## 13.2 Cost Estimate

The construction cost of the project was estimated taking into account the geological conditions, the local conditions and the work scale.

### 13.2.1 Basic Conditions

(1) Price Level and Currency Exchange Rate

Price level : 1991 January
Currency Exchange Rate: 1 US$ = 26 Baht

(2) Items of Cost Estimate

- Preliminary Works : EGAT's camp and office facilities, site preparation, access roads, electric facilities

- Environmental Mitigation : resettlement and compensation in the project area, mitigation for environmental impact

- Civil Works

  • Upper Reservoir
  • Waterway : intake, penstock, tailrace
  • Powerhouse and Switchyard: civil works and architecture works

- Hydraulic Equipment : gate, penstock, etc.

- Electro-mechanical Equipment : turbine, generator, transformer, telecommunication system, etc.

- Transmission Line : expense concerning transmission facilities

- Import Duties : import duties and tax

- EGAT Administration : administration cost concerning the project's construction

- Engineering Service : engineering fee for detailed design and supervision

- Physical Contingency : contingency for unforseen physical conditions

- Price Contingency : contingency for escalation

- Interest During Construction

(3) Condition for Cost Estimate

- Preliminary Works

5% of civil works are estimated as the cost of the preliminary works.

- Environmental Mitigation

Considering the project's condition, 2% of the sum of civil works, hydraulic equipment, electro-mechanical equipment, transmission line, EGAT's administration and engineering service are estimated as the environmental mitigation cost.

- Civil Works

The cost of civil works is estimated in accordance with the drawings of the feasibility-grade design and unit costs. The bill of quantities is shown in Appendix. The unit costs are

derived from the planned construction schedule and methods, the site conditions and the availability of construction materials.

- Hydraulic Equipment and Electro-mechanical Equipment

The costs of hydraulic and electro-mechanical equipments are based on budget prices quoted by manufacturers and on contract or bid prices of recent similar projects, updated January 1991 price. These equipments are imported from foreign countries.

- Transmission Line

The costs of the new 230 kV transmission line (2 cct, $\ell$ = 110 km) and the line equipment for 230 kV - 2 cct are included in the project cost.

- Import Duties

Import duties are estimated by considering the foreign currency component; hydraulic equipment (11.40%), turbine, generator and transformers (11.40%), electro-mechanical accessories (11.40%), switchyard equipments (11.40%), transmission lines (21.86%).

- EGAT's Administration and Engineering Service

The costs of EGAT's administration and engineering service are separately estimated at 3% respectively, of above costs from the preliminary works to the transmission line.

- Physical Contingency

The physical contingency of 10% for all of the costs from the preliminary works to the hydraulic equipments and 7% from the electro-mechanical equipments to the transmission line is added to cover the cost of unforseen physical conditions except price escalation.

- Price Contingency

The price contingency for all of the costs from the preliminary works to the transmission line is estimated on the basis of the escalation rates as follows.

Escalation Rate

| Year | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 and onward |
|---|---|---|---|---|---|---|
| Rate (F.C., %) | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 |
| Rate (L.C., %) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 |

(Source: IBRD Bangkok, Oct. 1989)

- Interest During Construction

The interests during construction are estimated to be an 8% of annual interest rate on the foreign currency portion and 11% on 50% of the local currency portion. Further, the commitment fee of 0.75% on the foreign currency is considered.

(4) Classification of Local and Foreign Currency Portion

Cement and reinforcement bars of domestic origin are used. Structural steel such as parts of penstocks, gates and parts of steel linings, and explosives are imported.

Heavy equipments such as heavy dump trucks, bulldozers, wheel loaders, vibratory rollers for civil works, and temporary facilities such as concrete plants, aggregate plants are imported. Also special types of equipments such as boring machines, grout pumps, compressors, etc. are imported.

The electro-mechanical equipment and transmission facilities are included under foreign currency while their transportation costs in Thailand and installation costs are in local currency.

Import duties are included in the local currency.

### 13.2.2 Project Cost

#### (1) Project Cost

The project cost was estimated on the basis of the above cited conditions.

Project Cost 16,674 Millon Baht (US$ 641 Million).

The detailed project cost is shown in Table 13-1.

#### (2) Annual Expenditure

The annual expenditure of the project cost during construction was estimated in Table 13-3-(1) ~ Table 13-3-(5).

### 13.2.3 Economic Cost

#### (1) Economic Cost

The economic cost excluding the import duties, price contingency and interest during construction are as follows:

Economic Cost 11,254 Million Baht (US$ 433 Million)

The detailed economic cost is shown in Table 13-2.

(2) Annual Expenditure

The annual expenditure of the economic cost is shown in Table 13-3-(1) ~ Table 13-3-(5).

Table 13-1 Project Cost of Development Plan

(Million Baht)

| Description | Lam Ta Khong Project | | |
|---|---|---|---|
| | F.C. | L.C. | Total |
| 1. Preliminary Works | 0.00 | 183.12 | 183.12 |
| 2. Environmental Mitigation | 0.00 | 248.73 | 248.73 |
| 3. Civil Works | 1,894.61 | 2,181.79 | 4,076.40 |
| 4. Hydraulic Equipment | 1,076.32 | 703.84 | 1,780.16 |
| 5. Electro-mechanical Equipment | 4,625.98 | 729.47 | 5,355.45 |
| 6. Transmission System | 639.23 | 269.24 | 908.46 |
| 7. EGAT Administration | 0.00 | 373.35 | 373.35 |
| 8. Engineering Service | 261.27 | 107.21 | 368.48 |
| 9. Import Duties and Taxes | 0.00 | 776.48 | 776.48 |
| 10. Interest During Construction | 0.00 | 2,603.20 | 2,603.20 |
| TOTAL PROJECT COST | 8,497.39 | 8,176.43 | 16,673.83 |

Table 13-2 Economic Cost of Development Plan

(Million Baht)

| Description | Lam Ta Khong Project | | |
|---|---|---|---|
| | F.C. | L.C. | Total |
| 1. Preliminary Works | 0.00 | 171.38 | 171.38 |
| 2. Environmental Mitigation | 0.00 | 220.00 | 220.00 |
| 3. Civil Works | 1,657.37 | 1,900.25 | 3,557.62 |
| 4. Hydraulic Equipment | 895.62 | 599.50 | 1,495.12 |
| 5. Electro-mechanical Equipment | 3,811.56 | 611.62 | 4,423.16 |
| 6. Transmission System | 524.30 | 224.70 | 749.00 |
| 7. EGAT Administration | 0.00 | 319.00 | 319.00 |
| 8. Engineering Service | 225.50 | 93.50 | 319.00 |
| TOTAL ECONOMIC COST | 7,114.34 | 4,139.94 | 11,254.29 |

## Table 13-3-(1) Annual Expenditure

BASE COST ( 1991 PRICE ) ( UNIT: MILLION BAHT )

| DESCRIPTION | TOTAL | | | 1992 | | 1993 | | 1994 | | 1995 | | 1996 | | 1997 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F.C | L.C | SUM | F.C | L.C | F.C | L.C | F.C | L.C | F.C | L.C | F.C | L.C | F.C | L.C |
| 1. PRELIMINARY WORKS | 0.00 | 155.80 | 155.80 | 0.00 | 50.00 | 0.00 | 105.80 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2. ENVIRONMENTAL MITIGATION | 0.00 | 200.00 | 200.00 | 0.00 | 20.00 | 0.00 | 40.00 | 0.00 | 60.00 | 0.00 | 60.00 | 0.00 | 20.00 | 0.00 | 0.00 |
| 3. CIVIL WORKS | 1,506.70 | 1,727.50 | 3,234.20 | 0.00 | 0.00 | 412.84 | 228.03 | 653.91 | 587.35 | 332.98 | 725.55 | 106.98 | 186.57 | 0.00 | 0.00 |
| 4. HYDRAULIC EQUIPMENT | 814.20 | 545.00 | 1,359.20 | 0.00 | 0.00 | 0.00 | 0.00 | 97.70 | 76.30 | 407.10 | 348.80 | 309.40 | 119.90 | 0.00 | 0.00 |
| 5. ELECTRO-MECHANICAL EQUIP. | | | | | | | | | | | | | | | |
| -TURBINE, GENERATOR & OTHERS | 3,331.50 | 546.10 | 3,877.60 | 0.00 | 0.00 | 299.84 | 48.15 | 0.00 | 0.00 | 1,232.66 | 202.06 | 1,499.18 | 245.75 | 299.84 | 49.15 |
| -MAIN TRANSFORMER | 230.70 | 25.50 | 256.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 23.07 | 2.55 | 207.63 | 22.95 | 0.00 | 0.00 |
| 6. TRANSMISSION SYSTEM | 490.00 | 210.00 | 700.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 196.00 | 84.00 | 294.00 | 126.00 | 0.00 | 0.00 |
| 7. EGAT ADMINISTRATION | 0.00 | 290.00 | 290.00 | 0.00 | 2.10 | 0.00 | 34.07 | 0.00 | 44.26 | 0.00 | 108.44 | 0.00 | 94.15 | 0.00 | 6.98 |
| 8. ENGINEERING SERVICE | | | | | | | | | | | | | | | |
| -D/D AND TENDER PREPARATION | 30.00 | 10.00 | 40.00 | 24.00 | 8.00 | 6.00 | 2.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| -CONSTRUCTION SUPERVISION | 175.00 | 75.00 | 250.00 | 0.00 | 0.00 | 26.25 | 11.25 | 52.50 | 22.50 | 43.75 | 18.75 | 43.75 | 18.75 | 8.75 | 3.75 |
| 9. IMPORT DUTIES & TAXES | 0.00 | 606.02 | 606.02 | 0.00 | 0.00 | 0.00 | 34.18 | 0.00 | 11.14 | 0.00 | 232.41 | 0.00 | 294.12 | 0.00 | 34.18 |
| SUM OF BASE COST | 6,578.10 | 4,390.92 | 10,969.02 | 24.00 | 80.10 | 744.92 | 504.48 | 804.11 | 801.55 | 2,235.56 | 1,782.56 | 2,460.93 | 1,128.18 | 308.59 | 94.06 |



## Table 13-3-(2) Annual Expenditure

PHYSICAL CONTINGENCY ( UNIT: MILLION BAHT )

| DESCRIPTION | TOTAL | | | 1992 | | 1993 | | 1994 | | 1995 | | 1996 | | 1997 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F.C | L.C | SUM | F.C | L.C | F.C | L.C | F.C | L.C | F.C | L.C | F.C | L.C | F.C | L.C |
| 1. PRELIMINARY WORKS | 0.00 | 15.58 | 15.58 | 0.00 | 5.00 | 0.00 | 10.58 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2. ENVIRONMENTAL MITIGATION | 0.00 | 20.00 | 20.00 | 0.00 | 2.00 | 0.00 | 4.00 | 0.00 | 6.00 | 0.00 | 6.00 | 0.00 | 2.00 | 0.00 | 0.00 |
| 3. CIVIL WORKS | 150.67 | 172.75 | 323.42 | 0.00 | 0.00 | 41.28 | 22.80 | 65.39 | 58.74 | 33.30 | 72.56 | 10.70 | 18.66 | 0.00 | 0.00 |
| 4. HYDRAULIC EQUIPMENT | 81.42 | 54.50 | 135.92 | 0.00 | 0.00 | 0.00 | 0.00 | 9.77 | 7.63 | 40.71 | 34.88 | 30.94 | 11.99 | 0.00 | 0.00 |
| 5. ELECTRO-MECHANICAL EQUIP. | | | | | | | | | | | | | | | |
| -TURBINE, GENERATOR & OTHERS | 233.21 | 38.23 | 271.43 | 0.00 | 0.00 | 20.99 | 3.44 | 0.00 | 0.00 | 86.29 | 14.14 | 104.94 | 17.20 | 20.99 | 3.44 |
| -MAIN TRANSFORMER | 16.15 | 1.79 | 17.93 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.61 | 0.18 | 14.53 | 1.61 | 0.00 | 0.00 |
| 6. TRANSMISSION SYSTEM | 34.30 | 14.70 | 49.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 13.72 | 5.88 | 20.58 | 8.82 | 0.00 | 0.00 |
| 7. EGAT ADMINISTRATION | 0.00 | 29.00 | 29.00 | 0.00 | 0.21 | 0.00 | 3.09 | 0.00 | 4.43 | 0.00 | 9.28 | 0.00 | 7.26 | 0.00 | 4.73 |
| 8. ENGINEERING SERVICE | | | | | | | | | | | | | | | |
| -D/D AND TENDER PREPARATION | 3.00 | 1.00 | 4.00 | 2.40 | 0.80 | 0.60 | 0.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| -CONSTRUCTION SUPERVISION | 17.50 | 7.50 | 25.00 | 0.00 | 0.00 | 2.63 | 1.13 | 5.25 | 2.25 | 4.38 | 1.88 | 4.38 | 1.88 | 0.88 | 0.38 |
| 9. IMPORT DUTIES & TAXES | 0.00 | 45.21 | 45.21 | 0.00 | 0.00 | 0.00 | 2.39 | 0.00 | 1.11 | 0.00 | 17.66 | 0.00 | 21.65 | 0.00 | 2.39 |
| SUM OF PHYSICAL CONTINGENCY | 536.24 | 400.25 | 936.49 | 2.40 | 8.01 | 65.50 | 47.63 | 80.41 | 80.15 | 180.00 | 162.45 | 186.07 | 91.06 | 21.86 | 10.94 |

## Table 13-3-(3) Annual Expenditure

PRICE CONTINGENCY ( UNIT: MILLION BAHT )

| DESCRIPTION | TOTAL | | | 1992 | | 1993 | | 1994 | | 1995 | | 1996 | | 1997 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F.C | L.C | SUM | F.C | L.C | F.C | L.C | F.C | L.C | F.C | L.C | F.C | L.C | F.C | L.C |
| 1. PRELIMINARY WORKS | 0.00 | 11.74 | 11.74 | 0.00 | 2.20 | 0.00 | 9.54 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2. ENVIRONMENTAL MITIGATION | 0.00 | 28.73 | 28.73 | 0.00 | 0.88 | 0.00 | 3.61 | 0.00 | 8.25 | 0.00 | 11.22 | 0.00 | 4.77 | 0.00 | 0.00 |
| 3. CIVIL WORKS | 237.24 | 281.54 | 518.78 | 0.00 | 0.00 | 40.87 | 20.57 | 99.26 | 80.76 | 68.86 | 135.68 | 28.24 | 44.53 | 0.00 | 0.00 |
| 4. HYDRAULIC EQUIPMENT | 180.70 | 104.34 | 285.04 | 0.00 | 0.00 | 0.00 | 0.00 | 14.83 | 10.49 | 84.19 | 65.23 | 81.68 | 28.62 | 0.00 | 0.00 |
| 5. ELECTRO-MECHANICAL EQUIP. | | | | | | | | | | | | | | | |
| -TURBINE, GENERATOR & OTHERS | 756.47 | 112.06 | 868.53 | 0.00 | 0.00 | 28.87 | 4.31 | 0.00 | 0.00 | 247.96 | 36.75 | 384.99 | 57.06 | 94.64 | 13.94 |
| -MAIN TRANSFORMER | 57.96 | 5.79 | 63.75 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 4.64 | 0.46 | 53.32 | 5.33 | 0.00 | 0.00 |
| 6. TRANSMISSION SYSTEM | 114.93 | 44.54 | 159.46 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 39.43 | 15.28 | 75.50 | 29.26 | 0.00 | 0.00 |
| 7. EGAT ADMINISTRATION | 0.00 | 54.35 | 54.35 | 0.00 | 0.09 | 0.00 | 3.05 | 0.00 | 6.09 | 0.00 | 20.01 | 0.00 | 22.01 | 0.00 | 3.10 |
| 8. ENGINEERING SERVICE | | | | | | | | | | | | | | | |
| -D/D AND TENDER PREPARATION | 1.76 | 0.53 | 2.29 | 1.16 | 0.35 | 0.59 | 0.18 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| -CONSTRUCTION SUPERVISION | 34.01 | 13.18 | 47.19 | 0.00 | 0.00 | 2.60 | 1.01 | 7.97 | 3.09 | 9.05 | 3.51 | 11.55 | 4.48 | 2.84 | 1.09 |
| 9. IMPORT DUTIES & TAXES | 0.00 | 125.25 | 125.25 | 0.00 | 0.00 | 0.00 | 3.00 | 0.00 | 1.53 | 0.00 | 42.51 | 0.00 | 68.52 | 0.00 | 9.69 |
| SUM OF PRICE CONTINGENCY | 1383.05 | 782.06 | 2165.11 | 1.16 | 3.52 | 72.94 | 45.27 | 122.06 | 110.21 | 454.13 | 330.65 | 635.28 | 264.57 | 97.48 | 27.83 |



## Table 13-3-(4) Annual Expenditure

BASE COST INCLUDE PHYSICAL CONTINGENCIES ( UNIT: MILLION BAHT )

| DESCRIPTION | TOTAL | | | 1992 | | 1993 | | 1994 | | 1995 | | 1996 | | 1997 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F.C | L.C | SUM | F.C | L.C | F.C | L.C | F.C | L.C | F.C | L.C | F.C | L.C | F.C | L.C |
| 1. PRELIMINARY WORKS | 0.00 | 171.38 | 171.38 | 0.00 | 55.00 | 0.00 | 116.38 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2. ENVIRONMENTAL MITIGATION | 0.00 | 220.00 | 220.00 | 0.00 | 22.00 | 0.00 | 44.00 | 0.00 | 66.00 | 0.00 | 66.00 | 0.00 | 22.00 | 0.00 | 0.00 |
| 3. CIVIL WORKS | 1657.37 | 1900.25 | 3557.62 | 0.00 | 0.00 | 454.12 | 250.83 | 719.30 | 646.09 | 366.28 | 798.11 | 117.67 | 205.23 | 0.00 | 0.00 |
| 4. HYDRAULIC EQUIPMENT | 895.62 | 599.50 | 1495.12 | 0.00 | 0.00 | 0.00 | 0.00 | 107.47 | 83.93 | 447.81 | 383.68 | 340.34 | 131.89 | 0.00 | 0.00 |
| 5. ELECTRO-MECHANICAL EQUIP. | | | | | | | | | | | | | | | |
| -TURBINE, GENERATOR & OTHERS | 3564.71 | 584.33 | 4149.03 | 0.00 | 0.00 | 320.82 | 52.59 | 0.00 | 0.00 | 1318.94 | 216.20 | 1604.12 | 262.95 | 320.82 | 52.59 |
| -MAIN TRANSFORMER | 246.85 | 27.29 | 274.13 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 24.68 | 2.73 | 222.16 | 24.56 | 0.00 | 0.00 |
| 6. TRANSMISSION SYSTEM | 524.30 | 224.70 | 749.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 209.72 | 89.88 | 314.58 | 134.82 | 0.00 | 0.00 |
| 7. EGAT ADMINISTRATION | 0.00 | 319.00 | 319.00 | 0.00 | 2.31 | 0.00 | 37.16 | 0.00 | 48.68 | 0.00 | 117.72 | 0.00 | 101.41 | 0.00 | 11.71 |
| 8. ENGINEERING SERVICE | | | | | | | | | | | | | | | |
| -D/D AND TENDER PREPARATION | 33.00 | 11.00 | 44.00 | 26.40 | 8.80 | 6.60 | 2.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| -CONSTRUCTION SUPERVISION | 192.50 | 82.50 | 275.00 | 0.00 | 0.00 | 28.88 | 12.38 | 57.75 | 24.75 | 48.13 | 20.63 | 48.13 | 20.63 | 9.63 | 4.13 |
| 9. IMPORT DUTIES & TAXES | 0.00 | 651.23 | 651.23 | 0.00 | 0.00 | 0.00 | 36.57 | 0.00 | 12.25 | 0.00 | 250.07 | 0.00 | 315.76 | 0.00 | 36.57 |
| T O T A L | 7114.34 | 4791.17 | 11905.52 | 26.40 | 88.11 | 810.42 | 552.11 | 884.52 | 881.70 | 2415.56 | 1945.01 | 2647.00 | 1219.24 | 330.45 | 105.00 |
| ECONOMIC COST | 7114.34 | 4139.94 | 11254.29 | 26.40 | 88.11 | 810.42 | 515.54 | 884.52 | 869.45 | 2415.56 | 1694.94 | 2647.00 | 903.47 | 330.45 | 68.43 |

## Table 13-3-(5) Annual Expenditure

TOTAL PROJECT COST (BASE COST INCLUDE PHYSICAL & PRICE CONTINGENCIES) ( UNIT: MILLION BAHT )

| DESCRIPTION | TOTAL | | | 1992 | | 1993 | | 1994 | | 1995 | | 1996 | | 1997 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F.C | L.C | SUM | F.C | L.C | F.C | L.C | F.C | L.C | F.C | L.C | F.C | L.C | F.C | L.C |
| 1. PRELIMINARY WORKS | 0.00 | 183.12 | 183.12 | 0.00 | 57.20 | 0.00 | 125.92 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2. ENVIRONMENTAL MITIGATION | 0.00 | 248.73 | 248.73 | 0.00 | 22.88 | 0.00 | 47.61 | 0.00 | 74.25 | 0.00 | 77.22 | 0.00 | 26.77 | 0.00 | 0.00 |
| 3. CIVIL WORKS | 1894.61 | 2181.79 | 4076.40 | 0.00 | 0.00 | 494.99 | 271.40 | 818.56 | 726.85 | 435.14 | 933.78 | 145.91 | 249.76 | 0.00 | 0.00 |
| 4. HYDRAULIC EQUIPMENT | 1076.32 | 703.84 | 1780.16 | 0.00 | 0.00 | 0.00 | 0.00 | 122.31 | 94.42 | 532.00 | 448.91 | 422.02 | 160.51 | 0.00 | 0.00 |
| 5. ELECTRO-MECHANICAL EQUIP. | | | | | | | | | | | | | | | |
| -TURBINE, GENERATOR & OTHERS | 4321.17 | 696.39 | 5017.56 | 0.00 | 0.00 | 349.70 | 56.90 | 0.00 | 0.00 | 1566.90 | 252.96 | 1989.11 | 320.01 | 415.47 | 66.53 |
| -MAIN TRANSFORMER | 304.81 | 33.08 | 337.89 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 29.33 | 3.19 | 275.48 | 29.89 | 0.00 | 0.00 |
| 6. TRANSMISSION SYSTEM | 639.23 | 269.24 | 908.46 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 249.15 | 105.16 | 390.08 | 164.08 | 0.00 | 0.00 |
| 7. EGAT ADMINISTRATION | 0.00 | 373.35 | 373.35 | 0.00 | 2.40 | 0.00 | 40.21 | 0.00 | 54.77 | 0.00 | 137.73 | 0.00 | 123.42 | 0.00 | 14.82 |
| 8. ENGINEERING SERVICE | | | | | | | | | | | | | | | |
| -D/D AND TENDER PREPARATION | 34.76 | 11.53 | 46.29 | 27.56 | 9.15 | 7.19 | 2.38 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| -CONSTRUCTION SUPERVISION | 226.51 | 95.68 | 322.19 | 0.00 | 0.00 | 31.47 | 13.39 | 65.72 | 27.84 | 57.17 | 24.13 | 59.68 | 25.10 | 12.46 | 5.22 |
| 9. IMPORT DUTIES & TAXES | 0.00 | 776.48 | 776.48 | 0.00 | 0.00 | 0.00 | 39.57 | 0.00 | 13.78 | 0.00 | 292.58 | 0.00 | 384.28 | 0.00 | 46.27 |
| T O T A L ( W/O IDC ) | 8497.39 | 5573.23 | 14070.63 | 27.56 | 91.63 | 883.36 | 597.39 | 1006.59 | 991.91 | 2869.68 | 2275.66 | 3282.27 | 1483.81 | 427.93 | 132.83 |
| I D C | 0.00 | 2603.20 | 2603.20 | 0.00 | 67.15 | 0.00 | 115.91 | 0.00 | 227.66 | 0.00 | 451.04 | 0.00 | 775.90 | 0.00 | 965.54 |
| TOTAL PROJECT COST | 8497.39 | 8176.43 | 16673.83 | 27.56 | 158.78 | 883.36 | 713.30 | 1006.59 | 1219.57 | 2869.68 | 2726.70 | 3282.27 | 2259.71 | 427.93 | 1098.37 |

# CHAPTER 14

# ECONOMIC EVALUATION

# CHAPTER 14 ECONOMIC EVALUATION

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# CHAPTER 14 ECONOMIC EVALUATION

## 14.1 Methodology

In general, economic evaluation of a development project is designed to measure its socio-economic impact on the country as a whole by comparing two cases; the project is implemented and the project is not implemented.

The economic evaluation employs indices such as net present value of the project, benefit/cost ratio and economic internal rate of return which are calculated from benefits and costs of the project using the "Discounted Cash Flow method".

To determine benefits and costs of a project, market prices obtained should be converted to real benefits and costs, since these are generally distorted due to taxes, government subsidies, import control, import duties, public charges, minimum wages, and other government intervention and monopolistic pricing.

The World Bank and other international financing organizations employ international market prices to estimate real project costs and benefits. The method of economic evaluation employed by the World Bank and other international financing organizations may be summarized as shown in Fig. 14-1.

Phase 1: To exclude items to be transferred to national income from market prices.

Phase 2: To convert market prices for trade goods, non-trade goods, skilled labor, unskilled labor and other items to real (border) prices.

Phase 3: To determine the internal rate of return on the basis of real benefits and costs, and compare it with opportunity cost of capital in the country.

Phase 4: To carry out a socio-economic evaluation considering national saving and income distribution.

For this project, economic evaluation up to Phase 3 is carried out (See Fig. 14-1).

In economic evaluation of hydroelectric power development projects, it is more realistic to measure and compare benefits and costs of the project using the long-term marginal cost method or the tariff system method, if benefits can be accounted for.

However, if benefits cannot be easily accounted for and the project is incorporated in a long range electric power development program which is a part of a national socio-economic development policy to satisfy future power demand (i.e., if the project is not implemented, other means of power supply is to be substituted for it.), an alternative plant approach will be employed to measure and evaluate economic costs of the proposed project and the alternative project.

For this project, the alternative plant approach is employed. Usually, the capacity benefit (kW benefit) of a hydro power plant is evaluated at the fixed cost of an appropriate alternative thermal power plant which has an equivalent capacity to the firm capacity of the hydro power plant. The energy benefit (kWh benefit) is taken to be equal to the variable cost of an alternative thermal power plant which produces an equal amount of energy.

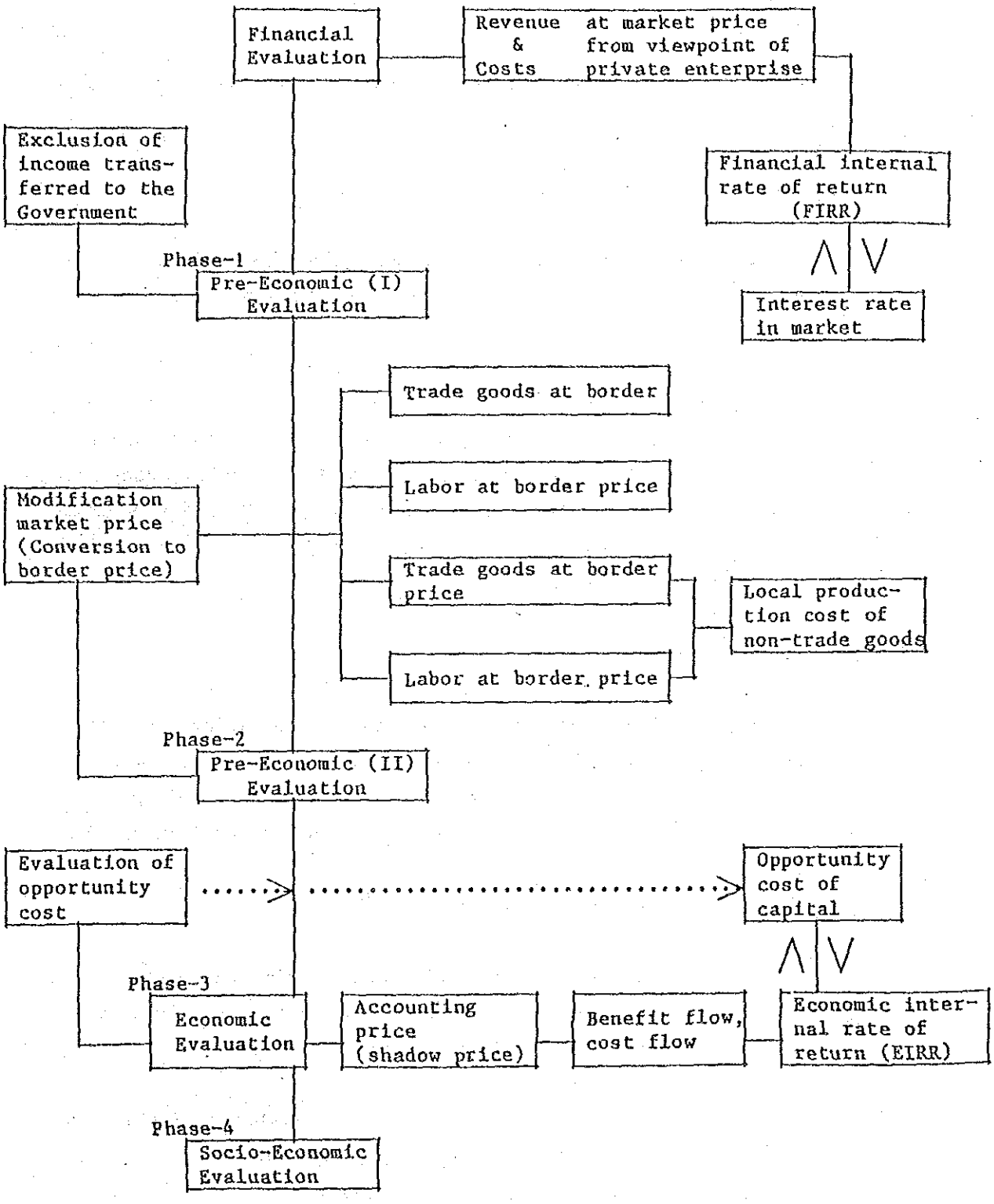


Fig. 14-1 Flow Chart of Economic Evaluation of Project

## 14.2 Basic Conditions

The basic conditions for confirming the economic justification of this project are follows:

(1) Alternative Thermal Power Plant

The gas turbine power plant using diesel oil as fuel is selected as the alternative thermal plant for the evaluation of this project.

Gas turbine or combined cycle is considered for the alternative thermal power plant for the evaluation of this project which is designed to supply peak energy. Since EGAT usually adopts the gas turbine as an alternative thermal power plant for economic justification of hydroelectric power projects, the gas turbine power plant was selected.

(2) Construction Cost

As described in Chapter 13, the cost eliminating the import duties, price contingency and interest during construction from the project cost is adopted as the economic cost of this project. The cost estimates are based on price levels as of January 1991.

— Economic Cost of Lam Ta Khong Project

The economic cost of this project including the transmission line is 11,254.3 Million Baht (US$ 432.9 Million), and annual disbursement schedule is as follows:

(Unit: Million Baht)

| 1st Year | 2nd Year | 3rd Year | 4th Year | 5th Year | 6th Year | Total |
|---|---|---|---|---|---|---|
| 114.5 | 1,326.0 | 1,754.0 | 4,110.5 | 3,550.5 | 398.9 | 11,254.3 |

— Economic Cost of Alternative Thermal Power Plant

Based on the standard unit construction cost of the gas turbine power plant of EGAT (12,064 Baht/kW (464 US$/kW) in economic cost), the following calculation and adjustment will be done for estimation of the economic cost of the gas turbine power plant selected as the alternative thermal power plant.

12,064 Baht/kW x 1,000,000 kW
x 1.09206 (kW adjustment ratio*) = 13,174.6 Million Baht

* KW Adjustment Ratio:

$$\text{<Lam Ta Khong Project>} \quad \frac{[1] \quad [2] \quad [3] \quad [4]}{(1-0.003)\times(1-0.01)\times(1-0.005)\times(1-0.03)}$$

$$\text{<Alternative Power Plant>} \quad (1-0.02)\times(1-0.039)\times(1-0.05)\times(1-0.025)$$

$$= 1.09206$$

[1]: Station Service Rate
[2]: Scheduled Outage Rate
[3]: Forced Outage Rate
[4]: Transmission Loss Ratio

The annual disbursement schedule of the economic cost of the alternative thermal power plant (13,174.6 Million Baht) is as follows:

(Unit: Million Baht)

| 1st Year | 2nd Year | Total |
|---|---|---|
| 2,634.9 | 10,539.7 | 13,174.6 |

(3) Exchange Rate of Currency

The construction cost is estimated using an exchange rate of US$1 = 26 Baht.

(4) Operation and Maintenance Costs

— Lam Ta Khong Project

| | | |
|---|---|---|
| Dam and Reservoir | : | 1% of the civil works and hydraulic equipment cost |
| Generating Facilities | : | 2.5% of the electro-mechanical equipment cost |
| Transmission Facilities | : | 1% of the transmission line cost |

— Alternative Thermal Power Plant

3% of the construction cost

(5) Service Life

— Lam Ta Khong Project

| | | |
|---|---|---|
| Dam and Reservoir | : | 50 years |
| Generating Facilities | : | 25 years |
| Transmission Facilities | : | 40 years |

— Alternative Thermal Power Plant

: 20 years

(6) Station Service Rate, Scheduled Outage Rate, Forced Outage Rate and Transmission Loss Ratio

| | Lam Ta Khong Project | Alternative Thermal Power Plant |
|---|---|---|
| • Station Service Rate | | |
| kW | 0.3% | 2.0% |
| kWh | 0.3% | 2.0% |
| • Scheduled Outage Rate | 1.0% | 3.9% |
| • Forced Outage Rate | 0.5% | 5.0% |
| • Transmission Loss Ratio | | |
| kW | | |
| Generating | 3.0% | 2.5% |
| Pumping | 1.5% | - |
| kWh | | |
| Generating | 1.5% | 1.5% |
| Pumping | 1.5% | - |

(7) Pumping Energy Cost

Based on the Power Development Program (PDP) of EGAT, thermal power plants as the sources of surplus energy and conditions of each thermal power plant are set as the following table:

| | Efficiency at Sending End | Heat Rate kcal/kWh | *Fuel Cost $/mkcal | Rate of Pumping Power Source |
|---|---|---|---|---|
| Lignite Thermal | 32% | 2,690 | 5 | 1% |
| Coal Thermal | 38% | 2,260 | 7 | 18% |
| Oil Thermal | 39% | 2,210 | 10 | 17% |
| Combined Cycle | 47% | 1,830 | 9 | 64% |
| Total | | | | 100% |

* Economic Cost as of 1991

The pumping energy cost is estimated on the condition that the incremental heat rate is 10% due to surplus energy of each thermal power plant.

Pumping Energy Cost = (2,690kcal/kWh x 5$/Mkcal x 1% +
2,260kcal/kWh x 7$/Mkcal x 18% +
2,210kcal/kWh x 10$/Mkcal x 17% +
1,830kcal/kWh x 9$/Mkcal x 64%)
x 26Baht/$ ÷ 110%
= 0.4084 Baht/kWh

(8) Overall Efficiency

The efficiency between pumping energy and generating energy of this project is set at 70%. The overall efficiency will be 68.9% considering the kWh transmission loss ratio (1.5%) for pumping.

(9) Fuel Cost of Alternative Thermal Power Plant

Basic conditions of the gas turbine power plant selected as the alternative power plant are as follows:

— Fuel type : Diesel oil
— Fuel calorific value : 860 kcal/kWh
— Thermal efficiency : 30%
— Unit fuel cost : 2.781 Baht/ℓ (285.3476 Baht/Mkcal)
(including transportation cost)

Accordingly, the unit fuel cost per kWh will be 0.8180 Baht/kWh.

860 kcal/kWh x 285.3476 Baht/Mkcal ÷ 0.3 = 0.8180 Baht/kWh

Furthermore, the unit fuel cost per kWh for estimation of the energy benefit (kWh benefit) of this project is calculated considering the kWh adjustment ratio between this project and the alternative thermal power plant.

0.8180 Baht/kWh x 1.01735 (kWh adjustment ratio*)

= 0.8322 Baht/kWh

* KWH Adjustment Ratio:

$$\text{<Lam Ta Khong Project>} \quad \frac{[1] \qquad [2]}{\text{<Alternative Power Plant>}} \quad \frac{(1-0.003) \times (1-0.015)}{(1-0.02) \times (1-0.015)} = 1.01735$$

[1]: Station Service Rate

[2]: Transmission Loss Ratio

(10) Discount Rate

The discount rate shall be set at 12%.

## 14.3 Economic Analysis

### 14.3.1 Economic Analysis of Adopted Development Plan

(1) As described in item 10.5, Chapter 10, the one stage development plan with a maximum output of 1,000 MW and the reservoir storage capacity of 8 hours is adopted. This economic evaluation is based on 500 MW pumping and 1,000 MW generating considering the present power system expansion plan of EGAT up to the year of 2006.

The cost flow and the benefit flow of the adopted development plan (The most appropriate annual pumping and generating hours are assumed to be 800 hours and 400 hours respectively.) is presented in Table 14-1, and the results of evaluation of B-C, B/C and EDR are as follows:

B-C: 1,504 Million Baht (Discount rate: 12%)
B/C: 1.16 (Discount rate: 12%)
EDR: 17.4%

As indicated by indices of B-C and B/C, the costs of construction and operation of this project is smaller than those of an alternative thermal power plant which can provide equivalent service, and it can be concluded that the project is superior to the alternative plan. It can be also concluded that the project can continue to maintain its superiority as long as the discount rate which reflects the capital opportunity cost does not exceed 17.4%.

(2) The one stage development plan with a maximum output of 1,000 MW (250 MW x 4 units) is the most economical plan, however, study on a deadline of installation of Units 3 and 4 (250 MW x 2 units) which can keep feasibility of the project is carried out on the assumption that the actual project development will be divided into two stages and Units 3 and 4 will be installed later than the year of 1997.

As presented in Fig. 14-2, it can be concluded that Units 3 and 4 shall be installed by the year of 2002 and that the sooner they are installed, the better feasibility of the project from an economic point of view is.

### 14.3.2 Sensitivity Analysis

The sensitivity analysis of the project was implemented for the cases based on conditions stated below;

(1) Increase of Construction Cost

(2) Fluctuation of Fuel Prices (50% ~ 200%)

(3) Fluctuation of Annual Generating Hours

(4) In the case of 1,000 MW Pumping and 1,000 MW Generating

The result of the sensitivity analysis on the increase of the construction cost is shown on Fig. 14-3, and the project is feasible and superior to the alternative thermal power plant as long as the ratio of the increase of the construction cost does not exceed 19%.

The result of the sensitivity analysis on the fluctuation of the fuel prices are as the following table, and it can be concluded that the project is always feasible regardless of the fuel prices.

| Fuel Price | 50% | 75% | 100% | 125% | 150% | 175% | 200% |
|---|---|---|---|---|---|---|---|
| E D R | 16.8% | 17.1% | 17.4% | 17.7% | 18.0% | 18.3% | 18.6% |

Three cases of the sensitivity analysis were implemented on the fluctuation of the annual generating hours.

— Case [1] 750 hours (Pumping: 1,500 hours)

— Case [2] 500 hours (Pumping: 1,000 hours)

— Case [3] 250 hours (Pumping: 500 hours)

The cost flows and the benefit flows of each case are shown on Table 14-2, 14-3 and 14-4 respectively. Judging from the result of evaluation of EDR ranging from 17.0% to 18.5% (in case of B/C: from 1.15 to 1.18), which has tendency to become slightly bigger as the annual generating hours becomes longer, it can be also concluded that the project is feasible.

In addition, the cost flow and benefit flow in the case of 1,000 MW pumping and 1,000 MW generating is shown on Table 14-5. The result of evaluation of EDR is 18.6% (B/C: 1.19), and it is better than the case of 500 MW pumping.

Table 14-1 Cost Flow and Benefit Flow of the Adopted Development Plan

(Unit: Million B)

| Serial Number | No. after Completion | Cost | | | | | Benefit | | | | | B - C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Investment Cost | O&M Cost | Fuel Cost for Pumping | Total | Total (N.P.V.) | Investment Cost | O&M Cost | Fuel Cost | Total | Total (N.P.V.) | |
| 0 | | 0.0 | | | 0.0 | 0.0 | 0.0 | | | 0.0 | 0.0 | 0.0 |
| 1 | | 114.5 | | | 114.5 | 102.2 | 0.0 | | | 0.0 | 0.0 | -114.5 |
| 2 | | 1326.0 | | | 1326.0 | 1057.0 | 0.0 | | | 0.0 | 0.0 | -1326.0 |
| 3 | | 1754.0 | | | 1754.0 | 1248.4 | 0.0 | | | 0.0 | 0.0 | -1754.0 |
| 4 | | 4110.5 | | | 4110.5 | 2612.3 | 0.0 | | | 0.0 | 0.0 | -4110.5 |
| 5 | | 3550.5 | | | 3550.5 | 2014.6 | 2634.9 | | | 2634.9 | 1495.1 | -915.5 |
| 6 | | 398.9 | | | 398.9 | 202.1 | 10539.7 | | | 10539.7 | 5339.7 | 10140.8 |
| 7 | 1 | | 182.9 | 237.1 | 420.0 | 190.0 | | 395.2 | 332.9 | 728.1 | 329.4 | 308.1 |
| 8 | 2 | | 182.9 | 237.1 | 420.0 | 169.6 | | 395.2 | 332.9 | 728.1 | 294.1 | 308.1 |
| 9 | 3 | | 182.9 | 237.1 | 420.0 | 151.4 | | 395.2 | 332.9 | 728.1 | 262.6 | 308.1 |
| 10 | 4 | | 182.9 | 237.1 | 420.0 | 135.2 | | 395.2 | 332.9 | 728.1 | 234.4 | 308.1 |
| 11 | 5 | | 182.9 | 237.1 | 420.0 | 120.7 | | 395.2 | 332.9 | 728.1 | 209.3 | 308.1 |
| 12 | 6 | | 182.9 | 237.1 | 420.0 | 107.8 | | 395.2 | 332.9 | 728.1 | 186.9 | 308.1 |
| 13 | 7 | | 182.9 | 237.1 | 420.0 | 96.2 | | 395.2 | 332.9 | 728.1 | 166.9 | 308.1 |
| 14 | 8 | | 182.9 | 237.1 | 420.0 | 85.9 | | 395.2 | 332.9 | 728.1 | 149.0 | 308.1 |
| 15 | 9 | | 182.9 | 237.1 | 420.0 | 76.7 | | 395.2 | 332.9 | 728.1 | 133.0 | 308.1 |
| 16 | 10 | | 182.9 | 237.1 | 420.0 | 68.5 | | 395.2 | 332.9 | 728.1 | 118.8 | 308.1 |
| 17 | 11 | | 182.9 | 237.1 | 420.0 | 61.2 | | 395.2 | 332.9 | 728.1 | 106.0 | 308.1 |
| 18 | 12 | | 182.9 | 237.1 | 420.0 | 54.6 | | 395.2 | 332.9 | 728.1 | 94.7 | 308.1 |
| 19 | 13 | | 182.9 | 237.1 | 420.0 | 48.8 | | 395.2 | 332.9 | 728.1 | 84.5 | 308.1 |
| 20 | 14 | | 182.9 | 237.1 | 420.0 | 43.5 | | 395.2 | 332.9 | 728.1 | 75.5 | 308.1 |
| 21 | 15 | | 182.9 | 237.1 | 420.0 | 38.9 | | 395.2 | 332.9 | 728.1 | 67.4 | 308.1 |
| 22 | 16 | | 182.9 | 237.1 | 420.0 | 34.7 | | 395.2 | 332.9 | 728.1 | 60.2 | 308.1 |
| 23 | 17 | | 182.9 | 237.1 | 420.0 | 31.0 | | 395.2 | 332.9 | 728.1 | 53.7 | 308.1 |
| 24 | 18 | | 182.9 | 237.1 | 420.0 | 27.7 | | 395.2 | 332.9 | 728.1 | 48.0 | 308.1 |
| 25 | 19 | | 182.9 | 237.1 | 420.0 | 24.7 | 2634.9 | 395.2 | 332.9 | 3363.0 | 197.8 | 2943.1 |
| 26 | 20 | | 182.9 | 237.1 | 420.0 | 22.1 | 10539.7 | 395.2 | 332.9 | 11267.8 | 591.8 | 10847.8 |
| 27 | 21 | 395.8 | 182.9 | 237.1 | 815.8 | 38.3 | | 395.2 | 332.9 | 728.1 | 34.1 | -87.7 |
| 28 | 22 | 0.0 | 182.9 | 237.1 | 420.0 | 17.6 | | 395.2 | 332.9 | 728.1 | 30.5 | 308.1 |
| 29 | 23 | 1656.3 | 182.9 | 237.1 | 2076.3 | 77.6 | | 395.2 | 332.9 | 728.1 | 27.2 | -1348.2 |
| 30 | 24 | 2240.6 | 182.9 | 237.1 | 2660.6 | 88.8 | | 395.2 | 332.9 | 728.1 | 24.3 | -1932.5 |
| 31 | 25 | 395.8 | 182.9 | 237.1 | 815.8 | 24.3 | | 395.2 | 332.9 | 728.1 | 21.7 | -87.7 |
| 32 | 26 | | 182.9 | 237.1 | 420.0 | 11.2 | | 395.2 | 332.9 | 728.1 | 19.4 | 308.1 |
| 33 | 27 | | 182.9 | 237.1 | 420.0 | 10.0 | | 395.2 | 332.9 | 728.1 | 17.3 | 308.1 |
| 34 | 28 | | 182.9 | 237.1 | 420.0 | 8.9 | | 395.2 | 332.9 | 728.1 | 15.4 | 308.1 |
| 35 | 29 | | 182.9 | 237.1 | 420.0 | 8.0 | | 395.2 | 332.9 | 728.1 | 13.8 | 308.1 |
| 36 | 30 | | 182.9 | 237.1 | 420.0 | 7.1 | | 395.2 | 332.9 | 728.1 | 12.3 | 308.1 |
| 37 | 31 | | 182.9 | 237.1 | 420.0 | 6.3 | | 395.2 | 332.9 | 728.1 | 11.0 | 308.1 |
| 38 | 32 | | 182.9 | 237.1 | 420.0 | 5.7 | | 395.2 | 332.9 | 728.1 | 9.8 | 308.1 |
| 39 | 33 | | 182.9 | 237.1 | 420.0 | 5.1 | | 395.2 | 332.9 | 728.1 | 8.8 | 308.1 |
| 40 | 34 | | 182.9 | 237.1 | 420.0 | 4.5 | | 395.2 | 332.9 | 728.1 | 7.8 | 308.1 |
| 41 | 35 | | 182.9 | 237.1 | 420.0 | 4.0 | | 395.2 | 332.9 | 728.1 | 7.0 | 308.1 |
| 42 | 36 | | 182.9 | 237.1 | 420.0 | 3.6 | | 395.2 | 332.9 | 728.1 | 6.2 | 308.1 |
| 43 | 37 | | 182.9 | 237.1 | 420.0 | 3.2 | | 395.2 | 332.9 | 728.1 | 5.6 | 308.1 |
| 44 | 38 | 317.6 | 182.9 | 237.1 | 737.5 | 5.0 | | 395.2 | 332.9 | 728.1 | 5.0 | -9.4 |
| 45 | 39 | 476.4 | 182.9 | 237.1 | 896.3 | 5.5 | 2634.9 | 395.2 | 332.9 | 3363.0 | 20.5 | 2466.7 |
| 46 | 40 | | 182.9 | 237.1 | 420.0 | 2.3 | 10539.7 | 395.2 | 332.9 | 11267.8 | 61.3 | 10847.8 |
| 47 | 41 | | 182.9 | 237.1 | 420.0 | 2.0 | | 395.2 | 332.9 | 728.1 | 3.5 | 308.1 |
| 48 | 42 | | 182.9 | 237.1 | 420.0 | 1.8 | | 395.2 | 332.9 | 728.1 | 3.2 | 308.1 |
| 49 | 43 | | 182.9 | 237.1 | 420.0 | 1.6 | | 395.2 | 332.9 | 728.1 | 2.8 | 308.1 |
| 50 | 44 | | 182.9 | 237.1 | 420.0 | 1.5 | | 395.2 | 332.9 | 728.1 | 2.5 | 308.1 |
| 51 | 45 | | 182.9 | 237.1 | 420.0 | 1.3 | | 395.2 | 332.9 | 728.1 | 2.2 | 308.1 |
| 52 | 46 | | 182.9 | 237.1 | 420.0 | 1.2 | | 395.2 | 332.9 | 728.1 | 2.0 | 308.1 |
| 53 | 47 | | 182.9 | 237.1 | 420.0 | 1.0 | | 395.2 | 332.9 | 728.1 | 1.8 | 308.1 |
| 54 | 48 | | 182.9 | 237.1 | 420.0 | 0.9 | | 395.2 | 332.9 | 728.1 | 1.6 | 308.1 |
| 55 | 49 | | 182.9 | 237.1 | 420.0 | 0.8 | | 395.2 | 332.9 | 728.1 | 1.4 | 308.1 |
| 56 | 50 | | 182.9 | 237.1 | 420.0 | 0.7 | | 395.2 | 332.9 | 728.1 | 1.3 | 308.1 |
| | | 16736.8 | 9143.6 | 11854.9 | 37735.2 | 9175.8 | 39523.8 | 19761.9 | 16644.0 | 75929.8 | 10680.3 | 38194.6 |

| | |
|---|---|
| B - C | 1504.4661 |
| B / C | 1.1639598 |
| E D R | 0.1744519 |

Table 14-2 Sensitivity Analysis

(Annual Generating Hours: 750 hrs)

(Unit: Million B)

| Serial Number | No. after Completion | Cost | | | | | Benefit | | | | | B - C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Investment Cost | O&M Cost | Fuel Cost for Pumping | Total | Total (N.P.V.) | Investment Cost | O&M Cost | Fuel Cost | Total | Total (N.P.V.) | |
| 0 | | 0.0 | | | 0.0 | 0.0 | 0.0 | | | 0.0 | 0.0 | 0.0 |
| 1 | | 114.5 | | | 114.5 | 102.2 | 0.0 | | | 0.0 | 0.0 | -114.5 |
| 2 | | 1326.0 | | | 1326.0 | 1057.0 | 0.0 | | | 0.0 | 0.0 | -1326.0 |
| 3 | | 1754.0 | | | 1754.0 | 1248.4 | 0.0 | | | 0.0 | 0.0 | -1754.0 |
| 4 | | 4110.5 | | | 4110.5 | 2612.3 | 0.0 | | | 0.0 | 0.0 | -4110.5 |
| 5 | | 3550.5 | | | 3550.5 | 2014.6 | 2634.9 | | | 2634.9 | 1495.1 | -915.5 |
| 6 | | 398.9 | | | 398.9 | 202.1 | 10539.7 | | | 10539.7 | 5339.7 | 10140.8 |
| 7 | 1 | | 182.9 | 444.6 | 627.4 | 283.8 | | 395.2 | 624.2 | 1019.4 | 461.1 | 392.0 |
| 8 | 2 | | 182.9 | 444.6 | 627.4 | 253.4 | | 395.2 | 624.2 | 1019.4 | 411.7 | 392.0 |
| 9 | 3 | | 182.9 | 444.6 | 627.4 | 226.3 | | 395.2 | 624.2 | 1019.4 | 367.6 | 392.0 |
| 10 | 4 | | 182.9 | 444.6 | 627.4 | 202.0 | | 395.2 | 624.2 | 1019.4 | 328.2 | 392.0 |
| 11 | 5 | | 182.9 | 444.6 | 627.4 | 180.4 | | 395.2 | 624.2 | 1019.4 | 293.0 | 392.0 |
| 12 | 6 | | 182.9 | 444.6 | 627.4 | 161.0 | | 395.2 | 624.2 | 1019.4 | 261.7 | 392.0 |
| 13 | 7 | | 182.9 | 444.6 | 627.4 | 143.8 | | 395.2 | 624.2 | 1019.4 | 233.6 | 392.0 |
| 14 | 8 | | 182.9 | 444.6 | 627.4 | 128.4 | | 395.2 | 624.2 | 1019.4 | 208.6 | 392.0 |
| 15 | 9 | | 182.9 | 444.6 | 627.4 | 114.6 | | 395.2 | 624.2 | 1019.4 | 186.2 | 392.0 |
| 16 | 10 | | 182.9 | 444.6 | 627.4 | 102.3 | | 395.2 | 624.2 | 1019.4 | 166.3 | 392.0 |
| 17 | 11 | | 182.9 | 444.6 | 627.4 | 91.4 | | 395.2 | 624.2 | 1019.4 | 148.5 | 392.0 |
| 18 | 12 | | 182.9 | 444.6 | 627.4 | 81.6 | | 395.2 | 624.2 | 1019.4 | 132.6 | 392.0 |
| 19 | 13 | | 182.9 | 444.6 | 627.4 | 72.8 | | 395.2 | 624.2 | 1019.4 | 118.4 | 392.0 |
| 20 | 14 | | 182.9 | 444.6 | 627.4 | 65.0 | | 395.2 | 624.2 | 1019.4 | 105.7 | 392.0 |
| 21 | 15 | | 182.9 | 444.6 | 627.4 | 58.1 | | 395.2 | 624.2 | 1019.4 | 94.4 | 392.0 |
| 22 | 16 | | 182.9 | 444.6 | 627.4 | 51.9 | | 395.2 | 624.2 | 1019.4 | 84.2 | 392.0 |
| 23 | 17 | | 182.9 | 444.6 | 627.4 | 46.3 | | 395.2 | 624.2 | 1019.4 | 75.2 | 392.0 |
| 24 | 18 | | 182.9 | 444.6 | 627.4 | 41.3 | | 395.2 | 624.2 | 1019.4 | 67.2 | 392.0 |
| 25 | 19 | | 182.9 | 444.6 | 627.4 | 36.9 | 2634.9 | 395.2 | 624.2 | 3654.3 | 215.0 | 3026.9 |
| 26 | 20 | | 182.9 | 444.6 | 627.4 | 33.0 | 10539.7 | 395.2 | 624.2 | 11559.1 | 607.1 | 10931.6 |
| 27 | 21 | 395.8 | 182.9 | 444.6 | 1023.2 | 48.0 | | 395.2 | 624.2 | 1019.4 | 47.8 | -3.9 |
| 28 | 22 | 0.0 | 182.9 | 444.6 | 627.4 | 26.3 | | 395.2 | 624.2 | 1019.4 | 42.7 | 392.0 |
| 29 | 23 | 1656.3 | 182.9 | 444.6 | 2283.7 | 85.4 | | 395.2 | 624.2 | 1019.4 | 38.1 | -1264.3 |
| 30 | 24 | 2240.6 | 182.9 | 444.6 | 2868.0 | 95.7 | | 395.2 | 624.2 | 1019.4 | 34.0 | -1848.7 |
| 31 | 25 | 395.8 | 182.9 | 444.6 | 1023.2 | 30.5 | | 395.2 | 624.2 | 1019.4 | 30.4 | -3.9 |
| 32 | 26 | | 182.9 | 444.6 | 627.4 | 16.7 | | 395.2 | 624.2 | 1019.4 | 27.1 | 392.0 |
| 33 | 27 | | 182.9 | 444.6 | 627.4 | 14.9 | | 395.2 | 624.2 | 1019.4 | 24.2 | 392.0 |
| 34 | 28 | | 182.9 | 444.6 | 627.4 | 13.3 | | 395.2 | 624.2 | 1019.4 | 21.6 | 392.0 |
| 35 | 29 | | 182.9 | 444.6 | 627.4 | 11.9 | | 395.2 | 624.2 | 1019.4 | 19.3 | 392.0 |
| 36 | 30 | | 182.9 | 444.6 | 627.4 | 10.6 | | 395.2 | 624.2 | 1019.4 | 17.2 | 392.0 |
| 37 | 31 | | 182.9 | 444.6 | 627.4 | 9.5 | | 395.2 | 624.2 | 1019.4 | 15.4 | 392.0 |
| 38 | 32 | | 182.9 | 444.6 | 627.4 | 8.5 | | 395.2 | 624.2 | 1019.4 | 13.7 | 392.0 |
| 39 | 33 | | 182.9 | 444.6 | 627.4 | 7.6 | | 395.2 | 624.2 | 1019.4 | 12.3 | 392.0 |
| 40 | 34 | | 182.9 | 444.6 | 627.4 | 6.7 | | 395.2 | 624.2 | 1019.4 | 11.0 | 392.0 |
| 41 | 35 | | 182.9 | 444.6 | 627.4 | 6.0 | | 395.2 | 624.2 | 1019.4 | 9.8 | 392.0 |
| 42 | 36 | | 182.9 | 444.6 | 627.4 | 5.4 | | 395.2 | 624.2 | 1019.4 | 8.7 | 392.0 |
| 43 | 37 | | 182.9 | 444.6 | 627.4 | 4.8 | | 395.2 | 624.2 | 1019.4 | 7.8 | 392.0 |
| 44 | 38 | 317.6 | 182.9 | 444.6 | 945.0 | 6.5 | | 395.2 | 624.2 | 1019.4 | 7.0 | 74.4 |
| 45 | 39 | 476.4 | 182.9 | 444.6 | 1103.8 | 6.7 | 2634.9 | 395.2 | 624.2 | 3654.3 | 22.3 | 2550.5 |
| 46 | 40 | | 182.9 | 444.6 | 627.4 | 3.4 | 10539.7 | 395.2 | 624.2 | 11559.1 | 62.9 | 10931.6 |
| 47 | 41 | | 182.9 | 444.6 | 627.4 | 3.1 | | 395.2 | 624.2 | 1019.4 | 5.0 | 392.0 |
| 48 | 42 | | 182.9 | 444.6 | 627.4 | 2.7 | | 395.2 | 624.2 | 1019.4 | 4.4 | 392.0 |
| 49 | 43 | | 182.9 | 444.6 | 627.4 | 2.4 | | 395.2 | 624.2 | 1019.4 | 4.0 | 392.0 |
| 50 | 44 | | 182.9 | 444.6 | 627.4 | 2.2 | | 395.2 | 624.2 | 1019.4 | 3.5 | 392.0 |
| 51 | 45 | | 182.9 | 444.6 | 627.4 | 1.9 | | 395.2 | 624.2 | 1019.4 | 3.1 | 392.0 |
| 52 | 46 | | 182.9 | 444.6 | 627.4 | 1.7 | | 395.2 | 624.2 | 1019.4 | 2.8 | 392.0 |
| 53 | 47 | | 182.9 | 444.6 | 627.4 | 1.5 | | 395.2 | 624.2 | 1019.4 | 2.5 | 392.0 |
| 54 | 48 | | 182.9 | 444.6 | 627.4 | 1.4 | | 395.2 | 624.2 | 1019.4 | 2.2 | 392.0 |
| 55 | 49 | | 182.9 | 444.6 | 627.4 | 1.2 | | 395.2 | 624.2 | 1019.4 | 2.0 | 392.0 |
| 56 | 50 | | 182.9 | 444.6 | 627.4 | 1.1 | | 395.2 | 624.2 | 1019.4 | 1.8 | 392.0 |
| | | 15736.8 | 9143.6 | 22227.9 | 48108.2 | 10048.7 | 39525.8 | 19761.9 | 31207.5 | 90493.3 | 11905.8 | 42386.1 |

| | |
|---|---|
| B - C | 1857.0810 |
| B / C | 1.1848086 |
| E D R | 0.1846826 |

## Table 14-3 Sensitivity Analysis

(Annual Generating Hours: 500 hrs)

(Unit: Million B)

| Serial Number | No. after Completion | Cost | | | | | Benefit | | | | | B - C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Investment Cost | O&M Cost | Fuel Cost for Pumping | Total | Total (N.P.V.) | Investment Cost | O&M Cost | Fuel Cost | Total | Total (N.P.V.) | |
| 0 | | 0.0 | | | 0.0 | 0.0 | 0.0 | | | 0.0 | 0.0 | 0.0 |
| 1 | | 114.5 | | | 114.5 | 102.2 | 0.0 | | | 0.0 | 0.0 | -114.5 |
| 2 | | 1326.0 | | | 1326.0 | 1057.0 | 0.0 | | | 0.0 | 0.0 | -1326.0 |
| 3 | | 1754.0 | | | 1754.0 | 1248.4 | 0.0 | | | 0.0 | 0.0 | -1754.0 |
| 4 | | 4110.5 | | | 4110.5 | 2612.3 | 0.0 | | | 0.0 | 0.0 | -4110.5 |
| 5 | | 3550.5 | | | 3550.5 | 2014.6 | 2634.9 | | | 2634.9 | 1495.1 | -915.5 |
| 6 | | 398.9 | | | 398.9 | 202.1 | 10539.7 | | | 10539.7 | 5339.7 | 10140.8 |
| 7 | 1 | | 182.9 | 296.4 | 479.2 | 216.8 | | 395.2 | 416.1 | 811.3 | 367.0 | 332.1 |
| 8 | 2 | | 182.9 | 296.4 | 479.2 | 196.6 | | 395.2 | 416.1 | 811.3 | 327.7 | 332.1 |
| 9 | 3 | | 182.9 | 296.4 | 479.2 | 172.8 | | 395.2 | 416.1 | 811.3 | 292.5 | 332.1 |
| 10 | 4 | | 182.9 | 296.4 | 479.2 | 154.3 | | 395.2 | 416.1 | 811.3 | 261.2 | 332.1 |
| 11 | 5 | | 182.9 | 296.4 | 479.2 | 137.8 | | 395.2 | 416.1 | 811.3 | 233.2 | 332.1 |
| 12 | 6 | | 182.9 | 296.4 | 479.2 | 123.0 | | 395.2 | 416.1 | 811.3 | 208.3 | 332.1 |
| 13 | 7 | | 182.9 | 296.4 | 479.2 | 109.8 | | 395.2 | 416.1 | 811.3 | 185.9 | 332.1 |
| 14 | 8 | | 182.9 | 296.4 | 479.2 | 98.1 | | 395.2 | 416.1 | 811.3 | 165.0 | 332.1 |
| 15 | 9 | | 182.9 | 296.4 | 479.2 | 87.6 | | 395.2 | 416.1 | 811.3 | 148.2 | 332.1 |
| 16 | 10 | | 182.9 | 296.4 | 479.2 | 78.2 | | 395.2 | 416.1 | 811.3 | 132.3 | 332.1 |
| 17 | 11 | | 182.9 | 296.4 | 479.2 | 69.8 | | 395.2 | 416.1 | 811.3 | 118.2 | 332.1 |
| 18 | 12 | | 182.9 | 296.4 | 479.2 | 62.3 | | 395.2 | 416.1 | 811.3 | 105.5 | 332.1 |
| 19 | 13 | | 182.9 | 296.4 | 479.2 | 55.6 | | 395.2 | 416.1 | 811.3 | 94.2 | 332.1 |
| 20 | 14 | | 182.9 | 296.4 | 479.2 | 49.7 | | 395.2 | 416.1 | 811.3 | 84.1 | 332.1 |
| 21 | 15 | | 182.9 | 296.4 | 479.2 | 44.4 | | 395.2 | 416.1 | 811.3 | 75.1 | 332.1 |
| 22 | 16 | | 182.9 | 296.4 | 479.2 | 39.6 | | 395.2 | 416.1 | 811.3 | 67.1 | 332.1 |
| 23 | 17 | | 182.9 | 296.4 | 479.2 | 35.4 | | 395.2 | 416.1 | 811.3 | 59.9 | 332.1 |
| 24 | 18 | | 182.9 | 296.4 | 479.2 | 31.6 | | 395.2 | 416.1 | 811.3 | 53.5 | 332.1 |
| 25 | 19 | | 182.9 | 296.4 | 479.2 | 28.2 | 2634.9 | 395.2 | 416.1 | 3446.3 | 202.7 | 2967.0 |
| 26 | 20 | | 182.9 | 296.4 | 479.2 | 25.2 | 10539.7 | 395.2 | 416.1 | 11351.0 | 596.2 | 10871.8 |
| 27 | 21 | 395.8 | 182.9 | 296.4 | 875.1 | 41.0 | | 395.2 | 416.1 | 811.3 | 38.0 | -63.7 |
| 28 | 22 | 0.0 | 182.9 | 296.4 | 479.2 | 20.1 | | 395.2 | 416.1 | 811.3 | 34.0 | 332.1 |
| 29 | 23 | 1656.3 | 182.9 | 296.4 | 2135.5 | 79.8 | | 395.2 | 416.1 | 811.3 | 30.3 | -1324.2 |
| 30 | 24 | 2240.6 | 182.9 | 296.4 | 2719.9 | 90.8 | | 395.2 | 416.1 | 811.3 | 27.1 | -1908.5 |
| 31 | 25 | 395.8 | 182.9 | 296.4 | 875.1 | 26.1 | | 395.2 | 416.1 | 811.3 | 24.2 | -63.7 |
| 32 | 26 | | 182.9 | 296.4 | 479.2 | 12.8 | | 395.2 | 416.1 | 811.3 | 21.6 | 332.1 |
| 33 | 27 | | 182.9 | 296.4 | 479.2 | 11.4 | | 395.2 | 416.1 | 811.3 | 19.3 | 332.1 |
| 34 | 28 | | 182.9 | 296.4 | 479.2 | 10.2 | | 395.2 | 416.1 | 811.3 | 17.2 | 332.1 |
| 35 | 29 | | 182.9 | 296.4 | 479.2 | 9.1 | | 395.2 | 416.1 | 811.3 | 15.4 | 332.1 |
| 36 | 30 | | 182.9 | 296.4 | 479.2 | 8.1 | | 395.2 | 416.1 | 811.3 | 13.7 | 332.1 |
| 37 | 31 | | 182.9 | 296.4 | 479.2 | 7.2 | | 395.2 | 416.1 | 811.3 | 12.2 | 332.1 |
| 38 | 32 | | 182.9 | 296.4 | 479.2 | 6.5 | | 395.2 | 416.1 | 811.3 | 10.9 | 332.1 |
| 39 | 33 | | 182.9 | 296.4 | 479.2 | 5.8 | | 395.2 | 416.1 | 811.3 | 9.8 | 332.1 |
| 40 | 34 | | 182.9 | 296.4 | 479.2 | 5.2 | | 395.2 | 416.1 | 811.3 | 8.7 | 332.1 |
| 41 | 35 | | 182.9 | 296.4 | 479.2 | 4.6 | | 395.2 | 416.1 | 811.3 | 7.8 | 332.1 |
| 42 | 36 | | 182.9 | 296.4 | 479.2 | 4.1 | | 395.2 | 416.1 | 811.3 | 7.0 | 332.1 |
| 43 | 37 | | 182.9 | 296.4 | 479.2 | 3.7 | | 395.2 | 416.1 | 811.3 | 6.2 | 332.1 |
| 44 | 38 | 317.6 | 182.9 | 296.4 | 796.8 | 5.4 | | 395.2 | 416.1 | 811.3 | 5.5 | 14.5 |
| 45 | 39 | 476.4 | 182.9 | 296.4 | 955.6 | 5.8 | 2634.9 | 395.2 | 416.1 | 3446.3 | 21.0 | 2490.7 |
| 46 | 40 | | 182.9 | 296.4 | 479.2 | 2.6 | 10539.7 | 395.2 | 416.1 | 11351.0 | 61.8 | 10871.8 |
| 47 | 41 | | 182.9 | 296.4 | 479.2 | 2.3 | | 395.2 | 416.1 | 811.3 | 3.9 | 332.1 |
| 48 | 42 | | 182.9 | 296.4 | 479.2 | 2.1 | | 395.2 | 416.1 | 811.3 | 3.5 | 332.1 |
| 49 | 43 | | 182.9 | 296.4 | 479.2 | 1.9 | | 395.2 | 416.1 | 811.3 | 3.1 | 332.1 |
| 50 | 44 | | 182.9 | 296.4 | 479.2 | 1.7 | | 395.2 | 416.1 | 811.3 | 2.8 | 332.1 |
| 51 | 45 | | 182.9 | 296.4 | 479.2 | 1.5 | | 395.2 | 416.1 | 811.3 | 2.5 | 332.1 |
| 52 | 46 | | 182.9 | 296.4 | 479.2 | 1.3 | | 395.2 | 416.1 | 811.3 | 2.2 | 332.1 |
| 53 | 47 | | 182.9 | 296.4 | 479.2 | 1.2 | | 395.2 | 416.1 | 811.3 | 2.0 | 332.1 |
| 54 | 48 | | 182.9 | 296.4 | 479.2 | 1.1 | | 395.2 | 416.1 | 811.3 | 1.8 | 332.1 |
| 55 | 49 | | 182.9 | 296.4 | 479.2 | 0.9 | | 395.2 | 416.1 | 811.3 | 1.6 | 332.1 |
| 56 | 50 | | 182.9 | 296.4 | 479.2 | 0.8 | | 395.2 | 416.1 | 811.3 | 1.4 | 332.1 |
| | | 16736.8 | 9143.6 | 14818.5 | 40698.9 | 9425.2 | 39523.8 | 19761.9 | 20805.0 | 80090.8 | 11030.4 | 39391.8 |

| | |
|---|---|
| B - C | 1605.2132 |
| B / C | 1.1703106 |
| E D R | 0.1774474 |

## Table 14-4 Sensitivity Analysis

(Annual Generating Hours: 250 hrs)

(Unit: Million B)

| Serial Number | No. after Completion | Cost | | | | | Benefit | | | | | B - C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Investment Cost | O&M Cost | Fuel Cost for Pumping | Total | Total (N.P.V.) | Investment Cost | O&M Cost | Fuel Cost | Total | Total (N.P.V.) | |
| 0 | | 0.0 | | | 0.0 | 0.0 | 0.0 | | | 0.0 | 0.0 | 0.0 |
| 1 | | 114.5 | | | 114.5 | 102.2 | 0.0 | | | 0.0 | 0.0 | -114.5 |
| 2 | | 1326.0 | | | 1326.0 | 1057.0 | 0.0 | | | 0.0 | 0.0 | -1326.0 |
| 3 | | 1754.0 | | | 1754.0 | 1248.4 | 0.0 | | | 0.0 | 0.0 | -1754.0 |
| 4 | | 4110.5 | | | 4110.5 | 2612.3 | 0.0 | | | 0.0 | 0.0 | -4110.5 |
| 5 | | 3550.5 | | | 3550.5 | 2014.6 | 2634.9 | | | 2634.9 | 1499.1 | -915.5 |
| 6 | | 398.9 | | | 398.9 | 202.1 | 10539.7 | | | 10539.7 | 5339.7 | 10140.8 |
| 7 | 1 | | 182.9 | 148.2 | 331.1 | 149.8 | | 395.2 | 208.1 | 603.3 | 272.9 | 272.2 |
| 8 | 2 | | 182.9 | 148.2 | 331.1 | 133.7 | | 395.2 | 208.1 | 603.3 | 243.7 | 272.2 |
| 9 | 3 | | 182.9 | 148.2 | 331.1 | 119.4 | | 395.2 | 208.1 | 603.3 | 217.6 | 272.2 |
| 10 | 4 | | 182.9 | 148.2 | 331.1 | 106.6 | | 395.2 | 208.1 | 603.3 | 194.2 | 272.2 |
| 11 | 5 | | 182.9 | 148.2 | 331.1 | 95.2 | | 395.2 | 208.1 | 603.3 | 173.4 | 272.2 |
| 12 | 6 | | 182.9 | 148.2 | 331.1 | 85.0 | | 395.2 | 208.1 | 603.3 | 154.8 | 272.2 |
| 13 | 7 | | 182.9 | 148.2 | 331.1 | 75.9 | | 395.2 | 208.1 | 603.3 | 138.3 | 272.2 |
| 14 | 8 | | 182.9 | 148.2 | 331.1 | 67.7 | | 395.2 | 208.1 | 603.3 | 123.4 | 272.2 |
| 15 | 9 | | 182.9 | 148.2 | 331.1 | 60.5 | | 395.2 | 208.1 | 603.3 | 110.2 | 272.2 |
| 16 | 10 | | 182.9 | 148.2 | 331.1 | 54.0 | | 395.2 | 208.1 | 603.3 | 98.4 | 272.2 |
| 17 | 11 | | 182.9 | 148.2 | 331.1 | 48.2 | | 395.2 | 208.1 | 603.3 | 87.9 | 272.2 |
| 18 | 12 | | 182.9 | 148.2 | 331.1 | 43.1 | | 395.2 | 208.1 | 603.3 | 78.5 | 272.2 |
| 19 | 13 | | 182.9 | 148.2 | 331.1 | 38.4 | | 395.2 | 208.1 | 603.3 | 70.0 | 272.2 |
| 20 | 14 | | 182.9 | 148.2 | 331.1 | 34.3 | | 395.2 | 208.1 | 603.3 | 62.5 | 272.2 |
| 21 | 15 | | 182.9 | 148.2 | 331.1 | 30.6 | | 395.2 | 208.1 | 603.3 | 55.8 | 272.2 |
| 22 | 16 | | 182.9 | 148.2 | 331.1 | 27.4 | | 395.2 | 208.1 | 603.3 | 49.9 | 272.2 |
| 23 | 17 | | 182.9 | 148.2 | 331.1 | 24.4 | | 395.2 | 208.1 | 603.3 | 44.5 | 272.2 |
| 24 | 18 | | 182.9 | 148.2 | 331.1 | 21.8 | | 395.2 | 208.1 | 603.3 | 39.7 | 272.2 |
| 25 | 19 | | 182.9 | 148.2 | 331.1 | 19.5 | 2634.9 | 395.2 | 208.1 | 3238.2 | 190.5 | 2907.2 |
| 26 | 20 | | 182.9 | 148.2 | 331.1 | 17.4 | 10539.7 | 395.2 | 208.1 | 11143.0 | 585.2 | 10811.9 |
| 27 | 21 | 395.8 | 182.9 | 148.2 | 726.9 | 34.1 | | 395.2 | 208.1 | 603.3 | 28.3 | -123.6 |
| 28 | 22 | 0.0 | 182.9 | 148.2 | 331.1 | 13.9 | | 395.2 | 208.1 | 603.3 | 25.3 | 272.2 |
| 29 | 23 | 1656.3 | 182.9 | 148.2 | 1987.4 | 74.3 | | 395.2 | 208.1 | 603.3 | 22.6 | -1384.1 |
| 30 | 24 | 2240.6 | 182.9 | 148.2 | 2571.7 | 85.8 | | 395.2 | 208.1 | 603.3 | 20.1 | -1968.4 |
| 31 | 25 | 395.8 | 182.9 | 148.2 | 726.9 | 21.7 | | 395.2 | 208.1 | 603.3 | 18.0 | -123.6 |
| 32 | 26 | | 182.9 | 148.2 | 331.1 | 8.8 | | 395.2 | 208.1 | 603.3 | 16.1 | 272.2 |
| 33 | 27 | | 182.9 | 148.2 | 331.1 | 7.9 | | 395.2 | 208.1 | 603.3 | 14.3 | 272.2 |
| 34 | 28 | | 182.9 | 148.2 | 331.1 | 7.0 | | 395.2 | 208.1 | 603.3 | 12.8 | 272.2 |
| 35 | 29 | | 182.9 | 148.2 | 331.1 | 6.3 | | 395.2 | 208.1 | 603.3 | 11.4 | 272.2 |
| 36 | 30 | | 182.9 | 148.2 | 331.1 | 5.6 | | 395.2 | 208.1 | 603.3 | 10.2 | 272.2 |
| 37 | 31 | | 182.9 | 148.2 | 331.1 | 5.0 | | 395.2 | 208.1 | 603.3 | 9.1 | 272.2 |
| 38 | 32 | | 182.9 | 148.2 | 331.1 | 4.5 | | 395.2 | 208.1 | 603.3 | 8.1 | 272.2 |
| 39 | 33 | | 182.9 | 148.2 | 331.1 | 4.0 | | 395.2 | 208.1 | 603.3 | 7.3 | 272.2 |
| 40 | 34 | | 182.9 | 148.2 | 331.1 | 3.6 | | 395.2 | 208.1 | 603.3 | 6.5 | 272.2 |
| 41 | 35 | | 182.9 | 148.2 | 331.1 | 3.2 | | 395.2 | 208.1 | 603.3 | 5.8 | 272.2 |
| 42 | 36 | | 182.9 | 148.2 | 331.1 | 2.8 | | 395.2 | 208.1 | 603.3 | 5.2 | 272.2 |
| 43 | 37 | | 182.9 | 148.2 | 331.1 | 2.5 | | 395.2 | 208.1 | 603.3 | 4.6 | 272.2 |
| 44 | 38 | 317.6 | 182.9 | 148.2 | 648.6 | 4.4 | | 395.2 | 208.1 | 603.3 | 4.1 | -45.3 |
| 45 | 39 | 476.4 | 182.9 | 148.2 | 807.4 | 4.9 | 2634.9 | 395.2 | 208.1 | 3238.2 | 19.7 | 2430.8 |
| 46 | 40 | | 182.9 | 148.2 | 331.1 | 1.8 | 10539.7 | 395.2 | 208.1 | 11143.0 | 60.7 | 10811.9 |
| 47 | 41 | | 182.9 | 148.2 | 331.1 | 1.6 | | 395.2 | 208.1 | 603.3 | 2.9 | 272.2 |
| 48 | 42 | | 182.9 | 148.2 | 331.1 | 1.4 | | 395.2 | 208.1 | 603.3 | 2.6 | 272.2 |
| 49 | 43 | | 182.9 | 148.2 | 331.1 | 1.3 | | 395.2 | 208.1 | 603.3 | 2.3 | 272.2 |
| 50 | 44 | | 182.9 | 148.2 | 331.1 | 1.1 | | 395.2 | 208.1 | 603.3 | 2.1 | 272.2 |
| 51 | 45 | | 182.9 | 148.2 | 331.1 | 1.0 | | 395.2 | 208.1 | 603.3 | 1.9 | 272.2 |
| 52 | 46 | | 182.9 | 148.2 | 331.1 | 0.9 | | 395.2 | 208.1 | 603.3 | 1.7 | 272.2 |
| 53 | 47 | | 182.9 | 148.2 | 331.1 | 0.8 | | 395.2 | 208.1 | 603.3 | 1.5 | 272.2 |
| 54 | 48 | | 182.9 | 148.2 | 331.1 | 0.7 | | 395.2 | 208.1 | 603.3 | 1.3 | 272.2 |
| 55 | 49 | | 182.9 | 148.2 | 331.1 | 0.6 | | 395.2 | 208.1 | 603.3 | 1.2 | 272.2 |
| 56 | 50 | | 182.9 | 148.2 | 331.1 | 0.6 | | 395.2 | 208.1 | 603.3 | 1.1 | 272.2 |
| | | 16736.8 | 9143.6 | 7409.3 | 33289.5 | 8801.7 | 39523.8 | 19761.9 | 10402.5 | 69688.3 | 10155.1 | 36398.6 |

| | |
|---|---|
| B - C | 1353.3454 |
| B / C | 1.1537588 |
| E D R | 0.1698410 |

## Table 14-5 Sensitivity Analysis

## (1,000 MW Pumping, 1,000 MW Generating)

(Unit: Million B)

| Serial Number | No. after Completion | Cost | | | | | Benefit | | | | | B - C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Investment Cost | O&M Cost | Fuel Cost for Pumping | Total | Total (N.P.V.) | Investment Cost | O&M Cost | Fuel Cost | Total | Total (N.P.V.) | |
| 0 | | 0.0 | | | 0.0 | 0.0 | 0.0 | | | 0.0 | 0.0 | 0.0 |
| 1 | | 114.5 | | | 114.5 | 102.2 | 0.0 | | | 0.0 | 0.0 | -114.5 |
| 2 | | 1326.0 | | | 1326.0 | 1057.0 | 0.0 | | | 0.0 | 0.0 | -1326.0 |
| 3 | | 1754.0 | | | 1754.0 | 1248.4 | 0.0 | | | 0.0 | 0.0 | -1754.0 |
| 4 | | 4110.5 | | | 4110.5 | 2612.3 | 0.0 | | | 0.0 | 0.0 | -4110.5 |
| 5 | | 3550.5 | | | 3550.5 | 2014.6 | 2634.9 | | | 2634.9 | 1495.1 | -915.5 |
| 6 | | 398.9 | | | 398.9 | 202.1 | 10539.7 | | | 10539.7 | 5339.7 | 10140.8 |
| 7 | 1 | | 182.9 | 474.2 | 657.1 | 297.2 | | 395.2 | 665.8 | 1061.0 | 479.9 | 403.9 |
| 8 | 2 | | 182.9 | 474.2 | 657.1 | 265.4 | | 395.2 | 665.8 | 1061.0 | 428.5 | 403.9 |
| 9 | 3 | | 182.9 | 474.2 | 657.1 | 236.9 | | 395.2 | 665.8 | 1061.0 | 382.6 | 403.9 |
| 10 | 4 | | 182.9 | 474.2 | 657.1 | 211.6 | | 395.2 | 665.8 | 1061.0 | 341.6 | 403.9 |
| 11 | 5 | | 182.9 | 474.2 | 657.1 | 188.9 | | 395.2 | 665.8 | 1061.0 | 305.0 | 403.9 |
| 12 | 6 | | 182.9 | 474.2 | 657.1 | 168.7 | | 395.2 | 665.8 | 1061.0 | 272.3 | 403.9 |
| 13 | 7 | | 182.9 | 474.2 | 657.1 | 150.6 | | 395.2 | 665.8 | 1061.0 | 243.2 | 403.9 |
| 14 | 8 | | 182.9 | 474.2 | 657.1 | 134.4 | | 395.2 | 665.8 | 1061.0 | 217.1 | 403.9 |
| 15 | 9 | | 182.9 | 474.2 | 657.1 | 120.0 | | 395.2 | 665.8 | 1061.0 | 193.8 | 403.9 |
| 16 | 10 | | 182.9 | 474.2 | 657.1 | 107.2 | | 395.2 | 665.8 | 1061.0 | 173.1 | 403.9 |
| 17 | 11 | | 182.9 | 474.2 | 657.1 | 95.7 | | 395.2 | 665.8 | 1061.0 | 154.5 | 403.9 |
| 18 | 12 | | 182.9 | 474.2 | 657.1 | 85.4 | | 395.2 | 665.8 | 1061.0 | 138.0 | 403.9 |
| 19 | 13 | | 182.9 | 474.2 | 657.1 | 76.3 | | 395.2 | 665.8 | 1061.0 | 123.2 | 403.9 |
| 20 | 14 | | 182.9 | 474.2 | 657.1 | 68.1 | | 395.2 | 665.8 | 1061.0 | 110.0 | 403.9 |
| 21 | 15 | | 182.9 | 474.2 | 657.1 | 60.8 | | 395.2 | 665.8 | 1061.0 | 98.2 | 403.9 |
| 22 | 16 | | 182.9 | 474.2 | 657.1 | 54.3 | | 395.2 | 665.8 | 1061.0 | 87.7 | 403.9 |
| 23 | 17 | | 182.9 | 474.2 | 657.1 | 48.5 | | 395.2 | 665.8 | 1061.0 | 78.3 | 403.9 |
| 24 | 18 | | 182.9 | 474.2 | 657.1 | 43.3 | | 395.2 | 665.8 | 1061.0 | 69.9 | 403.9 |
| 25 | 19 | | 182.9 | 474.2 | 657.1 | 38.7 | 2634.9 | 395.2 | 665.8 | 3695.9 | 217.4 | 3038.9 |
| 26 | 20 | | 182.9 | 474.2 | 657.1 | 34.5 | 10539.7 | 395.2 | 665.8 | 11600.7 | 609.3 | 10943.6 |
| 27 | 21 | 395.8 | 182.9 | 474.2 | 1052.9 | 49.4 | | 395.2 | 665.8 | 1061.0 | 49.8 | 8.1 |
| 28 | 22 | 0.0 | 182.9 | 474.2 | 657.1 | 27.5 | | 395.2 | 665.8 | 1061.0 | 44.4 | 403.9 |
| 29 | 23 | 1656.3 | 182.9 | 474.2 | 2313.4 | 86.5 | | 395.2 | 665.8 | 1061.0 | 39.7 | -1252.4 |
| 30 | 24 | 2240.6 | 182.9 | 474.2 | 2897.7 | 96.7 | | 395.2 | 665.8 | 1061.0 | 35.4 | -1836.7 |
| 31 | 25 | 395.8 | 182.9 | 474.2 | 1052.9 | 31.4 | | 395.2 | 665.8 | 1061.0 | 31.6 | 8.1 |
| 32 | 26 | | 182.9 | 474.2 | 657.1 | 17.5 | | 395.2 | 665.8 | 1061.0 | 28.2 | 403.9 |
| 33 | 27 | | 182.9 | 474.2 | 657.1 | 15.6 | | 395.2 | 665.8 | 1061.0 | 25.2 | 403.9 |
| 34 | 28 | | 182.9 | 474.2 | 657.1 | 13.9 | | 395.2 | 665.8 | 1061.0 | 22.5 | 403.9 |
| 35 | 29 | | 182.9 | 474.2 | 657.1 | 12.4 | | 395.2 | 665.8 | 1061.0 | 20.1 | 403.9 |
| 36 | 30 | | 182.9 | 474.2 | 657.1 | 11.1 | | 395.2 | 665.8 | 1061.0 | 17.9 | 403.9 |
| 37 | 31 | | 182.9 | 474.2 | 657.1 | 9.9 | | 395.2 | 665.8 | 1061.0 | 16.0 | 403.9 |
| 38 | 32 | | 182.9 | 474.2 | 657.1 | 8.9 | | 395.2 | 665.8 | 1061.0 | 14.3 | 403.9 |
| 39 | 33 | | 182.9 | 474.2 | 657.1 | 7.9 | | 395.2 | 665.8 | 1061.0 | 12.8 | 403.9 |
| 40 | 34 | | 182.9 | 474.2 | 657.1 | 7.1 | | 395.2 | 665.8 | 1061.0 | 11.4 | 403.9 |
| 41 | 35 | | 182.9 | 474.2 | 657.1 | 6.3 | | 395.2 | 665.8 | 1061.0 | 10.2 | 403.9 |
| 42 | 36 | | 182.9 | 474.2 | 657.1 | 5.6 | | 395.2 | 665.8 | 1061.0 | 9.1 | 403.9 |
| 43 | 37 | | 182.9 | 474.2 | 657.1 | 5.0 | | 395.2 | 665.8 | 1061.0 | 8.1 | 403.9 |
| 44 | 38 | 317.6 | 182.9 | 474.2 | 974.6 | 8.7 | | 395.2 | 665.8 | 1061.0 | 7.2 | 86.4 |
| 45 | 39 | 476.4 | 182.9 | 474.2 | 1133.4 | 8.9 | 2634.9 | 395.2 | 665.8 | 3695.9 | 22.5 | 2562.5 |
| 46 | 40 | | 182.9 | 474.2 | 657.1 | 3.6 | 10539.7 | 395.2 | 665.8 | 11600.7 | 63.2 | 10942.6 |
| 47 | 41 | | 182.9 | 474.2 | 657.1 | 3.2 | | 395.2 | 665.8 | 1061.0 | 5.2 | 403.9 |
| 48 | 42 | | 182.9 | 474.2 | 657.1 | 2.9 | | 395.2 | 665.8 | 1061.0 | 4.6 | 403.9 |
| 49 | 43 | | 182.9 | 474.2 | 657.1 | 2.5 | | 395.2 | 665.8 | 1061.0 | 4.1 | 403.9 |
| 50 | 44 | | 182.9 | 474.2 | 657.1 | 2.3 | | 395.2 | 665.8 | 1061.0 | 3.7 | 403.9 |
| 51 | 45 | | 182.9 | 474.2 | 657.1 | 2.0 | | 395.2 | 665.8 | 1061.0 | 3.3 | 403.9 |
| 52 | 46 | | 182.9 | 474.2 | 657.1 | 1.8 | | 395.2 | 665.8 | 1061.0 | 2.9 | 403.9 |
| 53 | 47 | | 182.9 | 474.2 | 657.1 | 1.6 | | 395.2 | 665.8 | 1061.0 | 2.6 | 403.9 |
| 54 | 48 | | 182.9 | 474.2 | 657.1 | 1.4 | | 395.2 | 665.8 | 1061.0 | 2.3 | 403.9 |
| 55 | 49 | | 182.9 | 474.2 | 657.1 | 1.3 | | 395.2 | 665.8 | 1061.0 | 2.1 | 403.9 |
| 56 | 50 | | 182.9 | 474.2 | 657.1 | 1.2 | | 395.2 | 665.8 | 1061.0 | 1.9 | 403.9 |
| | | 16736.8 | 9143.6 | 23709.7 | 49590.1 | 10173.4 | 39523.8 | 19761.9 | 33288.0 | 92573.8 | 12080.8 | 42983.7 |
| | | | | | | | | | | B - C | 1907.4545 | |
| | | | | | | | | | | B / C | 1.1874949 | |
| | | | | | | | | | | E D R | 0.1860887 | |

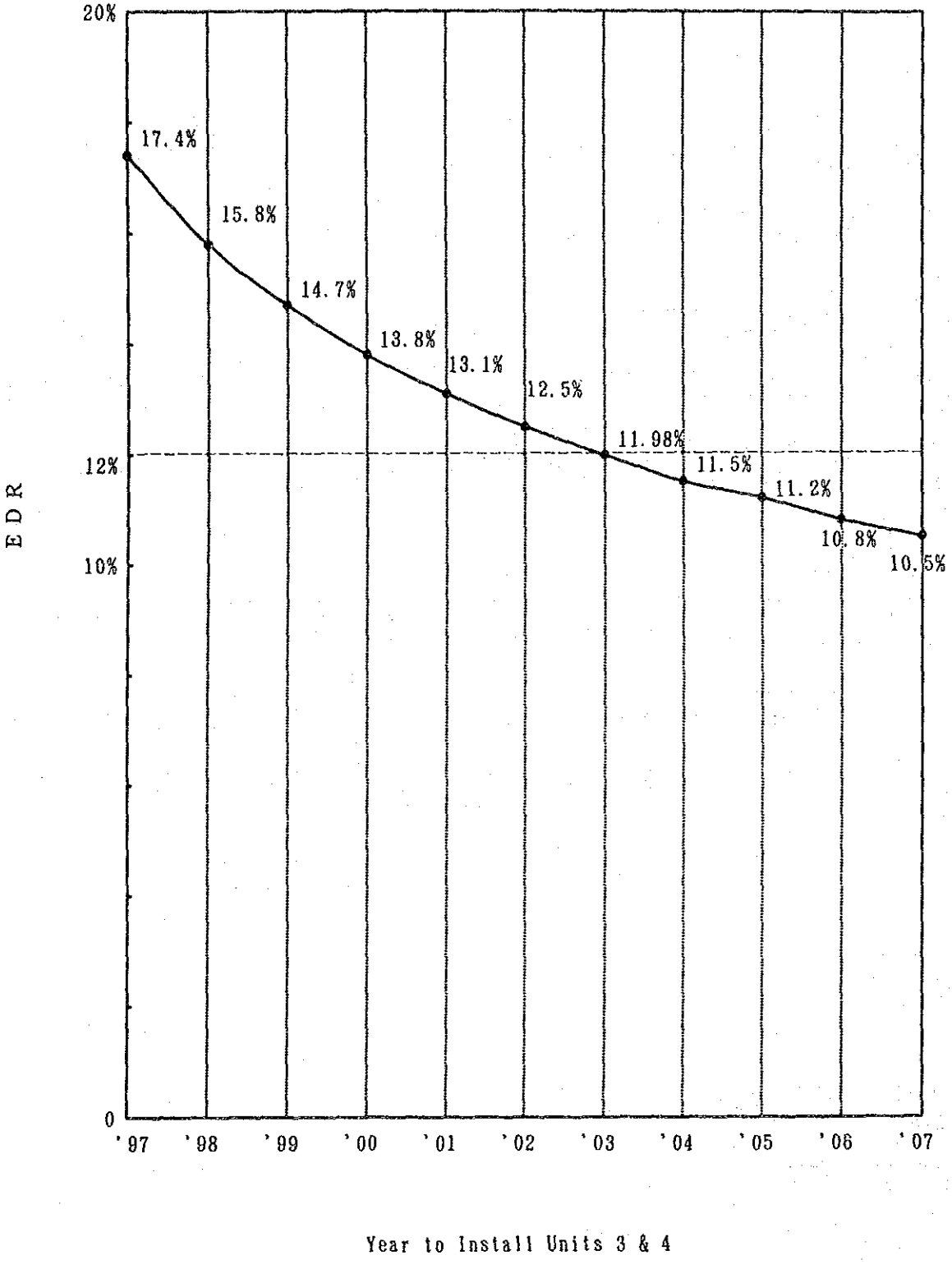


Fig. 14-2 Sensitivit Analysis on Istallation of Units 3 and 4

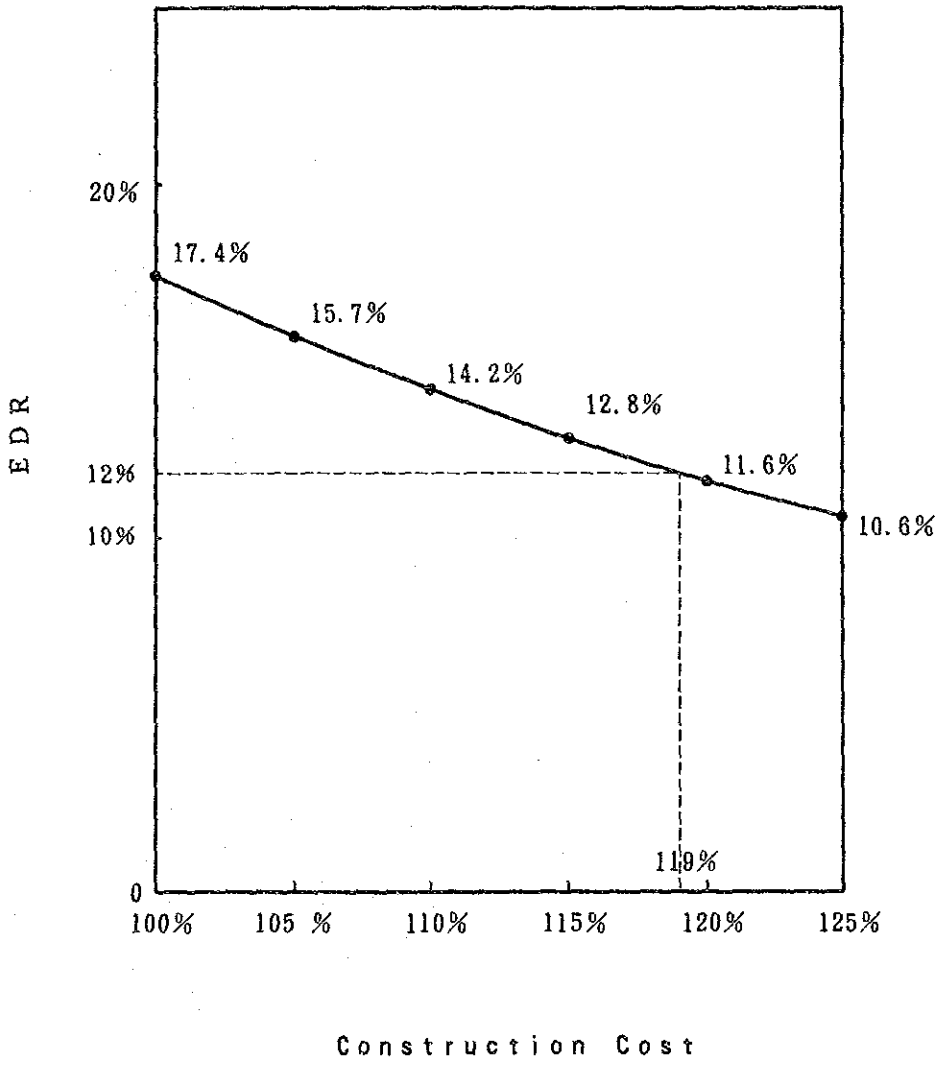


Fig. 14-3 Sensitivity Analysis (Construction Cost)

# CHAPTER 15

# FINANCIAL ANALYSIS

# CHAPTER 15 FINANCIAL ANALYSIS

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# CHAPTER 15 FINANCIAL ANALYSIS

## 15.1 Methodology and Basic Conditions

### 15.1.1 Methodology

For the financial analysis of this Project, the following two cases described below will be analyzed and judgement will be made for the evaluation.

(1) Financial Evaluation from Viewpoint of Total Investment

In this financial evaluation, the financial internal rate of return (FIRR), in which the present value of the revenue from business (revenue from power sold) equals the present value of the total cost will be calculated. And the profitability of this project will be judged by comparing the EDR with the discount rate that reflects the capital opportunity cost.

The cost applicable to this evaluation will include the total investment (Project Cost excluding the interest during construction) without consideration of the financing conditions, such as interest, repayment of principal, repayment period, etc., and the operation and maintenance cost.

In this evaluation, the profitability of the investment for the project will be judged regardless of financing conditions.

(2) Financial Analysis from Viewpoint of Project Equity

Looking generally from the viewpoint of an enterprise, when a project is to be implemented it is necessary that the enterprise will have to finance for the project. The indices that are given serious consideration regarding the financing by the enterprise, generally include the following:

- Rate of Return

  This is the ratio of the business profit against the net working fixed assets, which provides for payment of interest on borrowing. The balance will be the net profit.

- Debt Service Ratio

  This is the ratio of the internal fund procured (business profit plus depreciation cost) against the debt to be repaid (principal plus interest).

The procedure for evaluation of these will be implemented as follows:

Establishment of the financing conditions

⇩

Preparation of the repayment schedule of the debt

⇩

Preparation of the statement of profit and loss and cash flow

⇩

Calculation of the rate of return and the debt service ratio

The cost that are applicable to this evaluation consist of the operation and maintenance cost and depreciation cost. The depreciation cost will be calculated based on the total construction cost including import duties and the interest during construction.

In this evaluation only the debt service ratio will be estimated.

### 15.1.2 Basic Conditions

The basic conditions for implementing the financial evaluation of this project will be as follows:

(1) Financing Conditions

- Foreign Currency Portion
  Interest: : 8%
  Commitment fee : 0.75%

  The repayment period shall be 20 years from the commencement of operation and repayment is in the form of regular installments.

- Local Currency Portion
  Interest: 11% on 50% of the local currency portion

  The repayment period shall be 10 years from the commencement of operation and repayment is in the form of regular installments.

(2) Electric Sales Revenue

The electric sales revenue will be estimated using the EGAT tariff for "Large Manufacturing & Mining".

(3) Construction Cost

The construction cost including the import duties, price contingency and interest during construction will be used. For estimation of FIRR, interest during construction will be excluded.

(4) Depreciation

The straight line method is adopted.

(5) Operation and Maintenance Costs

| | | |
|---|---|---|
| Dam and Reservoir | : | 1% of the civil works and hydraulic equipment cost |
| Hydro Power Station | : | 2.5% of the electro-mechanical equipment cost |
| Transmission Line | : | 1% of the transmission line cost |

(6) Escalation

The project cost for the financial analysis will be estimated considering the escalation rate of IBRD.

(7) Others

The other conditions such as service life etc. are to be the same conditions described in Chapter 14.

## 15.2 Financial Analysis

### 15.2.1 Financial Internal Rate of Return (FIRR)

(1) Construction Cost

The construction cost adopted for calculation of FIRR including import duties and considering the escalation based on Table 13-1 and 13-2 in Chapter 13 is 14,070.6 Million Baht, and the annual disbursement schedule is as follows:

| 1st Year | 2nd Year | 3rd year | 4th Year | 5th Year | 6th Year | Total |
|---|---|---|---|---|---|---|
| 119.2 | 1,480.8 | 1,998.5 | 5,145.3 | 4,766.1 | 560.8 | 14,070.6 |

(2) Operation and Maintenance Cost

The operation and maintenance cost based on the above construction cost is as follows:

| | | | |
|---|---|---|---|
| — Dam and Reservoir | : | 66.4 | Million Baht/year |
| — Generating Facilities | : | 158.0 | Million Baht/year |
| — Transmission Facilities | : | 11.2 | Million Baht/year |
| Total | | 235.6 | Million Baht/year |

(3) Fuel Cost for Pumping

The fuel cost for pumping for the financial analysis is estimated using the fuel price (economic cost) as of 1997 described in EGAT PDP, and the market price will be estimated by multiplying 110%.

The fuel cost for pumping considering the efficiency between pumping energy and generating energy is calculated as follows:

0.4434 Baht/kwh ÷ 0.689 x 110% = 0.7079 Baht/kwh

(4) Revenue

The annual energy production of this project (annual generating hours: 400 hrs) considering the station service rate and the transmission loss ratio is as follows:

1,000 MW x 400 hrs x (1-0.003) x (1-0.015) = 392.8 GWh

The revenue from this Project is calculated by using the EGAT tariff for "Large Manufacturing & Mining" as follows:

- Demand charge: 180 Baht/KW/Month x 1,000MW x 12months x 96%
  = 2,073.6 Million Baht/year

- Energy charge: 392.8 GWh x 1.22 Baht/KWh x 96%
  = 460.0 Million Baht/year

Total 2,533.6 Million Baht/year

(5) Financial Internal Rate of Return (FIRR)

The cost flow and the flow of the revenue are presented on Table 15-1 based on the above calculation, and FIRR is evaluated as 11.2%.

Although this FIRR is slightly less than the social discount rate (12%), it can be concluded that this project has no big problem from the financial point of view.

### 15.2.2 Debt Service Ratio

(1) Repayment Schedule of Debt

The repayment schedule of the debt based on the financing conditions stated in section 15.1.2 is shown on Table 15-2. The interest during construction shown on Tables 13-1 and 13-2 in Chapter 13 is not included in the construction cost which is the base of the debt amount. However the interest during construction will be estimated and recovered as a part of the depreciation cost.

(2) Statement of Profit and Loss and Cash Flow

The statement of profit and loss and the cash flow are shown on Tables 15-3 and 15-4 respectively.

The depreciation cost is estimated based on the construction cost including the interest during construction, and the results of calculation of the depreciation cost are as follows:

— Dam and reservoir (Service Life: 50 years)
8,172.4 Million Baht ÷ 50 years = 163.4 Million Baht/year

— Generating Facilities (Service Life: 25 years)
7,235.8 Million Baht ÷ 25 years = 298.4 Million Baht/year

— Transmission Facilities (Service Life: 40 years)
1,265.6 Million Baht ÷ 40 years = 31.6 Million Baht/year

(3) Debt Service Ratio

The result of calculation of the debt service ratio is shown on Table 15-5. Average debt service ratio for 20 years is 2.09 and it can be concluded that the Project is sound from the viewpoint of profitability.

Table 15-1 Cost Flow and Flow of Revenue of Adopted Development Plan

(Unit: Million B)

| Serial Number | Year | Cost | | | | Revenue | R - C |
|---|---|---|---|---|---|---|---|
| | | Investment Cost | O&M Cost | Fuel Cost for Pump. | Total | | |
| 0 | 1991 | 0.0 | | | 0.0 | | 0.0 |
| 1 | 1992 | 119.2 | | | 119.2 | | -119.2 |
| 2 | 1993 | 1480.8 | | | 1480.8 | | -1480.8 |
| 3 | 1994 | 1998.5 | | | 1998.5 | | -1998.5 |
| 4 | 1995 | 5145.3 | | | 5145.3 | | -5145.3 |
| 5 | 1996 | 4766.1 | | | 4766.1 | | -4766.1 |
| 6 | 1997 | 560.8 | | | 560.8 | | -560.8 |
| 7 | 1998 | | 235.6 | 283.2 | 518.8 | 2533.6 | 2014.8 |
| 8 | 1999 | | 235.6 | 283.2 | 518.8 | 2533.6 | 2014.8 |
| 9 | 2000 | | 235.6 | 283.2 | 518.8 | 2533.6 | 2014.8 |
| 10 | 2001 | | 235.6 | 283.2 | 518.8 | 2533.6 | 2014.8 |
| 11 | 2002 | | 235.6 | 283.2 | 518.8 | 2533.6 | 2014.8 |
| 12 | 2003 | | 235.6 | 283.2 | 518.8 | 2533.6 | 2014.8 |
| 13 | 2004 | | 235.6 | 283.2 | 518.8 | 2533.6 | 2014.8 |
| 14 | 2005 | | 235.6 | 283.2 | 518.8 | 2533.6 | 2014.8 |
| 15 | 2006 | | 235.6 | 283.2 | 518.8 | 2533.6 | 2014.8 |
| 16 | 2007 | | 235.6 | 283.2 | 518.8 | 2533.6 | 2014.8 |
| 17 | 2008 | | 235.6 | 283.2 | 518.8 | 2533.6 | 2014.8 |
| 18 | 2009 | | 235.6 | 283.2 | 518.8 | 2533.6 | 2014.8 |
| 19 | 2010 | | 235.6 | 283.2 | 518.8 | 2533.6 | 2014.8 |
| 20 | 2011 | | 235.6 | 283.2 | 518.8 | 2533.6 | 2014.8 |
| 21 | 2012 | | 235.6 | 283.2 | 518.8 | 2533.6 | 2014.8 |
| 22 | 2013 | | 235.6 | 283.2 | 518.8 | 2533.6 | 2014.8 |
| 23 | 2014 | | 235.6 | 283.2 | 518.8 | 2533.6 | 2014.8 |
| 24 | 2015 | | 235.6 | 283.2 | 518.8 | 2533.6 | 2014.8 |
| 25 | 2016 | | 235.6 | 283.2 | 518.8 | 2533.6 | 2014.8 |
| 26 | 2017 | | 235.6 | 283.2 | 518.8 | 2533.6 | 2014.8 |
| 27 | 2018 | 477.3 | 235.6 | 283.2 | 996.1 | 2533.6 | 1537.5 |
| 28 | 2019 | 0.0 | 235.6 | 283.2 | 518.8 | 2533.6 | 2014.8 |
| 29 | 2020 | 2174.7 | 235.6 | 283.2 | 2693.5 | 2533.6 | -159.9 |
| 30 | 2021 | 3069.4 | 235.6 | 283.2 | 3588.2 | 2533.6 | -1054.6 |
| 31 | 2022 | 565.9 | 235.6 | 283.2 | 1084.6 | 2533.6 | 1449.0 |
| 32 | 2023 | | 235.6 | 283.2 | 518.8 | 2533.6 | 2014.8 |
| 33 | 2024 | | 235.6 | 283.2 | 518.8 | 2533.6 | 2014.8 |
| 34 | 2025 | | 235.6 | 283.2 | 518.8 | 2533.6 | 2014.8 |
| 35 | 2026 | | 235.6 | 283.2 | 518.8 | 2533.6 | 2014.8 |
| 36 | 2027 | | 235.6 | 283.2 | 518.8 | 2533.6 | 2014.8 |
| 37 | 2028 | | 235.6 | 283.2 | 518.8 | 2533.6 | 2014.8 |
| 38 | 2029 | | 235.6 | 283.2 | 518.8 | 2533.6 | 2014.8 |
| 39 | 2030 | | 235.6 | 283.2 | 518.8 | 2533.6 | 2014.8 |
| 40 | 2031 | | 235.6 | 283.2 | 518.8 | 2533.6 | 2014.8 |
| 41 | 2032 | | 235.6 | 283.2 | 518.8 | 2533.6 | 2014.8 |
| 42 | 2033 | | 235.6 | 283.2 | 518.8 | 2533.6 | 2014.8 |
| 43 | 2034 | | 235.6 | 283.2 | 518.8 | 2533.6 | 2014.8 |
| 44 | 2035 | 453.0 | 235.6 | 283.2 | 971.8 | 2533.6 | 1561.8 |
| 45 | 2036 | 708.5 | 235.6 | 283.2 | 1227.3 | 2533.6 | 1306.3 |
| 46 | 2037 | | 235.6 | 283.2 | 518.8 | 2533.6 | 2014.8 |
| 47 | 2038 | | 235.6 | 283.2 | 518.8 | 2533.6 | 2014.8 |
| 48 | 2039 | | 235.6 | 283.2 | 518.8 | 2533.6 | 2014.8 |
| 49 | 2040 | | 235.6 | 283.2 | 518.8 | 2533.6 | 2014.8 |
| 50 | 2041 | | 235.6 | 283.2 | 518.8 | 2533.6 | 2014.8 |
| 51 | 2042 | | 235.6 | 283.2 | 518.8 | 2533.6 | 2014.8 |
| 52 | 2043 | | 235.6 | 283.2 | 518.8 | 2533.6 | 2014.8 |
| 53 | 2044 | | 235.6 | 283.2 | 518.8 | 2533.6 | 2014.8 |
| 54 | 2045 | | 235.6 | 283.2 | 518.8 | 2533.6 | 2014.8 |
| 55 | 2046 | | 235.6 | 283.2 | 518.8 | 2533.6 | 2014.8 |
| 56 | 2047 | | 235.6 | 283.2 | 518.8 | 2533.6 | 2014.8 |
| | | 21519.5 | 11780.0 | 14157.9 | 47457.4 | 126680.0 | 79222.6 |

F I R R 0.111565

## Table 15-2 Repayment Schedule of Debt

(Unit: Million B)

| No. | Year | Construction Cost | | | Repayment of F.C. | | | | Repayment of L.C. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | F.C. | L.C. | Total | Interest | Principal | Total | Balance | Interest | Principal | Total | Balance |
| | 1992 | 27.56 | 91.63 | 119.19 | | | | | | | | |
| | 1993 | 888.36 | 597.39 | 1480.75 | | | | | | | | |
| | 1994 | 1006.59 | 991.91 | 1998.5 | | | | | | | | |
| | 1995 | 2869.68 | 2275.66 | 5145.34 | | | | | | | | |
| | 1996 | 3282.27 | 1483.81 | 4766.08 | | | | | | | | |
| | 1997 | 427.93 | 132.83 | 560.76 | | | | 8497.39 | | | | 2786.62 |
| 1 | 1998 | | | | 679.79 | 185.69 | 865.48 | 8311.70 | 306.53 | 166.64 | 473.17 | 2619.97 |
| 2 | 1999 | | | | 664.94 | 200.54 | 865.48 | 8111.16 | 288.20 | 184.97 | 473.17 | 2435.00 |
| 3 | 2000 | | | | 648.89 | 216.59 | 865.48 | 7894.58 | 267.85 | 205.32 | 473.17 | 2229.68 |
| 4 | 2001 | | | | 631.57 | 233.91 | 865.48 | 7660.66 | 245.26 | 227.91 | 473.17 | 2001.77 |
| 5 | 2002 | | | | 612.85 | 252.62 | 865.48 | 7408.04 | 220.19 | 252.98 | 473.17 | 1748.79 |
| 6 | 2003 | | | | 592.64 | 272.83 | 865.48 | 7135.21 | 192.37 | 280.80 | 473.17 | 1467.99 |
| 7 | 2004 | | | | 570.82 | 294.66 | 865.48 | 6840.54 | 161.48 | 311.69 | 473.17 | 1156.30 |
| 8 | 2005 | | | | 547.24 | 318.23 | 865.48 | 6522.31 | 127.19 | 345.98 | 473.17 | 810.32 |
| 9 | 2006 | | | | 521.78 | 343.69 | 865.48 | 6178.62 | 89.13 | 384.04 | 473.17 | 426.28 |
| 10 | 2007 | | | | 494.29 | 371.19 | 865.48 | 5807.43 | 46.89 | 426.28 | 473.17 | 0.00 |
| 11 | 2008 | | | | 464.59 | 400.88 | 865.48 | 5406.54 | | | | |
| 12 | 2009 | | | | 432.52 | 432.95 | 865.48 | 4973.59 | | | | |
| 13 | 2010 | | | | 397.89 | 467.59 | 865.48 | 4506.00 | | | | |
| 14 | 2011 | | | | 360.48 | 505.00 | 865.48 | 4001.00 | | | | |
| 15 | 2012 | | | | 320.08 | 545.40 | 865.48 | 3455.60 | | | | |
| 16 | 2013 | | | | 276.45 | 589.03 | 865.48 | 2866.57 | | | | |
| 17 | 2014 | | | | 229.33 | 636.15 | 865.48 | 2230.42 | | | | |
| 18 | 2015 | | | | 178.43 | 687.04 | 865.48 | 1543.38 | | | | |
| 19 | 2016 | | | | 123.47 | 742.01 | 865.48 | 801.37 | | | | |
| 20 | 2017 | | | | 64.11 | 801.37 | 865.48 | 0.00 | | | | |
| | Total | 8497.39 | 5573.23 | 14070.62 | 8812.17 | 8497.39 | 17309.56 | | 1945.10 | 2786.62 | 4731.71 | |

Table 15-3 Statement of Profit and Loss

(Unit: Million B)

| No. | Year | Revenue | Business Expenses | | | Business Profit | Financial Cost | | Net Profit |
|---|---|---|---|---|---|---|---|---|---|
| | | | O&M Cost | Depreci-ation | Total | | I.D.C. | Interest | |
| | 1992 | | | | | | 67.15 | | -67.15 |
| | 1993 | | | | | | 115.91 | | -115.91 |
| | 1994 | | | | | | 227.66 | | -227.66 |
| | 1995 | | | | | | 451.04 | | -451.04 |
| | 1996 | | | | | | 775.90 | | -775.90 |
| | 1997 | | | | | | 965.54 | | -965.54 |
| 1 | 1998 | 2533.60 | 235.60 | 484.40 | 720.00 | 1813.60 | | 986.32 | 827.28 |
| 2 | 1999 | 2533.60 | 235.60 | 484.40 | 720.00 | 1813.60 | | 953.13 | 860.47 |
| 3 | 2000 | 2533.60 | 235.60 | 484.40 | 720.00 | 1813.60 | | 916.74 | 896.86 |
| 4 | 2001 | 2533.60 | 235.60 | 484.40 | 720.00 | 1813.60 | | 876.83 | 936.77 |
| 5 | 2002 | 2533.60 | 235.60 | 484.40 | 720.00 | 1813.60 | | 833.05 | 980.55 |
| 6 | 2003 | 2533.60 | 235.60 | 484.40 | 720.00 | 1813.60 | | 785.01 | 1028.59 |
| 7 | 2004 | 2533.60 | 235.60 | 484.40 | 720.00 | 1813.60 | | 732.30 | 1081.30 |
| 8 | 2005 | 2533.60 | 235.60 | 484.40 | 720.00 | 1813.60 | | 674.44 | 1139.16 |
| 9 | 2006 | 2533.60 | 235.60 | 484.40 | 720.00 | 1813.60 | | 610.92 | 1202.68 |
| 10 | 2007 | 2533.60 | 235.60 | 484.40 | 720.00 | 1813.60 | | 541.18 | 1272.42 |
| 11 | 2008 | 2533.60 | 235.60 | 484.40 | 720.00 | 1813.60 | | 464.59 | 1349.01 |
| 12 | 2009 | 2533.60 | 235.60 | 484.40 | 720.00 | 1813.60 | | 432.52 | 1381.08 |
| 13 | 2010 | 2533.60 | 235.60 | 484.40 | 720.00 | 1813.60 | | 397.89 | 1415.71 |
| 14 | 2011 | 2533.60 | 235.60 | 484.40 | 720.00 | 1813.60 | | 360.48 | 1453.12 |
| 15 | 2012 | 2533.60 | 235.60 | 484.40 | 720.00 | 1813.60 | | 320.08 | 1493.52 |
| 16 | 2013 | 2533.60 | 235.60 | 484.40 | 720.00 | 1813.60 | | 276.45 | 1537.15 |
| 17 | 2014 | 2533.60 | 235.60 | 484.40 | 720.00 | 1813.60 | | 229.33 | 1584.27 |
| 18 | 2015 | 2533.60 | 235.60 | 484.40 | 720.00 | 1813.60 | | 178.43 | 1635.17 |
| 19 | 2016 | 2533.60 | 235.60 | 484.40 | 720.00 | 1813.60 | | 123.47 | 1690.13 |
| 20 | 2017 | 2533.60 | 235.60 | 484.40 | 720.00 | 1813.60 | | 64.11 | 1749.49 |
| | Total | 50672.00 | 4712.00 | 9688.00 | 14400.00 | 36272.00 | 2603.20 | 10757.27 | 22911.53 |

Table 15-4 Cash Flow

(Unit: Million B)

| No. | Year | Cash Inflow | | | | Cash Outflow | | | Balance | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Financing | Net Profit | Depreci-ation | Total | Investment | Repayment of Princi. | Total | Year | Accumlated |
| | 1992 | 119.19 | -67.15 | | 52.04 | 119.19 | | 119.19 | -67.15 | -67.15 |
| | 1993 | 1480.75 | -115.91 | | 1364.84 | 1480.75 | | 1480.75 | -115.91 | -183.06 |
| | 1994 | 1998.50 | -227.66 | | 1770.84 | 1998.50 | | 1998.50 | -227.66 | -410.72 |
| | 1995 | 5145.34 | -451.04 | | 4694.30 | 5145.34 | | 5145.34 | -451.04 | -861.76 |
| | 1996 | 4766.08 | -775.90 | | 3990.18 | 4766.08 | | 4766.08 | -775.90 | -1637.66 |
| | 1997 | 560.76 | -965.54 | | -404.78 | 560.76 | | 560.76 | -965.54 | -2603.20 |
| 1 | 1998 | | 827.28 | 484.40 | 1311.68 | | 352.33 | 352.33 | 959.35 | -1643.85 |
| 2 | 1999 | | 860.47 | 484.40 | 1344.87 | | 385.52 | 385.52 | 959.35 | -684.50 |
| 3 | 2000 | | 896.86 | 484.40 | 1381.26 | | 421.91 | 421.91 | 959.35 | 274.85 |
| 4 | 2001 | | 936.77 | 484.40 | 1421.17 | | 461.82 | 461.82 | 959.35 | 1234.20 |
| 5 | 2002 | | 980.55 | 484.40 | 1464.95 | | 505.60 | 505.60 | 959.35 | 2193.55 |
| 6 | 2003 | | 1028.59 | 484.40 | 1512.99 | | 553.64 | 553.64 | 959.35 | 3152.91 |
| 7 | 2004 | | 1081.30 | 484.40 | 1565.70 | | 606.35 | 606.35 | 959.35 | 4112.26 |
| 8 | 2005 | | 1139.16 | 484.40 | 1623.56 | | 664.21 | 664.21 | 959.35 | 5071.61 |
| 9 | 2006 | | 1202.68 | 484.40 | 1687.08 | | 727.73 | 727.73 | 959.35 | 6030.96 |
| 10 | 2007 | | 1272.42 | 484.40 | 1756.82 | | 797.47 | 797.47 | 959.35 | 6990.31 |
| 11 | 2008 | | 1349.01 | 484.40 | 1833.41 | | 400.88 | 400.88 | 1432.52 | 8422.83 |
| 12 | 2009 | | 1381.08 | 484.40 | 1865.48 | | 432.95 | 432.95 | 1432.52 | 9855.35 |
| 13 | 2010 | | 1415.71 | 484.40 | 1900.11 | | 467.59 | 467.59 | 1432.52 | 11287.87 |
| 14 | 2011 | | 1453.12 | 484.40 | 1937.52 | | 505.00 | 505.00 | 1432.52 | 12720.40 |
| 15 | 2012 | | 1493.52 | 484.40 | 1977.92 | | 545.40 | 545.40 | 1432.52 | 14152.92 |
| 16 | 2013 | | 1537.15 | 484.40 | 2021.55 | | 589.03 | 589.03 | 1432.52 | 15585.44 |
| 17 | 2014 | | 1584.27 | 484.40 | 2068.67 | | 636.15 | 636.15 | 1432.52 | 17017.96 |
| 18 | 2015 | | 1635.17 | 484.40 | 2119.57 | | 687.04 | 687.04 | 1432.52 | 18450.49 |
| 19 | 2016 | | 1690.13 | 484.40 | 2174.53 | | 742.01 | 742.01 | 1432.52 | 19883.01 |
| 20 | 2017 | | 1749.49 | 484.40 | 2233.89 | | 801.37 | 801.37 | 1432.52 | 21315.53 |
| | Total | 14070.62 | 22911.53 | 9688.00 | 46670.15 | 14070.62 | 11284.01 | 25354.63 | 21315.53 | |

## Table 15-5 Calculation of Debt Service Ratio

(Unit: Million B)

| No. | Year | Internal Fund Procured | | | | Repayment of Debt | | | | Debt Service Ratio |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Business Profit | Depreci-ation | Total | Accumlated | Interest | Principal | Total | Accumlated | |
| | 1992 | | | | (A) | | | | (B) | (A)/(B) |
| | 1993 | | | | | | | | | |
| | 1994 | | | | | | | | | |
| | 1995 | | | | | | | | | |
| | 1996 | | | | | | | | | |
| | 1997 | | | | | | | | | |
| 1 | 1998 | 1813.60 | 484.40 | 2298.00 | 2298.00 | 986.32 | 352.33 | 1338.65 | 1338.65 | |
| 2 | 1999 | 1813.60 | 484.40 | 2298.00 | 4596.00 | 953.13 | 385.52 | 1338.65 | 2677.30 | |
| 3 | 2000 | 1813.60 | 484.40 | 2298.00 | 6894.00 | 916.74 | 421.91 | 1338.65 | 4015.95 | |
| 4 | 2001 | 1813.60 | 484.40 | 2298.00 | 9192.00 | 876.83 | 461.82 | 1338.65 | 5354.60 | |
| 5 | 2002 | 1813.60 | 484.40 | 2298.00 | 11490.00 | 833.05 | 505.60 | 1338.65 | 6693.25 | 1.72 |
| 6 | 2003 | 1813.60 | 484.40 | 2298.00 | 13788.00 | 785.01 | 553.64 | 1338.65 | 8031.89 | |
| 7 | 2004 | 1813.60 | 484.40 | 2298.00 | 16086.00 | 732.30 | 606.35 | 1338.65 | 9370.54 | |
| 8 | 2005 | 1813.60 | 484.40 | 2298.00 | 18384.00 | 674.44 | 664.21 | 1338.65 | 10709.19 | |
| 9 | 2006 | 1813.60 | 484.40 | 2298.00 | 20682.00 | 610.92 | 727.73 | 1338.65 | 12047.84 | |
| 10 | 2007 | 1813.60 | 484.40 | 2298.00 | 22980.00 | 541.18 | 797.47 | 1338.65 | 13386.49 | 1.72 |
| 11 | 2008 | 1813.60 | 484.40 | 2298.00 | 25278.00 | 464.59 | 400.88 | 865.48 | 14251.97 | |
| 12 | 2009 | 1813.60 | 484.40 | 2298.00 | 27576.00 | 432.52 | 432.95 | 865.48 | 15117.45 | |
| 13 | 2010 | 1813.60 | 484.40 | 2298.00 | 29874.00 | 397.89 | 467.59 | 865.48 | 15982.93 | |
| 14 | 2011 | 1813.60 | 484.40 | 2298.00 | 32172.00 | 360.48 | 505.00 | 865.48 | 16848.40 | |
| 15 | 2012 | 1813.60 | 484.40 | 2298.00 | 34470.00 | 320.08 | 545.40 | 865.48 | 17713.88 | 1.95 |
| 16 | 2013 | 1813.60 | 484.40 | 2298.00 | 36768.00 | 276.45 | 589.03 | 865.48 | 18579.36 | |
| 17 | 2014 | 1813.60 | 484.40 | 2298.00 | 39066.00 | 229.33 | 636.15 | 865.48 | 19444.84 | |
| 18 | 2015 | 1813.60 | 484.40 | 2298.00 | 41364.00 | 178.43 | 687.04 | 865.48 | 20310.31 | |
| 19 | 2016 | 1813.60 | 484.40 | 2298.00 | 43662.00 | 123.47 | 742.01 | 865.48 | 21175.79 | |
| 20 | 2017 | 1813.60 | 484.40 | 2298.00 | 45960.00 | 64.11 | 801.37 | 865.48 | 22041.27 | 2.09 |
| | Total | 1125580.4 | 248997.10 | 1352821.5 | | 333497.17 | 445754.23 | 779251.40 | | |

# CHAPTER 16

# FURTHER INVESTIGATION

# CHAPTER 16 FURTHER INVESTIGATION

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# CHAPTER 16 FURTHER INVESTIGATION

The following investigation should be necessary to perform definite design of the Lam Ta Khong project.

## 16.1 Topographic Survey (1/1,000)

(1) Disposal Area for Dam (to the south of the upper reservoir)

- Quantity : 0.80 $km^2$ (800 m x 1,000 m)

(2) Dam site (to the east of the upper reservoir)

- Quantity : 0.20 $km^2$ (200 m x 1,000 m)

(3) Switchyard Site

- Quantity : 0.80 $km^2$ (400 m x 2,000 m)

(4) Disposal Area for Waterway and Powerhouse

- Quantity : 0.80 $km^2$

(5) Proposed Quarry Site for Concrete Aggregate (coarse-grained sandstone)

- Quantity : 0.20 $km^2$ (400 m x 500 m)

## 16.2 Geological Investigation

(1) Upper Reservoir Site

(a) Pitting

- Quantity : 5 m (depth) x 2 pits (in coarse-grained sandstone)

: 5 m (depth) x 2 pits (in claystone)

- Purpose : To collect the samples for embankment material test (see 16.3 (1)),
  To test deformability and strength of the foundation rock

(b) Drilling

- Quantity : 30 m (depth) x 2 holes
- Purpose : Detailed exploration of the distribution and the geologic conditions of the foundation rock

(2) Underground Powerhouse Site

(a) Exploratory Adit and Drilling (in adit)

- Quantity : 1,400 m (length) x 1 adit, 150 m (length) x 2 holes
- Purpose : To grasp the geologic conditions of the underground powerhouse site and lower part of penstock site,
  To perform the following in situ and laboratory tests

- Main in situ rock mechanical test to be performed:

  Plate Bearing Test,
  Rock Shear Test,
  Convergence Measurement,
  In situ Stress Measurement,
  Rock Bolt Extraction Test,
  Drill Hole Deformation Test

- Main Laboratory Test to be performed:

  Uniaxial Compression Test,
  Triaxial Compression Test,

Slake-Durability Test (ASTM D-4644)

(3) Outlet Site

(a) Drilling

- Location : In the Lam Ta Khong reservoir
- Quantity : 30 m (depth) x 2 holes
- Purpose : To grasp the geologic conditions of surrounding bedrock for the sealing works at the outlet site

16.3 Materials Investigation

(1) Embankment Materials

(a) Coarse Material Test

- Samples : Coarse-grained sandstone
- Purpose : To grasp the physical properties of coarse material

(b) Mixed Material Test

- Samples : Mixed Samples of claystone and coarse-grained sandstone
- Purpose : To grasp the relation between the mixing ratio of the mixed material to be used and the physical properties

(2) Concrete Aggregate

(a) Drilling

- Location : The proposed quarry site of coarse-grained sandstone

- Quantity : 30 m (depth) x 2 holes
- Purpose : To grasp the geologic conditions such as weathering condition and the distribution of intercalated beds

(b) Concrete Prism Test (ASTM C-157)

- Samples : Crushed limestone
- Purpose : To examine alkali-carbonate reaction

(c) Mix Proportion Test

This test should be performed for the finally selected material.

16.4 Asphalt Concrete Test

(1) Aggregate Test

- Purpose : To examine the suitability of aggregate, contacting and stripping between asphalt and aggregate and so forth

(2) Asphalt Concrete Mix Proportion Test

- Purpose : To examine impermeability, deflection, stability on slope and durability of asphalt concrete for the design of the mix proportion