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DISCUSSION PAPER

CDM Baseline Construction for Vietnam National Electricity Grid

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295

Hamburgisches Welt-Wirtschafts-Archiv (HWWA)
Hamburg Institute of International Economics
2004
ISSN 1616-4814

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This paper profited from a short stay by Tran Minh Tuyen as a guest researcher at Hamburg Institute of International Economics in June 2004. We thank Dr. Nguyen Tien Nguyen from the Research Center for Energy and Environment and Dr. Bui Huy Phung from the Vietnamese Academy of Science and Technology (National Center for Natural Science and Technology of Vietnam) for valuable information.

Edited by the Department World Economy
Head: PD Dr. Carsten Hefeker

HWWA DISCUSSION PAPER 295
September 2004

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ABSTRACT

For projects under the Clean Development Mechanism (CDM), a baseline has to be set to allow calculation of the greenhouse gas emissions reductions achieved. An important obstacle to CDM project development is the lack of data for baseline definition; often project developers do not have access to data and therefore incur high transaction costs to collect them. The government of Vietnam has set up all necessary institutions for CDM, wants to promote CDM projects and thus is interested to reduce transaction costs. We calculate emission factors of the Vietnam electricity grid according to the rules defined by the CDM Executive Board for small scale projects and for large renewable electricity generation projects. The emission factors lie between 365 and 899 g CO_2/kWh depending on the specification. The weighted operating and build margin reaches 600 g for 2003, while grid average reaches 399 g. Using three-year averages, a combined build and operating margin of 705 g is calculated. We hope that these data facilitate CDM project development in the electricity supply and energy efficiency improvement in Vietnam.

Key words: CDM, baseline, electricity generation, Vietnam

JEL codes: D62, F18, Q25, Q41

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relevant Vietnamese institutions and analysis of the Vietnamese plans and regulations mentioning sustainable development. They shall make up for the fact that so far Vietnam did not have a general list of Sustainable Development objectives.

Table II.1: Criteria set for CDM project approval

a. Exclusive Criteria

<table>
<tr><th>Category</th><th colspan="2">Criterion Content</th></tr>
<tr><td rowspan="2">A. Sustainability</td><td colspan="2">A1. Be congruent with the national sustainable objectives</td></tr>
<tr><td colspan="2">A2. Meets the sectoral and provincial strategy objectives</td></tr>
<tr><td rowspan="4">B. Additionality</td><td rowspan="2">B1. Baseline</td><td>B11. For existed baseline project: All economical and technical indicators are in accordance with sub-sectoral business-as-usual (BAU). If indicators relevant to CDM are lower than BAU’s, it must be shown that, the own resources have been maximally mobilized for achieving present stage.</td></tr>
<tr><td>B12. For planned baseline project: All economical and technical indicators are in accordance with sub-sectoral BAU. If indicators relevant to CDM are lower than BAU’s, it must be shown that, all indicators are in medium regional level or Country’s environment regulatory requirements at the considered momentum.</td></tr>
<tr><td>B2. Emission Reduction</td><td>B2. GHG emissions from CDM projects must be less than that of the project baseline. Emission reductions should be measurable and verifiable</td></tr>
<tr><td>B3. Financial</td><td>B31. CDM’s financial source shall be additional to current obligations such as ODA, GEF...</td></tr>
<tr><td rowspan="2">C. Feasibility</td><td colspan="2">C1. The support of the government shall be secured.</td></tr>
<tr><td colspan="2">C2. Monitoring methodology and performance shall be clearly described.</td></tr>
</table>

I. Introduction

Vietnam is embarking on an active role in the international CDM market. To be an attractive host, the transaction costs for project developers have to be minimised. As determination of the baseline can be one of the most complex and costly parts of a Project Design Document, provision of baseline data plays an important role in increasing attractiveness to project developers. This paper provides data for all approved methodologies for projects that provide electricity to the grid. All data are referenced to the official sources, thus allowing to fully quote them in case an Operational Entity or the Executive Board requires to do so.

II. CDM institutions and approval criteria in Vietnam[1]

Vietnam fulfils all requirements to be a CDM host country. It has signed and ratified UNFCCC in 1994, signed the Kyoto Protocol in 1997 and ratified it on August 20, 2002. The ratification comes into force in September 25, 2002.

The Vietnamese government is highly interested in the climate change issue. It considers that the global warming due to anthropogenic greenhouse gases is a real threat and Vietnam is one of the most vulnerable countries. By participating in CDM, Vietnam wants to show its willingness to contribute to global environmental protection while looking for additional investment and for technology transfer.

In June 2003, the Vietnamese government designated the National Office for Climate Change and Ozone Protection (NOCCOP), part of the International Cooperation Department (ICD) of the Ministry of Natural Resources and Environment (MONRE) as CDM National Authority (CNA)[2]. Moreover, the CDM National Executive and Consultative Board was established in April 2003[3]. It is composed of government officials from MONRE, Ministry of Planning and Investment (MPI), Ministry of Science and Technology (MOST), Ministry of Finance (MOF), Ministry of Foreign Affairs (MOFA), Ministry of Industry (MOI), Ministry of Agriculture and Rural Development (MOARD), Ministry of Trade (MOT), Ministry of Training and Education (MOTE), and a representative from Viet Nam Union of Science and Technology Associations (VUSTA). The Board is chaired by the Director General of ICD, MONRE. It is responsible for approving project proposals and for the definition of project eligibility criteria.

CNA‘s functions are as follows:

- Undertake the administrative functions of the Board.
- Liaison with project developers and with the UNFCCC CDM Executive Board.
- Provide information related to CDM to interested investors and hosts companies, national and international operation entities, and consultants.

The Board has defined a detailed set of CDM eligibility criteria that consist of a set of exclusive criteria that have to be fulfilled by all projects and a set of further criteria that define the project’s importance. The latter have been identified after consultation with selected stakeholders in the

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[1] This section is based on Ministry of Natural Resources and Environment (2003).

[2] Contact address : Department of International Cooperation, MONRE, 83-Nguyen Chi Thanh Str., Hanoi, Vietnam, Tel: 84-4-8357910/Fax: 84-4-8352191

[3] Decision No. 553 by MONRE. Contact address : National Office for Climate Change&Ozone Protection, 57 Nguyen Du Str., Hanoi, Vietnam, Tel: 84-4-8228974/Fax: 84-4-8263847, E-mail: vnccoffice@fpt.vn

b. Priority Criteria for CDM projects in Vietnam

Category	Criterion content		
A. Sustainability	Economic Sustainability	National Income Generation	– Growth of national income. – CER revenues
		Economic Externalities	– Technology transfer – Import Substitution
	Environment Sustainability	Green House Effect	– GHG emission reduction
		Non GHG Air Pollution	– Non GHG Air Pollution emission – Non GHG water pollution
		Waste	– Waste generation rate
		Ecosystem	– % change in forest cover – Soil erosion – Likely effect on biodiversity
	Social and Institutional Sustainability	Poverty eradication	– Creation of rural employment – Reduction in number of boor households
		Quality of life	– People income – Improving of living conditions
		Readiness of Implementing Agencies	– Public sector – Private sector
B. Commercial Viability	International demand		
	Attractiveness to investors		
C. Feasibility	Get strong support from the central and local authorities and be more attractive for investor		
	Having adequate infrastructure and manpower		

Project developers that want to get approval by CNA have to submit a Project Idea Note (PIN) to CNA. The final template for the PIN remains be decided. Currently developers shall use the form developed by the Prototype Carbon Fund. If the PIN is found to fulfil the criteria, CNA issues an endorsement letter. On that basis, developers prepare the Project Document (PDD) according to the UNFCCC rules and submit it to CNA. Whether specific Vietnamese criteria will be set remains to be decided. The PDD will be then be validated against the criteria specified above by an advisory committee established by CNA. If found to fulfil the criteria, the CNA will issue the approval document and then developers can submit the PDD to the CDM Executive Board.

III. Current Energy and Electricity Consumption

As baselines for large-scale projects often need a description of the overall economic and energy situation of a host country, we give concise information about Vietnam's economy and general energy situation.

Table III.1. describes the economical development of Vietnam in the last decade, with detail for the last five years. The data source is government statistics unless noted otherwise.

Table III.1: Economic development

Indicators \ Year	1990	1992	1994	1996	1998	1999	2000	2001	2002	2003 (est.)
Population (million).	65.6	68.2	70.8	73.2	75.5	76.6	77.7	78.7	79.7	80.6
GDP (Bill.US$*)	14.0	16.1	19.0	22.7	26.0	27.3	29.0	31.6	34.4	37.1
Growth rate (%)	5.1	8.6	8.8	9.3	5.8	4.8	6.8	6.8	7.0	7.7
GDP/capita (US$)	213	236	268	310	344	356	379	402	431	460

*1995 US$.

III.1. Commercial Primary Energy Production.

Energy production has been developed quickly to provide a good infrastructure for socio-economic development. Especially electricity and oil and gas production are growing exponentially, see table III.2.

Table III.2: Commercial primary energy production.

Types \ Year	1990	1992	1994	1996	1998	1999	2000	2001	2002	2003 (est.)
Coal(million t)	4.64	5.31	6.37	9.74	11.4	9.39	10.8	13.0	15.0	18.1
Oil (million t)	2.70	5.50	7.07	8.80	12.6	15.2	16.3	16.7	16.6	18.0
Gas (Bill. m^3)	-	-	-	0.27	0.83	1.20	1.35	1.40	2.0	2.8
Hydro (TWh)	5.37	7.23	9.25	12.0	11.1	13.8	14.7	18.2	18.2	18.98

Due to the high increase rates of energy production, Vietnam has increasingly become an energy exporter, see table III.3.

Table III.3: Energy Im- and Export of Vietnam (million t oil equivalent)

Year / Product	1990	1992	1994	1996	1998	1999	2000	2001	2002	2003 (est.)
Oil product import	-3.11	-3.09	-4.73	-5.93	-7.19	-7.40	-8.75	-8.99	-9.96	-11.0
Oil export *	2.80	5.50	7.07	9.46	13.3	14.9	15.4	16.7	16.88	18.0
Coal export	0.44	0.71	1.21	2.07	1.64	1.83	2.11	2.78	3.70	4.05
Balance	+0.1	+3.1	+3.5	+5.6	+7.8	+9.3	+8.8	+10.5	+10.6	+11.05

* Crude oil and oil products

III.2. Electricity Production

Electricity production has more than multiplied by 4 since 1990, see table III.4.

Table III.4: Electricity Production (TWh)

Year	1990	1992	1994	1996	1998	1999	2000	2001	2002	2003 (est.)
Generation	8.69	9.70	12.28	16.94	21.66	23.56	26.68	31.37	36.05	40.93

Concerning the overall environmental impact of electricity generation, a positive trend can be seen with a strong increase of the gas share, and a reduction of oil. However, coal is increasing again after a decrease in the late 1990s (see table III.5.)

Table III.5. Share of generation sources (%)

Year / Source	1996	1997	1998	1999	2000	2001	2002	2003 (est.)
Coal fired	14.0	17.3	16.1	12.3	12.5	10.3	13.6	15.0
Gas fired	6.5	10.3	15.9	15.3	19.6	14.5	23.3	29.0
Hydro	70.9	61.0	51.2	58.4	55.4	58.4	51.0	46.4
Oil fired	8.6	11.4	11.4	8.1	4.3	10.0	6.1	4.0
Others-IPP	0	0	3.6	5.7	8.2	6.80	6.0	5.6
Total	100	100	100	100	100	100	100	100

Source: Vietnamese Academy of Science and Technology (National Center for Natural Science and Technology of Vietnam)

III.3. Final Commercial Energy Consumption

From table III.6 one can see that commercial electricity increases three times faster than electricity production. It is explained by the reduction of transmission loss which is a positive development. The share of electricity use in industry is falling; this is a negative trend. It reflects the industry modernization is not really completed. Electricity use in the household and service sector is rather high which makes it difficult to run the system and implement a full-cost electricity pricing.

Table III.6. Consumption and structure of commercial electricity (TWh).

Year / Sector	1990	1992	1994	1996	1998	1999	2000	2001	2002	2003 (est.)
Industry	2.84	3.2	3.94	5.5	6.78	7.57	9.09	10.4	12.64	15.21
Agriculture	0.59	0.97	1.36	1.87	2.19	0.57	0.43	0.48	0.55	0.56
Services	2.7	2.7	3.9	5.89	8.59	11.24	12.71	14.72	16.75	18.60
Transport	0.05	0.06	0.08	0.11	0.16	0.16	0.17	0.15	0.16	0.21
Total	**6.18**	**6.93**	**9.28**	**13.37**	**17.72**	**19.54**	**22.40**	**25.75**	**30.10**	**34.58**
Share, %										
Industry	46.0	46.2	42.5	41.1	38.3	38.7	40.4	40.4	42.0	44.0
Agriculture	9.5	14.0	14.7	14.0	12.4	2.9	1.94	1.90	1.80	1.6
Services	43.7	39.0	42.0	44.1	48.5	57.5	56.9	57.1	55.6	53.8
Transport	0.8	0.9	0.9	0.8	0.9	0.8	0.76	0.60	0.60	0.6
Total	100	100	100	100	100	100	100	100	100	100

Remark: The sharp fall in agriculture after 1998 is due to a change in statistical methodology

III.4. Some Energy Indicators.

III.4.1.Commercial Energy Intensity

In contrast to other developing countries such as China, energy intensity in Vietnam has been rising quickly. Therefore CDM projects that improve energy intensity will be welcome.

Table III.7. Commercial energy intensity

Indicators	**1990**	**1995**	**2000**	**2001**	**2002**	**2003 (est.)**
Final Energy/GDP, kgOE/US$*	0.30	0.34	0.47	0.49	0.52	0.55
Electricity consumption/GDP, kWh/US$	0.44	0.54	0.77	0.85	0.88	1.10

*1995 US$.

III.4.2. Efficiency parameters of electricity sector

The following table III.8 shows several efficiency parameters of the electricity system. While T&D losses could be reduced considerably, the efficiency of coal-fired power plants has been rather low but the trend of the latest years is encouraging.

Table III.8. Efficiency parameters of Vietnamese electricity system (%)

Norms \ Year	1990	1992	1994	1996	1997	1998	1999	2000	2001	2002
T&D losses	24.3	25.8	25.9	18.5	17.7	15.6	15.0	14.0	14.0	14.0
Self consumption	4.4	2.8	1.9	2.6	2.4	2.6	2.0	2.1	2.1	2.5
Eff. of coal fired power plants	16.4	19.4	-	22.8	23.3	23.2	23.4	24.0	25.0	30.0
Eff. of oil fired power plants	28.3	26.6	21.7	23.2	30.5	31.1	31.0	31.0	31.0	31.0
Eff. of gas fired power plants	-	-	-	36.9	34.7	38.4	39.0	39.0	40.0	40.5

Source: Vietnamese Academy of Science and Technology (National Center for Natural Science and Technology of Vietnam)

IV. Energy and Electricity Demand Projection up to 2020

To develop a baseline forecast, we look at Economic Development Scenarios developed by the Development Strategic Institute, Ministry of Planning and Investment before the year 2001 (see tables IV.1 and IV.2). The key assumptions are shown below.

Table IV.1: GDP growth rate.(%/year)

GDP growth is assumed to remain above 7% for the high case, but even the low case sees an average of above 6%. After 2010, growth rates decline somewhat.

Scenario \ Period	1996-2000	2001-2010	2011-2020	1996-2020
High	6.9	7.8	7.0	7.4
Base	6.9	7.2	6.5	6.8
Low	6.9	6.5	6.0	6.4

Population continues to grow by 10 million per decade, meaning that the rate declines slowly. GDP multiplies by three in the low case, quadrupling in the high case.

Table IV.2: Population and GDP

Year	2000	2005	2010	2015	2020
Population (million)	77.9	82.9	88.2	93.3	98.4
GDP(1995 price)					
High (Bill. US$)	28.98	43.04	62.66	87.88	123.29
Base (Bill. US$)	28.98	41.03	58.08	79.58	109.03
Low (Bill. US$)	28.98	39.73	54.35	72.74	97.35
GDP per capita					
High (US$/cap.)	372	519	710	942	1253
Base (US$/cap.)	372	495	658	853	1111
Low (US$/cap.)	372	479	616	780	989

IV.1. Total Final Energy Demand Projection

In the high case, energy demand quintuples, meaning that energy efficiency decreases consistently.

Table IV.3: Total final energy demand projection (million t OE)

Year / Scenario	2000	2005	2010	2015	2020
High	11.60	19.23	30.16	42.59	59.71
Base	11.60	17.72	26.24	36.49	50.25
Low	11.60	16.60	23.64	31.43	41.64

The industrial share in energy consumption increases while the share of transport falls. Whether this is realistic, remains to be seen. In most middle income countries transport energy use has grown over-proportionally.

Table IV.4: Structure of final energy consumption (%)

Year / Sector	2000	2005	2010	2015	2020
Industry	34.7	38.1	40.4	43.1	45.2
Agriculture	3.7	2.9	2.3	1.8	1.4
Transportation	39.8	38.0	37.4	36.0	35.1
Services & households	21.9	21.0	19.9	19.0	18.2
Total	100	100	100	100	100

IV.2. Electricity Demand Projection.

As expected, electricity use increases more quickly than energy use, multiplying by seven in the base case.

Table IV.5: Electricity consumption projection (TWh)

Scenario \ Year	2000	2005	2010	2015	2020
High	21.39	39.07	68.59	111.07	176.70
Base	21.39	37.15	61.57	95.75	146.56
Low	21.39	35.59	56.43	84.78	127.70

The share of industry rises considerably.

Table IV.6: Structure of electricity consumption by sectors (%)

Sector \ Year	2000	2005	2010	2015	2020
Industry	41.6	44.6	49.2	53.6	56.8
Agriculture	3.6	2.6	1.9	1.5	1.2
Transportation	0.6	0.5	0.5	0.4	0.4
Services & households	54.1	52.2	48.4	44.5	41.6
Total	100	100	100	100	100

The electricity consumption and generation are related to the loss factor, projected as follows:

Table IV.7: Transmission and distribution losses (%)

Year	2000	2005	2010	2015	2020
Loss	17.7*	13.9	12.6	12.5	12.3

Remark: The new data show that reality was better than projection. The loss in 2000 was about 15.5%

Table IV.8: Electricity generation projection (TWh)

Scenario \ Year	2000	2005	2010	2015	2020
High	26.7	46.57	78.47	126.95	201.4
Base	26.7	44.29	70.44	109.44	167.1
Low	26.7	42.42	64.55	96.90	142.2

IV.3. Total Primary Energy Demand(commercial).

If one looks at the share of the different fuels, in the high case gas use expands by a factor of 14, coal by a factor of 6 and oil by a factor of 4.

Table IV.9: Total primary energy demand (for domestic use only) (million t OE)

Scenario \ Year	2000	2005	2010	2015	2020
High					
Coal	4.18	6.33	9.91	12.46	26.58
Oil	8.42	11.42	17.61	23.87	32.62
Gas	1.00	4.55	7.73	12.47	14.87
Hydro	1.34	1.64	2.23	4.08	4.46
Geothermal	-	0.03	0.08	0.08	0.10
Total	14.94	23.97	37.56	52.96	78.63
Base					
Coal	4.12	5.81	8.70	9.48	18.00
Oil	8.35	10.43	15.32	20.20	26.88
Gas	1.00	4.20	6.47	10.10	14.14
Hydro	1.34	1.64	2.23	4.08	4.46
Geothermal	-	0.03	0.08	0.08	0.10
Total	14.81	22.11	32.80	43.94	63.63
Low					
Coal	4.05	5.26	7.59	8.23	11.12
Oil	8.07	9.63	13.49	17.20	22.31
Gas	1.00	4.13	6.35	10.10	14.14
Hydro	1.34	1.64	2.23	4.08	4.46
Geothermal	-	0.03	0.08	0.08	0.10
Total	14.46	20.69	29.74	39.69	52.13

V. Baseline Construction for Vietnam National Electricity Grid

V.1. Approved Methodology for Small Scale Projects

Due to the fear that transaction costs will be prohibitive for small projects (Michaelowa et al. 2003), more lenient rules have been decided for renewable energy projects below 15 MW capacity, energy efficiency projects that save less than 15 GWh per annum and other projects that annually directly emit less than 15,000 t CO_2. These simplified modalities were defined by the CDM Executive Board in January 2003, revised twice (UNFCCC 2004a) and define baseline rules. These rules define standard parameters.

The host country national electricity grid plays a decisive role and determines the baseline for all projects, that can substitute, cut-off or reduce the electricity consumption supplied from the grid such as:

- Grid-connected renewable energy projects.
- Power generation for self use to reduce electricity consumption from grid.
- Electricity saving, efficiency or DSM.

The rules specify (§ 29) that "the baseline is the kWh produced by the renewable generating unit or saved (§ 36, 50, 59, 67) multiplied by an emission coefficient (measured in kg CO_2 eq./kWh) calculated in a transparent and conservative manner as:

(a) The average of the "approximate operating margin" and the "build margin", where:

(i) The "approximate operating margin" is the weighted average emissions (in kg CO_2 eq./kWh) of all generating sources serving the system, excluding hydro, geothermal, wind, low-cost biomass, nuclear and solar generation;

(ii) The "build margin" is the weighted average emissions (in kg CO_2 eq./kWh) of recent capacity additions to the system, which capacity additions are defined as the greater (in MWh) of most recent 20%[4] of existing plants or the 5 most recent plants.;

or,

(b) The weighted average emissions (in kg CO_2 eq./kWh) of the current generation mix."

The operating margin (OM) is derived in two steps

$$E(tCO_2/year) = \Sigma_j E_j = \Sigma_j Q_J \, x \, F_j \quad (1)$$

where:

E_j is CO_2 emissions per year in tons for fuel j

Q_j is quantity of fuel j in year

F_j is CO_2 emissions per unit for each fuel j

$$OM(t\,CO_2/MWh) = \Sigma_j E_j \div \Sigma_j K_j \quad (2)$$

[4] If 20% falls on part capacity of a plant, that plant is included in the calculation.

where:

K_j is electricity generation from fuel j

The formula to calculate the build margin (BM) is:

$$BM(tCO_2/MWh) = \frac{\sum_j^m e_j.G_j}{\sum_j^m G_j} = \frac{e_1.G_1 + e_2.G_2 + ... + e_m.G_m}{G_1 + G_2 + ... + G_m}$$

(3)

where:

G_j : the generation (MWh) from unit j

e_j : the emission rate (in t CO_2/MWh) for unit j

j : invidual plants included among the selected representative set of plants

The idea of looking at OM and BM was developed by Kartha et al. (2002).

Therefore, we need the following data for the Vietnamese grid:

- Weighted average emissions of all thermal power stations for the most recent year (OM)
- Generation of most recent 20% of existing plants (G-BM1)
- Generation of 5 most recent plants (G-BM2)
- Weighted average emissions of the higher of the two generation levels for the most recent year (BM)
- Weighted average emissions of all power stations (grid average, GA)

For all power plants serving the national grid, detailed data on capacity, fuel used and fuel consumption are available for 2000, 2001 and 2002. Preliminary data are available for 2003. The big challenge is to keep these data up to date in the long term. As there is a very detailed plan for power supply expansion, we can estimate these numbers until 2010. For the period 2003 – 2010, the different parameters are calculated using the expansion plan of Energy of Vietnam (EVN) (Electricity of Vietnam 2002). The weighted average emissions of all thermal power stations for the most recent year (OM) and the weighted average emissions of all power stations (GA) can easily be calculated from the aggregated grid numbers. Here, the strong expansion of coal power plants leads to an increase in OM from 2007 onwards.

For calculation of the 20% of most recent plants, table V.1 is used.

Table V.1: Installed capacity and capacity additions

Year	Thermal MW	Additions from year to the next (fuel, MW)	Hydro MW	Additions (MW)	Total (MW)
2000		Phu My 1, gas, 720		Hing river, hydropower, 70	
2001	2932		3830	Ham Thuan, hydropwer, 300 MW Da Mi, hydropower, 175 MW Yaly, hydropower, 360 MW	6762
2002	3853	Pha Lai II, coal, 600, MW Steam tail of Phu My 1, 370, MW Steam tail 306-2 of Ba Ria, 56 MW	4069		7922

The capacity of the 20% recent plants for the year 2002 amounts to 1584.4 MW and includes the plants opened in 2002 as well as a subset of those opened in 2000. The capacity of the 20% recent plants for the year 2001 amounts to 1352.4 MW and includes all plants opened in 2001. The generation of the last 20% (G-BM1) and the generation of the last five plants (G-BM2) compares as follows:

Table V.2: Calculation of the build margin for 2001 and 2002

End of year	Grid cap., MW		Last five plants		Last 20% plants		Build Margin (BM)		
	Total	20%	Plant	MW	Plant	MW	GWh	kt CO_2	gCO_2/kWh
2001	6762	1352.4	1. Da mi, hydropower	86	1. Da mi, hydropower	86	401		**102**
			2. Ham Thuan, hydropower	150	2. Ham Thuan, hydropower	150	923		
			3. Yaly, hydropower	720	3. Yaly, hydropower	720	2975		
			4. Song Hinh, hydropower	70	4. Song Hinh, hydropower	70	441		
			5. Phu My 1, gas	720	5. Phu My 1, gas	720	1074	595	
			Total	**1746**	**Total**	**1746**	**5814**	**595**	
2002	7922	1584.4	1. Ba ria, gas	312	1. Ba ria, gas	312	2210	961	**497**
			2. Phu My 1, gas	1090	2. Phu My 1, gas	1090	4160	1646	
			3. Pha Lai II, coal	600	3. Pha Lai II, coal	600	2430	2487	
			4. Da mi, hydropower	175			540	0	
			5. Ham Thuan, hydropower	300			910	0	
			Total	**2477**	**Total**	**2002**	**10,250**	**5094**	

The weighted average of all thermal power stations (OM) and of the grid (GA) can be calculated as follows:

Table V.3: Calculation of weighted average emissions of all thermal power stations and the whole grid 2001-2010

Fuel type		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Hydropower	GWh	18,004	16,839	17,883	17,883	18,451	19,502	21,602	24,139	26,768	32,179
Coal	GWh	3218	5510	6521	6435	8408	8813	11692	14958	18048	21771
5700 kcal/kg-Vietnam	kt	2112	3100	3541	3415	4255	4129	5493	6946	8302	9958
26.8 TC/TJ – IPCC	kt CO_2	4,858	7,131	8,145	7,856	9,788	9,498	12,636	15,978	19,097	22,906
Gas	GWh	5093	8684	14170	21440	25291	29180	30438	35894	36747	41486
8500 kcal/m^3 – VN	Million m^3	1397	1966	3262	4963	5645	6418	6667	7934	8172	9279
15.3 TC/TJ – IPCC	kt CO_2	2,764	3,889	6,453	9,818	11,168	12,697	13,189	15,696	16,167	18,357
DO	GWh	741	605	338	336	235	155	152	153	140	140
10200 kcal/kg – VN	kt	216	177	98	98	68	45	45	45	41	41
20.2 TC/TJ – IPCC	kt CO_2	677	555	307	307	213	141	141	141	129	129
FO	GWh	3239	3260	1419	319	1054	2284	3431	127	116	116
9900 kcal/kg – VN	kt	864	871	375	89	249	524	782	36	32	32
21.1 TC/TJ – IPCC	kt CO_2	2,745	2,768	1,192	283	791	1,665	2,485	114	102	102
Total CO_2 emission from Vietnam grid, kt CO_2		11,044	14,343	16,097	18,264	21,960	24,001	28,451	31,929	35,494	41,493
Total thermal output generated, GWh		12,291	18,059	22,448	28,530	34,988	40,432	45,713	51,132	55,051	63,513
OM: Weighted thermal average, gCO_2/kWh		**899**	**794**	**717**	**640**	**628**	**594**	**622**	**624**	**645**	**653**
Total electricity output generated, GWh		30,295	34,898	40,331	46,413	53,439	59,934	67,315	75,271	81,819	95,692
GA: Weighted grid average, g CO_2/kWh		**364.6**	**411.0**	**399.1**	**393.5**	**410.9**	**400.5**	**422.7**	**424.2**	**433.8**	**433.6**

Fraction of carbon oxidized: + Coal = 0.98, + Gas = 0.99, + Oil and Oil production = 0.99, + Gas = 0.99.

In 2004 and past years, the generation level of 5 most recent plants (G-BM2) will always be higher than the generation of most recent 20% of existing plants (G-BM1) due to still relatively small size of existing plants capacity. Then the “build margin” will be the weighed average emission of 5 most recent plants. But after 2004, this is reversed because of the constant expansion of generation capacity and relatively small size of the new plants, than the “build margin” will be the weighed average emission of most recent 20% of existing plants. Now we derive the build margin (BM), see table V.4.

Table V.4: Calculation of the build margin for the period of 2003-2010

End of year	Grid cap., MW		Last five plants		Last 20% plants		Build Margin (BM)		
	Total	20%	Plant	MW	Plant	MW	GWh	kt CO_2	gCO_2/kWh
2003	9146	1829.2	1. Phu My 3, gas	720	1. Phu My 3, gas	720	2478	1274	**483**
			2. Phu My 2.1, gas	1008	2. Phu My 2.1, gas	1008	4561	2311	
			3. Phu My 4, gas		3. Phu My 4, gas				
			4. Can Don, hydropower	72	4. Can Don, hydropower	72	266	0	
			5. Ba Ria, gas	312	5. Ba Ria, gas	312	1205	514	
			Total	**2112**	**Total**	**2112**	**8510**	**4109**	
2004	10,110	2022	1. Na Duong, coal	100	1. Na Duong, coal	100	605	722	**518**
			2. Phu My 4, gas	1152	2. Phu My 4, gas	1152	6538	3001	
			3. Phu My 2.1, gas		3. Phu My 2.1, gas				
			4. Phu My 2.2, gas	720	4. Phu My 2.2, gas	720	7435	3824	
			5. Phu My 3, gas	720	5. Phu My 3, gas	720			
			Total	**2692**	**Total**	**2692**	**14578**	**7547**	

End of year	Grid cap., MW		Last five plants		Last 20% plants		Build Margin (BM)		
	Total	20%	Plant	MW	Plant	MW	GWh	kt CO_2	gCO_2/kWh
2005	12,164	2435.8	1. Ca Mau, gas	480	1. Ca Mau, gas	480	1261	499	**565**
			2. Se San 3, hydropower	130	2. Se San 3, hydropower	130	568	0	
			3. Cao Ngan, coal	100	3. Cao Ngan, coal	100	1209	1447	
			4. Expansion Uong Bi, coal	300	7. Na Duong, coal	100			
			5. Cam Pha, coal	300	4. Expansion Uong Bi, coal	300	814	1856	
					5. Cam Pha, coal	300	1000		
					6. O Mon, FO	300	833	597	
					8. Phu My 4, gas	450	7010	2774	
					9. Phu My 2.1, gas	846			
			Total	**1310**	**Total**	**3006**	**12,695**	**7173**	
2006	13,737	2747.4	1. Tuyen Quang, hydropower	114	1. Tuyen Quang, hydropower	114	225	0	**619**
			2. Srok Phu Mieng, hydropower	54	2. Srok Phu Mieng, hydropower	54	72	0	
			3. Sesan 3A	100	3. Sesan 3A	100	141	0	
			4. Bac Binh, hydropower	35	4. Bac Binh, hydropower	35	44	0	
			5. Sesan 3, hydropower	260	5. Sesan 3, hydropower	260	1137	0	
					6. Ca Mau, gas	720	4494	1,778	
					7. O Mon	600	2156	1,547	
					8. Hai Phong, coal	300	545	3789	
					9. Expansion Uong Bi I	300	1855		
					11. Cam Pha I	300	1300		
					10. Cao Ngan, coal	100	500	598	
			Total	**563**	**Total**	**2883**	**12469**	**7713**	

End of year	Grid cap., MW		Last five plants		Last 20% plants		Build Margin (BM)		
	Total	20%	Plant	MW	Plant	MW	GWh	kt CO_2	gCO_2/kWh
2007	14,880	2976	1. Quang Ninh, coal	300	1. Quang Ninh, coal	300	330	338	
			2. Nhon Trach, gas	300	2. Nhon Trach, gas	300	1736	686	
			3. Hai Phong, coal	600	3. Hai Phong, coal	600	2275	2329	
			4. A Vuong, hydropower	170	4. A Vuong, hydropower	170	115	0	
			5. Tuyen Quang, hydropower	342	5. Tuyen Quang, hydropower	342	1296	0	
					6. Quang Tri, hydropower	70	71	0	
					7. Dai Ninh	150	272	0	**409**
					8. Srok Phu Mieng, hydropower	54	243	0	
					9. Sesan 3A	100	441	0	
					10. Bac Binh, hydropower	35	144	0	
					11. Sesan 3, hydropower	260	1137	0	
					12. Ca Mau, gas	720	4395	1739	
			Total	**1712**	**Total**	**3101**	**12,455**	**5092**	
2008	16,627	3325.4	1. Ban La, hdropower	300	1. Ban La, hdropower	300	328	0	
			2. PleiKrong, hydropower	110	2. PleiKrong, hydropower	110	175	0	
			3. Cua Dat, hydropower	97	3. Cua Dat, hydropower	97	165	0	
			4. Srepok 3, hydropower	90	4. Srepok 3, hydropower	90	198	0	
			5. Dai Ninh, hydropower	300	5. Dai Ninh, hydropower	300	1143	0	
					6. Nhon Trach, gas	600	3512	1389	
					7. Expansion Ninh Binh, coal	300	334	342	**547**
					8. Quang Ninh, coal	600	1878	1922	
					9. Hai Phong, coal	600	3512	3595	
					10. A Vuong, hydropower	170	715	0	
					11. Tuyen Quang, hydropower	342	1296	0	
			Total	**897**	**Total**	**3509**	**13,256**	**7248**	

End of year	Grid cap., MW		Last five plants		Last 20% plants		Build Margin (BM)		
	Total	20%	Plant	MW	Plant	MW	GWh	kt CO_2	gCO_2/kWh
2009	18,585	3717	1. Buon Kuop, hydropower	140	1. Buon Kuop, hydropower	140	432	0	**492**
			2. Dong Nai 3, hydropower	120	2. Dong Nai 3, hydropower	120	120	0	
			3. Dong Nai 4, hydropower	135	3. Dong Nai 4, hydropower	135	135	0	
			4. An Khe+Ka Nak, hydropower	165	4. An Khe+Ka Nak, hydropower	165	175	0	
			5. Nhon Trach, gas	900	5. Nhon Trach, gas	900	4795	1897	
					6. O Mon, gas	850	4576	2271	
					7. Expansion Uong Bi, coal	600	2095	2144	
					8. Nghi Son, coal	300	1405	1438	
					9. Ban La, hydropower	300	1055	0	
					10. PleiKrong, hydropower	110	575	0	
					11. Cua Dat, hydropower	97	405	0	
			Total	**1458**	**Total**	**3717**	**15,768**	**7751**	
2010	21,440	4288	1. Nhon Trach, gas	1200	1. Nhon Trach, gas	1200	6406	2947	**430**
			2. Nghi Son, coal	600	2. Nghi Son, coal	600	3369	3449	
			3. Ban Chac, hydropower	200	3. Ban Chac, hydropower	200	748	0	
			4. Dong Nai 3	240	4. Dong Nai 3	240	794	0	
			5. Dong Nai 4	270	5. Dong Nai 4	270	906	0	
					6. Song Ba Ha, Hydropower	125	544	0	
					7. Se San 4, hydropower	110	473	0	
					8. Buon Kuop	280	1348	0	
					9. Con River 2, hydropower	70	112	0	
					10. Tranh River 2	135	239	0	
					11. Upstream of Kontum	220	414	0	
					12. An Khe+Ka Nak, hydropower	163	695	0	
					13. O Mon	1350	7647	3798	
			Total	**2510**	**Total**	**4963**	**23,695**	**10,194**	

For small-scale projects, we thus get the following baseline parameters:

Table V.5: Baseline emission factors for the period of 2001 – 2003

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
GA	364.6	411.0	399.1	393.5	410.9	400.5	422.7	424.2	433.8	433.6
OM	899	794	717	640	628	594	622	624	645	653
BM	102	497	483	518	565	619	409	547	492	430
½ OM + ½ BM	500.5	645.5	600.0	579.0	596.5	606.5	515.5	585.5	568.5	541.5

V.2. Approved methodologies for large projects

Until September 2004, the CDM Executive Board has approved the following methodologies that relate to electricity grids: El Gallo Hydroelectric Project in Mexico (AM 5), Bagasse power plant in Brazil (AM15), Rice husk power plant in Thailand (AM 4), Landfill gas plant in South Africa (AM 10) (UNFCCC 2004c). These methodologies have a lot in common with the small-scale methodologies discussed above. One uses a combination of operating (OM) and build margin (BM): ½ OM + ½ BM. Differences occur in the calculation of the build margin. The others just use grid average (GA).

V.2.1. Baseline methodology (barrier analysis, baseline scenario development and baseline emission rate, using combined margin) for small grid-connected zero-emissions renewable electricity generation (El Gallo Hydroelectricity Project in Mexico)

This methodology is only applicable for renewable energy projects with a capacity of < 60 MW serving a grid with less than 50% of generating sources with zero- or low –operating costs such as hydro, geothermal, wind, solar, nuclear, and low-cost biomass. So it is applicable to Vietnam as the share of hydro has recently dropped below 50%.

The formula ½ OM + ½ BM is used with OM equal to the emission factor of the thermal plants, such as calculated above. However, the BM can be chosen among the weighted emission of the last 5 plants or the last 20% installed under the following condition: “The project participant is to demonstrate which is appropriate for the proposed project to the Operational Entity, otherwise, the more conservative one is selected”. The ex-post monitoring of the BM may be used only if the project is small compared with the total additions to the grid.

This methodology accounts for imports and exports with the emission factors of the respective grids.

We calculate the baseline for renewable electricity generation project using the El Gallo methodology: The OM for 2002 can be taken from Table V.5 above. The BM for 2002 of the weighted average emissions coefficient of 5 most recent plants is derived as follows:

Table V.6: Build margin based on the most 5 recent plants in Vietnam in 2002 and 2003

Plants	Type	Installed capacity, MW	Commission date	Electricity output, GWh	
				2002	2003
1. Ba ria	Gas	312	2002	2210	1205
2. Phu My 1	Gas	1090	2002	4160	5926
3. Pha Lai II	Coal	600	2002	2430	3627
4. Da mi	Hydro	175	2001	540	575
5. Ham Thuan	Hydro	300	2001	910	907
Total				6,598	11,479

Table V.7: Build margin based on the most 5 recent plants in Vietnam in 2002 and 2003

Plants	Fuel consumption			Efficiency, %		CO_2 Emission, Mt CO_2	
	2002	2003		2002	2003	2002	2003
1. Ba ria	486	265	$M.m^3$	46	46	0.961	0.524
2. Phu My 1	832	1185	"	50.58	50.59	1.646	2.344
3. Pha Lai II	1081	1614	kt	33.91	33.90	2.487	3.713
4. Da mi	0	0	-	-	-	-	-
5. Ham Thuan	0	0	-	-	-	-	-
Total						5.094	6.581

Based on the information shown in table V.5 and V.6, the weighted average emissions coefficient of the 5 most recent plants is 772 g CO_2/kWh for 2002 and 573 g CO_2/kWh for 2003. This shows the strong changes due to different loads of the plants in the two years.

Using default weighting of ½ OM and ½ BM, the baseline emission factor for Vietnam grid using this methodology will be 783 g CO_2/kWh for 2002 and 684 g CO_2/kWh for 2003.

V.2.2. Grid-connected biomass power generation that avoids uncontrolled burning of biomass (AT biopower plant, Thailand)

This methodology can be used for projects that use biomass that would otherwise be dumped or burned in an uncontrolled manner and have access to an abundant supply of biomass that is unutilised and is too dispersed to be used for grid electricity generation under business as usual (BAU). The projects must have a negligible impact on plans for construction of new power plants as well as on the average grid emissions factor. GA has to be lower than the emission factor of the most likely operating margin candidate. These requirements are likely to be fulfilled in Vietnam.

The baseline emission factor is the lower of GA and OM calculated ex post. The OM can be calculated by identifying particular units that may change over the crediting period and thus can be different from the OM calculated above.

V.2.3. Landfill gas capture and electricity generation projects where landfill gas capture is not mandated by law (Durban landfill gas project, South Africa)

This methodology uses GA calculated ex-post.

V.2.4. Consolidated methodology

At its session of April 2004, the Methodology Panel suggested a consolidated methodology for electricity generation additions from hydro, wind, geothermal, and solar. Public comments on this proposal were invited by the CDM EB and in July, a revised version was presented (UNFCCC 2004b) that was adopted with slight revisions by the EB in September (UNFCCC 2004d). The baseline emissions factor is ½ OM + ½ BM or GA. The OM is calculated in three ways, of which only one applies to Vietnam:- Average of all power plants with relevant operating costs. The share of these plants in total generation must be higher than 50%. Electricity imports have to be taken into account at the average emission factor of the exporting grid. The emission factor is calculated as energy content of fuels used (GJ) times carbon emission factor of the fuel (t CO_2/GJ). Here local statistics have to be used; if they do not exist IPCC emission factors replace them. Either three-year averages going backwards from the "most recent statistics at time of PDD submission" or ex-post updates for every year of the crediting period can be used.

As Vietnam's hydro share has fallen below 50%, this OM is applicable. Based on table V.5, it reaches 803 g CO_2/kWh in 2004.

The BM is calculated as defined in the small-scale baseline rules. Projects above 60 MW have to update it annually. The BM now allows a choice between ex-ante and annual, ex-post calculation at least for the first crediting period. We are able to calculate the 3-year average BM (see tables V.8 and V.9). CDM projects are not taken into account in the BM.

Table V.8: Three-year build margin based on the most 5 recent plants in Vietnam in 2002

Plants	Type	Installed capacity, MW	Commission date	Electricity output, GWh		
				2002	2003	2004
1. Ba ria	Gas	312	2002	2210	1205	992
2. Phu My 1	Gas	1090	2002	4160	5926	6475
3. Pha Lai II	Coal	600	2002	2430	3627	3627
4. Da mi	Hydro	175	2001	540	575	575
5. Ham Thuan	Hydro	300	2001	910	907	907
Total				6,598	11,479	12,240
Total for 3 years				30,317 GWh		

Table V.9: Three-year build margin based on the most 5 recent plants in Vietnam in 2002 (continued)

Plants	Fuel consumption				Efficiency, %			CO_2 Emission, Mt CO_2		
	2002	2003	2004		2002	2003	2004	2002	2003	2004
1. Ba ria	486	265	218	M.m^3	46	46	46	0.961	0.524	0.431
2. Phu My 1	832	1185	1295	"	50.58	50.59	50.58	1.646	2.344	2.562
3. Pha Lai II	1081	1614	1614	kt	33.91	33.90	33.90	2.487	3.713	3.713
4. Da mi	0	0	0	-	-	-	-	-	-	-
5. Ham Thuan	0	0	0	-	-	-	-	-	-	-
Total								5.094	6.581	6.706
Total for 3 years								18.38 Mt CO_2		

The ex-ante BM thus reaches 606 g CO_2/kWh. ½ OM + ½ BM gives 705 g CO_2/kWh as the baseline emissions factor.

VI. Conclusion

We are able to calculate all necessary parameters for small and large CDM projects related to the electricity grid for Vietnam. In this regard, Vietnam has a competitive advantage to other countries where these data are not readily available. The challenge now is to ensure timely availability of data in the future as CERs can only be issued if the verifier can check the actual data. A delay of two years would mean that CDM project owners would have to wait for CER issuance accordingly.

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APPENDIX

Table A.1: Electricity output from generation sources during 2000 – 2020

Cap. (MW)	Generation sources	Electricity output, GWh										
		2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2020**
I	**Hydropower**											
1920	Hoa Binh	8447	8010	8067	8067	8067	8067	8067	8067	8067	8067	9304
360 (2000) 360 (2001)	Yaly	2975	3200	3558	3558	3558	3558	3558	3558	3558	3558	3558
400	Tri An	2179	1675	1658	1658	1658	1658	1658	1658	1658	1658	1658
300	Ham Thuan	923	910	907	907	907	907	907	907	907	907	907
160	Da Nhim	1096	915	1005	1005	1005	1005	1005	1005	1005	1005	1005
150	Thac Mo	926	665	882	882	882	882	882	882	882	882	882
175	Da Mi	401	540	575	575	575	575	575	575	575	575	575
108	Thac Ba	401	364	414	414	414	414	414	414	414	414	414
66	Vinh Son	215	240	201	201	201	201	201	201	201	201	201
70	Hinh River	441	320	350	350	350	350	350	350	350	350	350
72	Can Don			266	266	266	266	266	266	266	266	266
130 (2005) 130 (2006)	Se San 3					568	1137	1137	1137	1137	1137	1137
114 (2006) 2 x114 (2007)	Tuyen Quang (Na Hang)						225	1296	1296	1296	1296	1296
100	Se San 3A						141	441	441	441	441	441
54	Srok Phu Mieng						72	243	243	243	243	243
35	Bac Binh						44	144	144	144	144	144

Cap. (MW)	Generation sources	Electricity output, GWh										
		2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2020**
I	**Hydropower**											
150 (2007) 150 (2008)	Dai Ninh							272	1143	1143	1143	1143
170	A Vuong 1							115	715	715	715	715
70	Quang Tri (Rao Quan)							71	271	271	271	271
300	Ban La								328	1055	1055	1055
180	Srepok 3								198	598	598	598
110	Plei Krong								175	575	575	575
97	Cua Dat								165	405	405	405
140 (2009) 140 (2010)	Buon Kuop									432	1348	1348
163	An Khe + Ka Nak									175	695	695
270	Dong Nai 4									135	906	906
240	Dong Nai 3									120	794	794
200	Ban Chac										748	748
125 (2010) 125 (2011)	Downstream of Ba River										544	1044
110 (2010) 2 x 110 (2011)	Se San 4										473	1373
110 (2010) 110 (2011)	Upstream of Kontum										414	714
70	Con River 2										112	242
120	Tranh River 2										239	539
2400	Son La											7689

Cap. (MW)	Generation sources	Electricity output, GWh										
		2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2020**
800	Lai Chau											3681
460	Huoi Quang											1760
280	Bac Me											995
250	Ban Uon											938
195	Hua La											933
210	Dak My 1											817
105	Dak My 4											768
210	Dong Nai 2 + 5											770
200	Bung River 4											745
175	Nam Chien											651
126	Bung River 2											459
97	Dak Drinh											444
200	Bao Loc + Duc Xuyen											315
Total Hydropower		**18,004**	**16,839**	**17,883**	**17,883**	**18,451**	**19,502**	**21,602**	**24,139**	**26,768**	**32,179**	**56,511**
II	**Nuclear**											
2000	Nuclear											13651
III	**Thermal power**											
III.1	**Coal power**											
440	Pha Lai 1	2219	2130	1887	1365	1024	337	390	373	331	332	1104
205	Uong Bi + Ninh Binh	999	950	1007	838	734	225	419	424	386	387	0
600	Pha Lai 2		2430	3627	3627	3627	3551	3472	3512	3196	3203	3283
200	Na Duong + Cao Ngan				605	1209	1000	1000	1000	1000	1000	987
300	Cam Pha					1000	1300	1800	1800	1800	1800	1642
300 (2005)	Expansion Uong Bi 1&2					814	1855	2006	2125	2095	3424	3283

Cap. (MW)	Generation sources	Electricity output, GWh										
		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2020
300 (2009)												
300 (2006) 300 (2007)	Hai Phong						545	2275	3512	3343	3203	3283
300 (2007) 300 (2008)	Quang Ninh							330	1878	2811	3369	6566
300	Expansion Ninh Binh								334	1681	1684	1642
300 (2009) 300 (2010)	Nghi Son									1405	3369	3283
2000	New coal-fired plant											10944
Total coal power		**3,218**	**5,510**	**6,521**	**6,435**	**8,408**	**8,813**	**11,692**	**14,958**	**18,048**	**21,771**	**36,017**
III.2	**Gas power**											
727 143 (2003) 140 (2004)	Phu My 2-1&4	2375	2314	4561	6538	7010	7669	7500	7586	6904	6919	7091
1090	Phu My 1	1074	4160	5926	6475	6623	6450	6308	6381	5807	5819	5964
378	Ba Ria	1644	2210	1205	992	935	1305	1277	1291	1175	1178	868
720 (2003) 720 (2004)	Phu My 2.2&3			2478	7435	9462	9262	9222	9335	9444	9462	9462
2 x 240 (2005) 240 (2006)	Ca Mau					1261	4494	4395	4446	4046	4055	4403
300 each 2007-9	Nhon Trach							1736	3512	4795	6406	6351
300 (2005) 300 (2006)	O Mon 1								3343	3043	3049	3133
250	O Mon 2									1533	4598	4898

Cap. (MW)	Generation sources	Electricity output, GWh										
		2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2020**
600	O Mon 3											3133
	Hon Dat Mixed Gas Turbine											4210
	New Mixed Gas Turbine											25257
	Central area gas-fired plant											3940
Total gas power		**5,093**	**8,684**	**14,170**	**21,440**	**25,291**	**29,180**	**30,438**	**35,894**	**36,747**	**41,486**	**78,710**
III.3	**FO power**											
375	Hiep Phuoc	2122	2100	1100								
157	Thu Duc	881	950	97	97	98	101	99	100	91	91	
33	Can Tho	236	210	222	222	123	27	27	27	25	25	
300 (2005) 300 (2006)	O Mon 1					833	2156	3305				
Total FO power		**3,239**	**3,260**	**1,419**	**319**	**1,054**	**2,284**	**3,431**	**127**	**116**	**116**	
III.4	**DO power**											
70	Thu Duc Gas Turbine	276	325	45	45	45	48	47	47	43	43	
140	Can Tho Gas Turbine	465	280	293	291	190	107	105	106	97	97	
Total DO power		**741**	**605**	**338**	**336**	**235**	**155**	**152**	**153**	**140**	**140**	
III	**Total thermal power**	**12,291**	**18,059**	**22,448**	**28,530**	**34,988**	**40,432**	**45,713**	**51,132**	**55,051**	**63,513**	**114,727**
II	**Electricity import**								434	434	434	16479
	Total	**30,295**	**34,898**	**40,331**	**46,413**	**53,439**	**59,934**	**67,315**	**75,705**	**82,253**	**96,126**	**201,368**
	% of Hydropower	59.43	47.87	44.34	38.53	34.53	32.54	32.09	31.89	32.54	33.48	28.06

Source: Electricity of Vietnam (10/2002).

Table A.2: Fuel consumption for electricity generation during 2002 – 2020

Capacity	Fuel types	Fuel Consumption										
		2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2020**
I	**Hydropower**	-	-	-	-	-	-	-	-	-	-	-
II	**Coal, kt**											
440	Pha Lai 1	1272	1220	1081	782	587	193	223	214	190	190	632
205	Uong Bi	413	393	416	347	304	93	173	175	160	160	0
	Ninh Binh	427	406	430	358	314	96	179	181	165	165	0
600	Pha Lai 2		1081	1614	1614	1614	1580	1545	1563	1422	1425	1461
200	Na Duong + Cao Ngan				314	629	520	520	520	520	520	513
300	Cam Pha					445.0	578.5	801.0	801.0	801.0	801.0	730.7
300 (2005) 300 (2009)	Expansion Uong Bi 1&2					362.2	825.5	892.7	945.6	932.3	1523.7	1460.9
300 (2006) 300 (2007)	Hai Phong						242.5	1012.4	1562.8	1487.6	1425.3	1460.9
300 (2007) 300 (2008)	Quang Ninh							146.8	835.7	1250.9	1499.2	2921.8
300	Expansion Ninh Binh								148.6	748.0	749.4	730.7
300 (2009) 300 (2010)	Nghi Son									625.2	1499.2	1460.9
2000	New coal-fired plant											4487
Total coal, kt		**2,112**	**3,100**	**3,541**	**3,415**	**4,255**	**4,128**	**5,493**	**6,947**	**8,302**	**9,958**	**15,859**

Capacity	Fuel types	Fuel Consumption										
		2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2020**
III	**Gas, million m3**											
727 143 (2003) 140 (2004)	Phu My 2-1&4	665	648	1168	1517	1402	1534	1500	1517	1381	1384	1418
1090	Phu My 1	301	832	1185	1295	1325	1290	1262	1276	1161	1164	1193
378	Ba Ria	431	486	265	218	206	287	281	284	259	259	191
720 (2003) 720 (2004)	Phu My 2.2&3			644	1933	2460	2408	2398	2427	2455	2460	2460
2 x 240 (2005) 240 (2006)	Ca Mau					252	899	879	889	809	811	-
300 each 2007-9	Nhon Trach							347	702	959	1281	1270
300 (2005) 300 (2006)	O Mon 1								839	1148	1920	2802
250	O Mon 2											
600	O Mon 3											
	Central area gas-fired plant											788
Total gas, million m3		**1,397**	**1,966**	**3,262**	**4,963**	**5,645**	**6,418**	**6,667**	**7,934**	**8,172**	**9,279**	**-**

Capacity	Fuel types	Fuel Consumption										
		2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2020**
IV	**FO power, kt**											
375	Hiep Phuoc	552	546	286								
157	Thu Duc	246	266	27	27	27	29	28	28	25	25	
33	Can Tho	66	59	62	62	34	8	7	8	7	7	
300 (2005) 300 (2006)	O Mon 1					188	487	747				
	Total FO, kt	**864**	**871**	**375**	**89**	**249**	**524**	**782**	**36**	**32**	**32**	
V	**DO power, kt**											
70	Thu Duc Gas Turbine	80	95	13	13	13	14	14	14	13	13	
140	Can Tho Gas Turbine	136	82	85	85	55	31	31	31	28	28	
	Total DO, kt	**216**	**177**	**98**	**98**	**68**	**45**	**45**	**45**	**41**	**41**	

Source: Electricity of Vietnam (10/2002).