# FINANCIAL ANALYSIS

## A. Introduction

1. The Grid Reinforcement Project will support Electricité du Cambodge (EDC), the state-owned power utility, in improving the capacity of its transmission network. The project team will (i) construct transmission lines and substations in Phnom Penh and surrounding provinces; and (ii) introduce as a pilot the first utility-scale battery energy storage system (BESS) in Cambodia, to assess its performance in providing grid services. The financial analysis is carried out separately for outputs 1 and 2 following Asian Development Bank (ADB) guidelines.[1]

## B. Key Assumptions (Output 1)

2. Incremental revenues less incremental costs are estimated for a 25-year period following the commissioning of the subprojects in 2024. Output 1 is considered financially viable if the financial internal rate of return (FIRR) meets or exceeds the cost of funds, using the weighted average cost of capital (WACC). The analysis is conducted using constant 2020 prices.

3. **Incremental revenues.** The incremental revenues are estimated as the additional sales relative to the without-project case multiplied by the average retail tariff. The average retail tariff is estimated at $0.154 per kilowatt-hour (kWh)—or 15.4 ¢/kWh—in 2020 and is assumed to remain constant in nominal terms thereafter (i.e., declining in real terms after allowing for inflation).

4. **Additional sales**. Forecast demand by year and by substation is compared with substation capacities with and without the project. Demand in excess of capacity represents load shedding, and the difference in load shedding with and without the project represents additional sales. Hourly load profiles by existing substation as at December 2019 are used, with loads assumed to grow in line with a demand forecast prepared using the following assumptions:

- (i) For 2020, the current low-demand forecast prepared by EDC is used. This is for a 2.5% fall in full-year sales relative to 2019.
- (ii) Gross domestic product (GDP) growth in 2021 is forecast at 3.1%. From 2022 onward, GDP growth is assumed to gradually rise, reaching 5.5% by 2030. This is still below pre-crisis growth rates, which averaged 7.1% annually from 2010 to 2019.
- (iii) Electricity sales are assumed to grow by 2.72 times the rate of GDP growth, representing the average ratio of sales to GDP growth over the preceding 10 years.

5. **Incremental costs.** Incremental costs are the sum of the capital and operation and maintenance (O&M) costs of the subprojects under output 1 and of the power purchase and distribution costs of supplying the additional sales. Capital costs are calculated as the sum of base costs and physical contingencies, excluding taxes and duties exemptions as a non-cash item, totaling $147.7 million. Annual O&M costs are estimated at 2% of the sum of base costs and physical contingencies, equivalent to $2.7 million annually.

6. The cost of additional power purchases is estimated as the average cost of generation and imports in each year, allowing for 4% transmission and 7% distribution losses. The average cost of generation in 2025 is estimated at 7.3 ¢/kWh, and at 7.4 ¢/kWh in 2030.[2] The distribution cost is estimated as the difference between the average retail tariff and the tariff charged to

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[1] ADB. 2009. Financial Due Diligence: A Methodology Note.

[2] Based on dispatch modeling from Intelligent Energy Services.

licensees connected to EDC's transmission network (and thereby not using EDC's distribution system). This equals 3.2 ¢/kWh in 2020 and is assumed to remain constant. The margin for transmission costs is the difference between the retail tariff and these costs. In 2025, for example, the estimated margin to recover transmission costs is 2.3 ¢/kWh (in real terms), which is calculated as the retail tariff (in real terms) less the distribution cost and the supply cost, including transmission and distribution losses.

7. **Weighted average cost of capital.** The WACC is calculated as the weighted average of the cost of equity and debt. The estimation of the cost of equity in Table 1 follows the capital asset pricing model (using proxy estimates in the absence of data for Cambodia and EDC). The cost of debt to EDC is calculated as the sum of the interest rate on the proposed ADB loan to the Ministry of Economy and Finance (MEF) of 1.50% during repayment and the 0.65% service charge applied by MEF. The calculation of the estimated WACC of 1.67% is shown in Table 2. The real cost of debt is set at zero rather than use the calculated negative value, following ADB guidelines.[3]

**Table 1: Cost of Equity**

| Component | Value |
|---|---|
| Risk-free rate (US 10-year)[a] | 0.76% |
| Equity risk premium (S&P 500)[b] | 5.77% |
| Equity beta[c] | 0.88 |
| Country risk premium[d] | 5.43% |
| Nominal, after-tax cost of equity | 11.27% |

S&P = Standard & Poor's, US = United States.
[a] Yield on 10-year US Treasury bond as at 10 March 2020 (https://www.treasury.gov/resource-center/data-chart-center/interest-rates/pages/TextView.aspx?data=yield).
[b] 12-month average S&P 500 return less 10-year US Treasury bond yield, Professor Aswath Damodaran (http://pages.stern.nyu.edu/~adamodar/).
[c] Average for listed power companies in emerging markets, Professor Aswath Damodaran.
[d] Estimate for Cambodia, Professor Aswath Damodaran.
Source: Asian Development Bank calculations using data sources as listed above.

**Table 2: Calculation of Weighted Average Cost of Capital**

| Component | Equity | Debt | Total |
|---|---|---|---|
| Amount ($ million) | 19.86 | 127.80 | 147.66 |
| Weighting | 13.4% | 86.6% | 100.0% |
| Nominal, after-tax cost | 11.27% | 2.15% | |
| Inflation rate [a] | 2.50% | 2.50% | |
| Real, after-tax cost [b, c] | 8.55% | - | |
| Weighted real after-tax cost | 1.15% | - | **1.15%** |

[a] Year-on-year change in United States Consumer Price Index for January 2020, all-items, urban consumers, not seasonally adjusted (https://www.bls.gov/cpi/).
[b] Calculated using the Fisher formula [(1 + interest/equity cost) / (1 + inflation rate)].
[c] The real cost of debt is treated as zero rather than the calculated negative value, following Asian Development Bank guidelines.
Source: Asian Development Bank calculations.

## C. Key Assumptions (Output 2)

8. Incremental revenues less incremental costs are estimated for a 10-year period in accordance with the expected life of the installed battery energy storage system (BESS), following its commissioning in 2022. The analysis is conducted using constant 2020 prices (i.e., excluding inflation).

9. **Incremental revenues.** The pilot BESS provides multiple services that are stacked for valuation purposes. These are shown in Table 3.

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[3] ADB. 2019. Financial Analysis and Evaluation: Technical Guidance Note. (A5.8)

**Table 3: Battery Energy Storage System Services**

| Service | Solar Plant Output Smoothing | Curtailment Reserve | Primary Frequency Response | Transformer Upgrade Deferral |
|---|---|---|---|---|
| Description | Charging when solar PV output is above target and discharging when output is below target | Charging continuously and discharging to avoid load shedding | Charging continuously and discharging to restore frequency | Charging off-peak and discharging at peak to relieve transformer overloading |
| Daily discharge[a] | 17.8 megawatt-hours per day (MWh/day) | 10.7 MWh/day | 11.2 MWh/day | 4.9 MWh/day (varies by year) |
| Cost of charging | Marginal supply cost | Marginal supply cost | Marginal supply cost | Marginal supply cost in off-peak hours |
| Benefit of discharging | Marginal supply cost | Average retail tariff | Marginal supply cost | Marginal supply cost in peak hours |

[a] The battery energy storage system goes through multiple cycles in one day for some services, so that daily discharge exceeds capacity.
Source: Asian Development Bank estimates.

10. The cost for charging is calculated as the energy cost of the marginal supply source in each hour. This applies even where the BESS is charged directly from the co-located solar photovoltaic plant because, if this solar output were not used for charging, it would replace the alternative marginal supply source at that time. The calculations allow for "round-trip" efficiency losses, meaning that 1.13 kWh of charging energy is required for each 1 kWh discharged.

11. **Incremental costs.** Incremental costs are the sum of the capital and O&M costs of the BESS. Capital costs are calculated as the sum of base costs and physical contingencies, totaling $8.92 million. Annual costs for air-conditioning, electronics, and battery racks are estimated at $0.16 million. Annual O&M costs after the initial 3 years are estimated at $0.06 million.

12. **Weighted average cost of capital.** The investment costs are grant-funded. Following ADB guidelines, the WACC applied is the estimated cost of government borrowing (Table 4).[4]

**Table 4: Cost of Government Borrowing**

| Component | Value |
|---|---|
| Risk-free rate (US 10-year)[a] | 0.76% |
| Country risk premium[b] | 5.43% |
| Nominal cost of borrowing | 6.19% |
| Inflation rate | 2.50% |
| Real cost of borrowing[c] | 3.60% |

[a] Yield on 10-year US Treasury bond as at 10 March 2020 (https://www.treasury.gov/resource-center/data-chart-center/interest-rates/pages/TextView.aspx?data=yield).
[b] Estimate for Cambodia, Professor Aswath Damodaran (http://pages.stern.nyu.edu/~adamodar/).
[c] Calculated using the Fisher formula [(1 + interest/equity cost) / (1 + inflation rate)].
Source: Asian Development Bank calculations using data sources as listed above.

## D. Financial Evaluation (Outputs 1 and 2)

13. For output 1, the FIRR exceeds the calculated WACC of 1.15%. For output 2, the estimated benefits of the pilot BESS do not meet the weighted average cost of government borrowing of 3.6%. However, average annual net revenues from the BESS cover annual operating expenditures, ensuring the system's sustainability throughout its operating life without any direct financial cost to EDC.

[4] ADB. 2019. Financial Analysis and Evaluation: Technical Guidance Note. (A5.6)

**Table 5: Summary of Financial Evaluation**

| | Base Value | FNPV $ million | FIRR | Switching Value | Change from Base |
|---|---|---|---|---|---|
| **Output 1** | | **249.0** | **10.9%** | | |
| +20% power supply cost (¢/kWh) | 8.3 | (1,038.2) | (12)% | 8.7 | 4.4% |
| +20% investment cost ($ million) | 147.7 | 216.8 | 8.7% | 352.5 | 138.7% |
| (20%) retail tariff (¢/kWh) | 15.4 | (614.2) | (10.1% | 14.6 | (4.9)% |
| 2 year delay in project (years) | 4 | 237.3 | 9.9% | | |
| **Output 2** | | **(7.4)** | **(40.7)** | | |

( ) = negative, ¢ = United States cent, FIRR = financial internal rate of return, FNPV = financial net present value, kWh = kilowatt-hour.
Source: Asian Development Bank calculations.

14. The project is sensitive to an increase in power supply costs and a reduction in the retail tariff. An increase in power supply costs will likely be offset by an increase in demand, which this analysis projected conservatively low, and in general by expanded lower-cost supply and contracted energy purchases. Between 2015 and 2020, EDC implemented a tariff reduction plan to pass through to customers the benefits of falling power purchase costs while maintaining cost recovery and a regulated return. Under this plan, residential tariffs fell by 10%–40%, commercial rates by 11%, and industrial rates by 18%.

## E. EDC financial performance

15. Summary financial statements for EDC are presented in Table 6. EDC meets its key financial covenants in all years. The projections assume constant tariffs in nominal terms from 2021, following reductions from 2015 to 2020 as costs declined.

16. The impacts of the coronavirus disease (COVID-19) pandemic on EDC are expected to be limited. Before the crisis took hold, sales in the first 3 months of 2020 were 14% above 2019 levels. For the year as a whole, sales are forecast to decline by 2.5% from 2019 levels. The reduced revenues are more than offset by declining power purchase costs thanks to expanding lower-cost supply. From 2023, power purchase costs start growing more rapidly than revenues because of the commissioning of already contracted new capacity (totaling 935 megawatts) with take-or-pay obligations on EDC. These lead to contracted energy purchases exceeding projected demand in some periods.

**Table 6: Electricité du Cambodge – Summary Financial Statements**

| KHR billion | 2016 actual | 2017 actual | 2018 actual | 2019 actual | 2020 projected | 2021 projected | 2022 projected | 2023 projected | 2024 projected | 2025 projected |
|---|---|---|---|---|---|---|---|---|---|---|
| **Income Statement** | | | | | | | | | | |
| Operating revenues | 4,236 | 4,680 | 5,671 | 6,551 | 6,389 | 6,928 | 7,682 | 8,518 | 9,560 | 10,730 |
| Power purchase and fuel costs | (2,996) | (3,345) | (4,016) | (4,734) | (3,324) | (3,412) | (4,233) | (5,652) | (6,929) | (8,189) |
| Other operating expenses | (600) | (693) | (812) | (949) | (953) | (1,037) | (1,144) | (1,268) | (1,418) | (1,589) |
| Operating profit | 641 | 642 | 843 | 868 | 2,113 | 2,479 | 2,305 | 1,598 | 1,214 | 953 |
| Net finance revenues/(costs) | (46) | (76) | (81) | (41) | (88) | (58) | (29) | 18 | 5 | (14) |
| Profit before tax | 594 | 566 | 762 | 827 | 2,025 | 2,421 | 2,276 | 1,616 | 1,219 | 939 |
| Income taxes | (119) | (101) | (152) | (165) | (405) | (484) | (455) | (323) | (244) | (188) |
| Net income | 475 | 465 | 610 | 662 | 1,620 | 1,936 | 1,821 | 1,293 | 975 | 751 |
| **Balance Sheet** | | | | | | | | | | |
| Non-current assets | 4,158 | 5,305 | 6,355 | 8,363 | 8,985 | 9,516 | 10,330 | 11,237 | 12,406 | 13,723 |
| Current assets | 2,055 | 2,326 | 2,687 | 2,583 | 3,390 | 4,698 | 6,164 | 6,432 | 6,968 | 7,643 |
| Total assets | 6,212 | 7,631 | 9,042 | 10,945 | 12,375 | 14,214 | 16,494 | 17,668 | 19,374 | 21,366 |
| Non-current borrowings and finance lease liabilities | 2,434 | 3,044 | 3,621 | 4,693 | 4,303 | 4,133 | 4,395 | 4,146 | 4,597 | 5,608 |
| Other non-current liabilities | 251 | 290 | 336 | 391 | 383 | 410 | 449 | 491 | 544 | 604 |
| Current liabilities | 827 | 1,095 | 1,201 | 1,310 | 1,363 | 1,481 | 1,713 | 1,873 | 2,172 | 2,415 |
| Total liabilities | 3,512 | 4,429 | 5,157 | 6,394 | 6,049 | 6,024 | 6,556 | 6,510 | 7,314 | 8,628 |
| Equity | 2,700 | 3,202 | 3,885 | 4,551 | 6,327 | 8,190 | 9,938 | 11,158 | 12,060 | 12,738 |
| **Statement of Cash Flows** | | | | | | | | | | |
| Net cash generated from operating activities | 372 | 627 | 588 | 619 | 1,753 | 2,161 | 2,055 | 1,546 | 1,240 | 1,042 |
| Net cash used in investing activities | (362) | (404) | (463) | (868) | (814) | (737) | (1,031) | (1,144) | (1,426) | (1,601) |
| Net cash used in financing activities | (69) | (65) | (45) | (150) | (148) | (235) | 272 | (325) | 483 | 965 |
| Net increase in cash | (59) | 158 | 80 | (400) | 791 | 1,189 | 1,295 | 77 | 297 | 406 |
| **Covenants** | | | | | | | | | | |
| DSCR (covenant = 1.3 times) | 2.75 | 3.58 | 2.54 | 2.60 | 6.19 | 6.33 | 6.05 | 4.06 | 3.20 | 2.14 |
| Debt:Equity Ratio (covenant = 70:30) | 47:53 | 49:51 | 48:52 | 51:49 | 40:60 | 34:66 | 31:69 | 27:73 | 28:72 | 31:69 |

( ) = negative, DSCR = debt service coverage ratio.
Source: Asian Development Bank calculations.

## Table 7: Financial Analysis – Output 1

| Year | Incremental revenues: Energy GWh | Incremental revenues: Revenues $ million | Incremental costs: Capital $ million | O&M $ million | Power purchase $ million | Distribution $ million | Tax $ million | Total $ million | Net Revenues $ million |
|---|---|---|---|---|---|---|---|---|---|
| 2020 | - | - | - | - | - | - | - | - | - |
| 2021 | - | - | (36.9) | - | - | - | - | (36.9) | (36.9) |
| 2022 | - | - | (66.5) | - | - | - | - | (66.5) | (66.5) |
| 2023 | - | - | (29.5) | - | - | - | - | (29.5) | (29.5) |
| 2024 | - | - | (14.8) | - | - | - | - | (14.8) | (14.8) |
| 2025 | 1,108 | 154.2 | - | (2.7) | (91.2) | (38.1) | (1.5) | (133.5) | 20.6 |
| 2026 | 1,536 | 208.4 | - | (2.7) | (126.0) | (52.8) | (2.4) | (183.9) | 24.4 |
| 2027 | 2,062 | 272.9 | - | (2.7) | (168.1) | (70.8) | (3.3) | (245.0) | 28.0 |
| 2028 | 2,705 | 349.4 | - | (2.7) | (220.9) | (92.9) | (3.6) | (320.2) | 29.2 |
| 2029 | 3,486 | 439.3 | - | (2.7) | (289.0) | (119.8) | (2.6) | (414.1) | 25.2 |
| 2030 | 4,501 | 553.3 | - | (2.7) | (375.3) | (154.6) | (1.2) | (533.8) | 19.5 |
| 2031 | 4,501 | 553.3 | - | (2.7) | (375.3) | (154.6) | (1.2) | (533.8) | 19.5 |
| 2032 | 4,501 | 553.3 | - | (2.7) | (375.3) | (154.6) | (1.2) | (533.8) | 19.5 |
| 2033 | 4,501 | 553.3 | - | (2.7) | (375.3) | (154.6) | (1.2) | (533.8) | 19.5 |
| 2034 | 4,501 | 553.3 | - | (2.7) | (375.3) | (154.6) | (1.2) | (533.8) | 19.5 |
| 2035 | 4,501 | 553.3 | - | (2.7) | (375.3) | (154.6) | (4.1) | (536.8) | 16.6 |
| 2036 | 4,501 | 553.3 | - | (2.7) | (375.3) | (154.6) | (4.1) | (536.8) | 16.6 |
| 2037 | 4,501 | 553.3 | - | (2.7) | (375.3) | (154.6) | (4.1) | (536.8) | 16.6 |
| 2038 | 4,501 | 553.3 | - | (2.7) | (375.3) | (154.6) | (4.1) | (536.8) | 16.6 |
| 2039 | 4,501 | 553.3 | - | (2.7) | (375.3) | (154.6) | (4.1) | (536.8) | 16.6 |
| 2040 | 4,501 | 553.3 | - | (2.7) | (375.3) | (154.6) | (4.1) | (536.8) | 16.6 |
| 2041 | 4,501 | 553.3 | - | (2.7) | (375.3) | (154.6) | (4.1) | (536.8) | 16.6 |
| 2042 | 4,501 | 553.3 | - | (2.7) | (375.3) | (154.6) | (4.1) | (536.8) | 16.6 |
| 2043 | 4,501 | 553.3 | - | (2.7) | (375.3) | (154.6) | (4.1) | (536.8) | 16.6 |
| 2044 | 4,501 | 553.3 | - | (2.7) | (375.3) | (154.6) | (4.1) | (536.8) | 16.6 |
| 2045 | 4,501 | 553.3 | - | (2.7) | (375.3) | (154.6) | (4.1) | (536.8) | 16.6 |
| 2046 | 4,501 | 553.3 | - | (2.7) | (375.3) | (154.6) | (4.1) | (536.8) | 16.6 |
| 2047 | 4,501 | 553.3 | - | (2.7) | (375.3) | (154.6) | (4.1) | (536.8) | 16.6 |
| 2048 | 4,501 | 553.3 | - | (2.7) | (375.3) | (154.6) | (4.1) | (536.8) | 16.6 |
| 2049 | 4,501 | 553.3 | - | (2.7) | (375.3) | (154.6) | (4.1) | (536.8) | 16.6 |
| 2050 | - | - | - | - | - | - | - | - | - |

| | |
|---|---|
| FIRR | 10.9% |
| FNPV @ 1.15% | 248.9 |

( ) = negative, FIRR = financial internal rate of return, FNPV = financial net present value, GWh = gigawatt-hour, O&M = operations and maintenance.
Source: Asian Development Bank calculations.

## Table 8: Financial Analysis – Output 2

| Year | Net Revenues from Services: PV Load Levelling $ million | Curtailment Reserve $ million | Primary Frequency Response $ million | Transmission Upgrade Deferral $ million | Total $ million | Costs: Capital $ million | O&M $ million | Tax $ million | Total $ million | Net Revenues $ million |
|---|---|---|---|---|---|---|---|---|---|---|
| 2020 | - | - | - | - | - | - | - | - | - | - |
| 2021 | - | - | - | - | - | (4.585) | - | - | (4.585) | (4.585) |
| 2022 | - | - | - | - | - | (4.011) | - | - | (4.011) | (4.011) |
| 2023 | (0.044) | 0.096 | (0.002) | 0.030 | 0.080 | (0.128) | (0.160) | - | (0.288) | (0.208) |
| 2024 | (0.044) | 0.086 | (0.000) | 0.207 | 0.249 | (0.128) | (0.160) | - | (0.288) | (0.039) |
| 2025 | (0.024) | 0.230 | 0.199 | - | 0.405 | (0.064) | (0.160) | - | (0.224) | 0.181 |
| 2026 | (0.025) | 0.216 | 0.209 | 0.365 | 0.765 | - | (0.216) | - | (0.216) | 0.549 |
| 2027 | (0.025) | 0.197 | 0.180 | - | 0.351 | - | (0.216) | - | (0.216) | 0.135 |
| 2028 | (0.025) | 0.187 | 0.196 | - | 0.358 | - | (0.216) | - | (0.216) | 0.142 |
| 2029 | (0.032) | 0.108 | 0.081 | 0.084 | 0.241 | - | (0.216) | - | (0.216) | 0.025 |
| 2030 | (0.032) | 0.085 | 0.063 | - | 0.116 | - | (0.216) | - | (0.216) | (0.100) |
| 2031 | (0.032) | 0.085 | 0.063 | - | 0.116 | - | (0.216) | - | (0.216) | (0.100) |
| 2032 | (0.032) | 0.085 | 0.063 | 0.172 | 0.288 | - | (0.216) | - | (0.216) | 0.072 |
| 2033 | - | - | - | - | - | - | - | - | - | - |

| | |
|---|---|
| FIRR | -40.7% |
| FNPV @ 3.6% | (7.4) |

( ) = negative, FIRR = financial internal rate of return, FNPV = financial net present value, O&M = operations and maintenance, PV = photovoltaic.
Source: Asian Development Bank calculations.