004	1.155								
2005	1.2705								
2006	1.39755								
2007	1.537305								
2008	1.691036								
2009	1.860139								
2010	2.046153	18.19	8.890	16.716	2.250	2.290	85.873	107.129	52.356
2011	2.250768	18.19	8.082	16.716	2.250	2.280	85.498	106.744	47.425
2012	2.475845	18.19	7.347	16.716	2.250	2.270	85.123	106.359	42.959
2013	2.72343	18.19	6.679	16.716	2.250	2.260	84.748	105.974	38.912
2014	2.995773	18.19	6.072	16.716	2.250	2.240	83.998	105.204	35.117
2015	3.29535	18.19	5.520	16.716	2.250	2.270	85.123	106.359	32.275
2016	3.624885	18.19	5.018	16.716	2.250	2.270	85.123	106.359	29.341
2017	3.987373	18.19	4.562	16.716	2.250	2.270	85.123	106.359	26.674
2018	4.386111	18.19	4.147	16.716	2.250	2.270	85.123	106.359	24.249
2019	4.824722	18.19	3.770	16.716	2.250	2.270	85.123	106.359	22.045
2020	5.307194	18.19	3.427	16.716	2.250	2.270	85.123	106.359	20.040
2021	5.837913	18.19	3.116	16.716	2.250	2.270	85.123	106.359	18.219
2022	6.421704	18.19	2.833	16.716	2.250	2.270	85.123	106.359	16.562
2023	7.063875	18.19	2.575	16.716	2.250	2.270	85.123	106.359	15.057
2024	7.770262	18.19	2.341	16.716	2.250	2.270	85.123	106.359	13.688
2025	8.547289	18.19	2.128	16.716	2.250	2.270	85.123	106.359	12.444
2026	9.402018	18.19	1.935	16.716	2.250	2.270	85.123	106.359	11.312
2027	10.34222	18.19	1.759	16.716	2.250	2.270	85.123	106.359	10.284
2028	11.37644	18.19	1.599	16.716	2.250	2.270	85.123	106.359	9.349
2029	12.51409	18.19	1.454	16.716	2.250	2.270	85.123	106.359	8.499
2030	13.76549	18.19	1.321	16.716	2.250	2.270	85.123	106.359	7.726
2031	15.14204	18.19	1.201	16.716	2.250	2.270	85.123	106.359	7.024
2032	16.65625	18.19	1.092	16.716	2.250	2.270	85.123	106.359	6.386
2033	18.32187	18.19	0.993	16.716	2.250	2.270	85.123	106.359	5.805
2034	20.15406	18.19	0.903	16.716	2.250	2.270	85.123	106.359	5.277