ADB

February 2011

Manual for Calculating Energy Output Indicators

Asian Development Bank

ABBREVIATIONS

ADB	–	Asian Development Bank
CO_2	–	carbon dioxide
CoP	–	community of practice
COSO	–	Central Operations Services Office
PRC	–	People's Republic Of China
DMC	–	developing member country
DMF	–	design and monitoring framework
FIRR	–	financial internal rate of return
Lao PDR	–	Lao People's Democratic Republic
MFF	–	multitranche financing facility
PCR	–	project completion report
PFR	–	periodic financing request
PID	–	project information document
PPR	–	project performance report
RRP	–	report and recommendation of the President
TA	–	technical assistance
TCR	–	technical assistance completion report

WEIGHTS AND MEASURES

GWh	–	gigawatt-hour
km	–	kilometer
kV	–	kilovolt
kWh	–	kilowatt-hour
MW	–	megawatt
tCO_2	–	tons of carbon dioxide

NOTE

In this report, "$" refers to US dollars.

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I. INTRODUCTION

A. Background

1. In 2009, the Energy Community of Practice (CoP) developed a set of indicators covering the 2009 Energy Policy and the ADB's corporate results framework level 2 indicators. These indicators would be used as a tool to monitor ADB's policy implementation.

2. As an initial step towards monitoring policy implementation, baseline information needed to be established. For this purpose, the first report[1] of indicators for ADB's energy sector operations (2005-2009) was prepared along with a database of these indicators. The *Manual for Calculating Energy Output Indicators* is a companion publication that explains the methodology used by staff in arriving at the figures in the said report.

B. Use of the Manual

3. ADB's policy implementation would be monitored through the indicators. Success of projects could be measured by meeting indicators specified in the *Reports and Recommendations of the President (*RRPs). In this light, it is hoped that the manual could guide the user in establishing the necessary data that should be contained in the RRP, which could lead to straightforward calculation of the indicators and ease of monitoring the project.

4. This manual will help consolidate the existing definitions of the indicators and provide steps in calculating the indicators specified in the energy indicators database. Section II gives an overview of the indicators while section III presents the 10 indicators and steps on how to calculate them.

II. INDICATORS UNDER THE 2009 ENERGY POLICY AND ADB'S CORPORATE RESULTS FRAMEWORK LEVEL 2

5. Based on the 2009 Energy Policy,[2] policy implementation shall be guided by three pillars: (i) promoting energy efficiency and renewable energy; (ii) maximizing access to energy for all; and (iii) promoting energy sector reform, capacity building, and governance. In 2009, the Energy CoP also developed the ADB's corporate results framework level 2 indicators in consultation with the Strategy and Policy Department. The definitions and guidelines for the indicators under these policies were set under the *Definitions and Guidelines for Monitoring Indicators: 2009 Energy Policy* and ADB's corporate results framework level 2[3] which was approved in early 2010 (Appendix 1). The indicators under each pillar and ADB's corporate results framework level 2 are as follows:

(i) Pillar 1: Promoting Energy Efficiency and Renewable Energy
  (a) Clean energy investment
  (b) Additional capacity using renewable energy
  (c) Electricity saved
  (d) Reduced CO_2 emission

[1] ADB. 2010. *Indicators for ADB's Energy Sector Operations (2005-2009).* Manila.
[2] ADB. 2009. *Energy Policy*. Manila
[3] ADB. 2010. *Definitions and Guidelines for Monitoring Indicators: 2009 Energy Policy and ADB Corporate Results Framework Level 2.* Manila.

(ii) Pillar 2: Maximizing Access to Energy for All
  (a) Number of loans and grants for expanding access to energy
  (b) Amount of loans and grants for expanded access to energy
  (c) Total additional installed capacity
  (d) Number of new households connected to electricity

(iii) Pillar 3: Promoting Energy Sector Reform, Capacity Building, and Governance
  (a) Number of loans and grants
  (b) Number of technical assistance (TA) projects
  (c) Amounts of loans and grants
  (d) Amounts of TA projects
  (e) Percentage of project completion reports (PCRs) rated *successful*
  (f) Percentage of TA completion reports (TCRs) rated *successful*

(iv) ADB's corporate results framework Level 2
  (a) Energy generation installed
  (b) Transmission lines installed/upgraded
  (c) Distribution lines installed/upgraded
  (d) Additional households connected to electricity
  (e) Reduced CO_2 emission

6. Three ADB's corporate results framework level 2 indicators are common with Energy Policy indicators, i.e., reduced carbon dioxide (CO_2) emission, total additional installed capacity, and number of new household connections. Also, some pillar 3 indicators such as number of loans and grants, number and amount of TA projects, and TCR and PCR ratings were summarized separately in the report, leaving 10 indicators in the database (Table 1).

Table 1: Indicators Under the Energy Policy and ADB's Corporate Results Framework Level 2

	Indicator	Energy Policy	ADB's corporate results framework Level2
1.	Clean energy investment	✓	
2.	Additional capacity using renewable energy	✓	
3.	Electricity saved	✓	
4.	Reduced CO_2 emission	✓	✓
5.	Amount of loans and grants for expanded access to energy	✓	
6.	Total additional installed capacity	✓	✓
7.	Number of new households connected to electricity	✓	✓
8.	Amounts of loans and grants for pillar 3 component	✓	
9.	Transmission line installed and/or upgraded		✓
10.	Distribution line installed and/or upgraded		✓

CO_2 = carbon dioxide

III. THE INDICATORS: DEFINITION AND CALCULATION

7. Consolidating the 2009 Energy Policy and the ADB's corporate results framework level 2 indicators, there are 10 indicators that could be monitored on a per project basis. The other indicators—such as the number of loans and TA projects and percentage of PCRs and TCRs rated *successful*—are collective indicators that may be monitored collectively each year.

8. The indicators were previously defined through the following documents: (i) *Definitions and Guidelines for Monitoring Indicators: 2009 Energy Policy* and ADB's corporate results framework level 2 that was approved by ADB in early 2010 (Appendix 1); (ii) *Guidelines for Estimating ADB Investments in Renewable Energy and Energy Efficiency Projects*, which is a working ADB document that may be updated from time to time (Appendix 2); and (iii) *Guidelines for Estimating ADB Investments in Access to Energy Projects and Number of Households Provided Access,* that is also a working document developed under ADB's Energy for All Initiative (Appendix 3[4]).

9. These guidelines have been summarized in the discussion that follows. Each of the 10 indicators is defined and a methodology for calculating the amount or getting the required value from the RRP and other relevant documents is subsequently discussed. For better appreciation of the calculation, sample computations are presented in Appendix 4.

A. Clean Energy Investment

1. Definition

10. Clean energy investment is that portion of the ADB assistance used to fund projects or project component(s) involving renewable energy, energy efficiency, and/or fuel switching. The common denominator of all clean energy projects is that they result in reduced greenhouse gas emissions.

2. Calculation

11. ADB's commitment to promote clean energy development is evident in its setting of a new target of $2 billion annually for clean energy investment by 2013. To monitor progress towards this target, a methodology for quantifying ADB's clean energy investment was established.

12. For instance, the entire ADB assistance for a wind energy project is considered clean energy investment, but only a certain percentage of the ADB assistance for a new coal power plant utilizing supercritical technology may be considered clean energy investment. Referring to Table A2.2, assuming emission from the baseline power plant (in this case a conventional coal plant) is 1.002 kilograms (kg) CO_2 per kilowatt-hour (kWh) and emission from the new plant using supercritical technology is 0.811 kgCO_2/kWh, then clean energy investment could be calculated as (1.002–0.811)/1.002, so 19% of ADB assistance could be considered clean energy investment.

13. ADB's clean energy (CE) investment may be calculated as follows:

[4] Only the portion on estimating ADB investment is attached. The methodology in calculating the number of households was not adopted in the database.

CE Investment = β x ADB assistance

where:

β is the percentage of the total project cost that may be attributed to funding the clean energy component.

14. Appendix 2 contains the guidelines established for estimating ADB investments in renewable energy and energy efficiency projects. The percentages calculated in Appendix 2 are applicable for projects in the pipeline. Otherwise, actual project data that may be sourced from RRPs—e.g., information on power plant efficiency, emission factors, systems loss, and annual energy savings—should be used as inputs in calculating β.

15. The basic concept in calculating this percentage is to get the efficiency that would result from a project and compare it with a baseline scenario, e.g., coal as a baseline fuel for power plants, or road transport as a baseline for railways. Thus, β could be given as the percentage change between the baseline and project scenarios, as follows:

$$\beta = \frac{(E_b - E_p)}{E_b} \times 100\%$$

where:

E_b = baseline efficiency or emission factor
E_p = project efficiency or emission factor

16. For example, for power plant fuel switching, E_b would be the emission factor of the baseline power plant or the power plant to switch from, and E_p would be the emission factor of the power plant proposed by the project.

17. The same principle would be applicable to railway projects; however, since baseline emission or consumption is usually not available, a different method has been developed. For projects with an energy efficiency (EE) component that is not clearly defined or is integral to the whole project, such as in a railway project, the present value of the CO_2 savings is assumed as the energy efficiency investment of the project. Assuming a conservative price for certified emission reductions (CERs), the energy efficiency investment is computed as the present value of CO_2 saving over the life of the project and using the project's financial internal rate of return (FIRR) as the discount rate.

$$\beta = \frac{\text{EE investment}}{\text{Total Project Cost}}$$

where:

EE investment = PV (FIRR, life of the project, annual CO_2 savings)

18. For the following projects, no calculation of percentage is necessary, as the entire ADB assistance is considered ADB's clean energy investment:

(i) Renewable energy:

(a) Renewable energy projects (wind, solar, small hydro, geothermal, biomass, biofuel, biogas, landfill gas, municipal waste).
(b) Transmission lines dedicated to transmitting power generated by renewable energy.

(i) Demand-side energy efficiency:
(a) Dedicated energy efficiency projects whose only purpose is to improve energy efficiency (efficiency power plant).
(b) Assistance provided to energy service company and manufacturers of energy efficient appliances.

B. Additional Installed Capacity Using Renewable Energy

1. Definition

19. This indicator is defined as the rated capacity of a project or project component involving renewable energy technologies. Projects with this indicator include small hydro, wind, solar, geothermal, biofuel, waste-to-energy, and biomass projects. The projects may either be new construction or from acquisition, e.g., the private sector acquiring a government-owned small hydro plant.

2. Calculation

20. No calculation is required here. The additional installed power plant capacity would simply have to be given in megawatts. This would apply whether the project is a result of new construction or involves the acquisition of an existing power plant. The installed capacity being "additional" would be from the viewpoint of ADB and not from the DMC's supply scenario; thus, construction of a 10 megawatt (MW) small hydropower plant would have the same indicator as a 10 MW small hydro plant acquired from government.

C. Electricity Savings

1. Definition

21. Electricity or energy savings result from a project or component of a project that involves energy efficiency. It is the difference between electricity or energy converted or used with and without the energy efficiency component.

22. This indicator, at first glance, may be associated with renewable energy projects inasmuch as there would be fossil fuel savings. However, it must be stressed that the operative word for energy savings is efficiency. A 100 MW renewable energy project displacing a 100 MW coal plant would be producing the same amount of energy. The fossil fuel savings in this case would be associated with reduced CO_2 emission rather than energy savings.

23. Energy efficiency projects may either be viewed as supply-side or demand-side energy efficiency. For supply-side energy efficiency projects, energy savings may result from an improved power plant needing less fossil fuel to run or a more efficient transmission system resulting in less systems loss. In both cases, less energy inputs would be needed to supply the same demand.

24. For demand-side energy efficiency, electricity savings would come from improved efficiency on how a given supply would be used. Projects may include efficient lighting or energy efficient appliances that require less energy inputs, or reduction in nonrevenue water, as each cubic meter of water saved is equivalent to a certain quantity of energy saved.

2. Calculation

25. Annual electricity savings may be in energy units such as GWh per year. It should be expected that dedicated energy efficiency projects provide the savings figures in the RRP. For other projects, however, especially transmission and distribution projects, calculation is needed.

a. Transmission and Distribution Projects

26. In the RRPs, electricity savings from transmission and distribution projects are usually given as improvement in system loss reduction, e.g., energy savings due to reduction in systems losses from 5% in 2009 to 3% in 2012. Based on this, the following formula could be followed; however, the process of estimating would really depend on the available data.

Given data: System loss reduction resulting from upgrading the transmission or distribution line.

Data required:

LL_b = Line loss in the baseline year (before the project), %
LL_p = Line loss after project completion, %
Sales = Projected sales after the project (in $ or GWh)
Tariff = Projected tariff in $/kWh if projected sales are given in $

$$\text{Electricity Savings} = \left(\frac{\text{Sales in GWh}}{(1 - LL_p)}\right) \times (LL_b - LL_p)$$

OR

$$\text{Electricity Savings} = \left(\frac{\text{Sales in \$ / Tariff}}{(1 - LL_p)}\right) \times (LL_b - LL_p)$$

27. To further understand this equation, note that electricity coming from power plants passes through transmission and distribution lines before reaching consumers. Let us call the electricity coming from power plants “energy input”. Line losses are inherent in a transmission and distribution system, thus energy input is reduced as it travels the lines.

28. Therefore, the electricity that reaches consumers, which is the basis for revenue or sales of an electricity provider, is energy input less the line losses. Sales could thus be calculated as follows:

Sales (in GWh) = Energy Input (in GWh)x (1 – line losses)

29. Energy input once the energy efficiency component is operational could be derived as

Energy Input = Sales / (1 – line losses after the project)
= Sales / (1- LL_p)

30. Electricity savings could be calculated as the difference in electricity losses before and after the project, as follows:

$$\text{Electricity losses before the project} = \text{Energy Input} \times LL_b$$
$$\text{Electricity losses after the project} = \text{Energy Input} \times LL_p$$

$$\text{Electricity Savings} = \text{Energy Input} \times (LL_b - LL_p)$$
$$= \frac{\text{Sales}}{(1 - LL_p)} \times (LL_b - LL_p)$$

b. Generation Projects

31. Efficient generation projects usually give savings in terms of tons of coal equivalent. A rehabilitation project that results in better efficiency, on the other hand, may provide data on heat rate improvement, in which case electricity savings are calculated based on the annual generation and the heat rate improvement.

Given	Other Data Required	Electricity Savings (ES) in GWh
Savings in million tons of oil equivalent (TOE)	1 million TOE = 11,630 GWh	ES = Savings in MTOE x 11,630
Savings in tons of coal equivalent (TCE)	Lower Heating Value (HV) of coal(MJ/ton)	ES = Savings in TCE x HV x (GWh/MJ)*
Tons of CO_2 reduction	Country emission factor (tCO_2/GWh)	ES = $\frac{\text{Tons of } CO_2 \text{ reduction}}{\text{Country emission factor}}$
Heat rate improvement (joules/kWh) due to rehabilitation works	Annual generation in kWh = MW capacity x 8,760 hours x load factor /1,000	ES = Generation x (heat rate improvement) x (GWh/MJ)*

*applicable conversion factor from joule to GWh

D. Reduced CO_2 Emissions

1. Definition

32. This is the avoided annual CO_2 equivalent emission as a result of a clean energy project or component. Projects with CO_2 emission reduction include renewable energy generation, energy efficiency projects, transmission and distribution with systems loss reduction, and use of cleaner fuels such as natural gas in place of coal or oil.

2. Calculation

33. The indicator is given as annual reduction in tons of CO_2 (tCO_2/year). The country emission factor would be mostly used in the calculation (Appendix 4). A proxy factor has been calculated by ADB and this could be used where the emission factor for a particular country is not available—739.73 tCO_2/GWh is the proxy indicator calculated based on power generation and CO_2 emissions of DMCs in 2006. This default factor would be updated as necessary.

Given	Other Data Required	CO_2 Emission Reduction
Electricity savings(GWh)	Country emission factor(tCO_2/GWh)	tCO_2 = Electricity savings x country emission factor
Installed renewable energy capacity (MW)	• Country emission factor(tCO_2/GWh) • Generation in GWh = renewable	tCO_2 = Generation x country emission factor

	energy capacity in MW x 8,760 hrs x load factor/1000	
Improvement in heat rate (joules/kWh)	• Heat rate before and after the project • Generation = (power plant capacity in MW x 8760 x load factor), MWh • Fuel emission factor(tCO_2/TJ)	tCO_2 = Generation x 1000 x (difference in heat rate) x fuel emission factor /10^{12}
Fuel switching from oil or coal to gas	• Generation • Fuel emission factor(tCO_2/GWh)	tCO_2 = Generation x (emission factor of oil or coal – emission factor of gas)
Fossil fuel savings, tons per year	• Fuel emission factor(tCO_2/ton)	tCO_2 = Fossil fuel savings x fuel emission factor

GWh = gigawatt-hour, kWh = kilowatt hour, tCO_2 = tons of carbon dioxide, TJ = terajoule.

E. Transmission Lines Installed or Upgraded

1. Definition

34. The indicator covers power, gas, and oil transmission lines. It is the measure of the ground distance, in kilometers, traversed by the transmission line. For power transmission lines, we are looking for the simple distance from tower A to tower B and not the circuit-kilometers.[5]

35. Although the indicator does not differentiate between a newly installed and an upgraded line, upgraded lines have certain criteria. Upgraded power transmission lines should involve increase in voltage level, e.g., from a low-voltage line to a high-voltage line. For gas and oil transmission lines, there should be an increase in pipe diameter or capacity of the line.

2. Calculation

36. As this is a simple distance between two points, not much calculation is needed except when circuit-kilometers is the unit involved as the type of line has to be considered. If it is a double circuit line then the number of circuit-kilometers is divided by two to give the indicator. If it is single circuit, the number of circuit-kilometers is the same as the distance between the given points.

F. Distribution Lines Installed or Upgraded

1. Definition

37. The indicator, given in kilometers, is a measure of the length of the network of lines or pipes installed and/or upgraded. This is the same as that of transmission lines except that it is associated with supply network lines or pipes. Distribution lines, whether upgraded or installed, include power distribution lines, district heating network pipelines, and urban gas supply network pipelines. An upgrade would involve improvement of the network including reconductoring or changing the wires of the distribution line.

[5] Circuit-kilometer is a measure of the distance from tower A to tower B multiplied by the number of circuits. A double-circuit transmission line means that there are two lines or cables running the length. Thus, for a double circuit line, 100 circuit-kilometers means it is a 50 km transmission line.

2. Calculation

38. The length of the line or pipeline would be measured in kilometers as the distance covered by the line.

G. Total Additional Capacity

1. Definition

39. The indicator, given in MW, is the total generating capacity of a generation project. This may be power sourced from renewable technology or from conventional sources e.g., oil, coal, or large hydro. A project may involve construction of a new power plant or simply acquisition of an asset, e.g., the private sector acquiring a government-owned coal plant. This also includes the MW-equivalent capacity of additional heating supply as well as hydrocarbon-based energy added through production or additional importation capacity.

2. Calculation

40. Total installed power plant capacity includes both conventional and renewable sources. This would not need any calculation, as the nominal capacity of the power plant is given in MW. In this light, construction of a 100 MW wind power plant that is intermittent would have the same indicator as a 100 MW base load coal plant. The difference would arise in other indicators, as the wind project would give clean energy indicators.

41. Further, construction of a new 20 MW small hydro plant would have the same indicator as acquisition of a government-owned 20 MW small hydro plant. In this case, although the 20 MW acquisition is not additional capacity when we talk of the country's power grid, it is additional capacity from the perspective of financing its acquisition.

42. Conversion to MW-equivalent (MW-eq) is calculated as follows:

MW-eq = fuel quantity (weight/volume) x heating value x 40% /3,600 MJ/hr

where:

The heating value is available in the RRP; otherwise the following may be considered as default:

coal: 18,900 MJ/ton
oil: 42,300 MJ/ton
gas: 40 MJ/m^3

40% is the energy conversion efficiency for hydrocarbon production.

H. New Households Connected to Electricity

1. Definition

43. The indicator is the number of new households connected to the grid. Only new household connections resulting from a project are counted; households already connected to the grid and receiving improved services through a project are not counted. Note further that the number of new household connections resulting from a project is counted in total and not

proportioned to the ADB funding component only.[6] The guiding principle is that ADB assistance is integral to the completion of the entire project; without the ADB assistance, the total target household connections would not be attained.

2. Calculation

44. New connections may be given as a straightforward number, being the number of households that the project would connect to the grid. However, this may also be given in terms of population that would be served by the project. In this case, the population is divided by the average household size of the country or of the locality. Thus, it is important that the average household size is mentioned in the RRP.

I. Amount of Loans or Grants for Expanding Access to Energy

1. Definition

45. This is the amount of assistance ADB extends to maximize access to energy. Access to energy projects or project components include household grid connection, rural electrification, off-grid power capacity addition, district heating distribution expansion or upgrade, and gas distribution pipeline extension.

2. Calculation

46. The first step is to check if the project is a dedicated access to energy project. If not, ADB's portion of the access to energy investment is calculated in two ways:

(i) From the detailed cost estimate by financier, the cost estimate of the relevant project components financed by ADB is totaled.
(ii) If the relevant component that would be financed by ADB could not be clearly sliced from the project, this is pro-rate to the ratio of ADB assistance to project cost.

47. For energy sector projects, the following guidelines apply (Appendix 3):

Project	ADB's Access to Energy Investment
Dedicated energy access projects (providing lighting, household electricity), rural electrification projects, off-grid/mini-grid electrification projects.	100% ADB assistance
Distribution pipeline or extension project to supply cleaner fuels to households.	100% ADB assistance
Generation projects with distribution component where the number of new household connections is specified.	Entire distribution component investment
New distribution, transmission and distribution, and district heating projects.	ADB's investment in the distribution component
Financing projects with clearly defined energy access components.	ADB's share in the project estimate for such components

[6] On the contrary, the *Guidelines for Estimating ADB Investments in Access to Energy Projects and Number of Households Provided Access* calculates the number of households by proportioning it to the amount of ADB assistance.

J. Amount of Loans or Grants for Promoting Energy Sector Reforms, Capacity Building, and Governance

1. Definition

48. Pillar 3 covers the promotion of energy sector reforms, capacity building, and governance. The indicator pertains to the amount of ADB assistance extended to the pillar 3 component of a project. Projects with capacity development components are the candidates for this indicator.

49. ADB also provides technical assistance in support of a particular project. However, what is being tallied here is only the amount that is directly part of the project. ADB assistance through TA projects is counted separately.

2. Calculation

50. A project's capacity development component may be partly financed by ADB and partly by the DMC government or local government. The indicator pertains only to the amount of ADB assistance that finances the capacity development component of a project, including taxes and contingencies.

IV. CALCULATING INDICATORS IN REPORTS AND RECOMMENDATIONS OF THE PRESIDENT

51. Having the indicators predefined and armed with the RRPs of the projects, it could be assumed that filling out the database of energy indicators would be a straightforward task. However, this was not the case. In considering the RRP as the main source of information, it was incorrect to presume that all relevant indicators would be available in the design and monitoring framework (DMF) or in the body of the RRP.

A. Data in the Reports and Recommendations of the President

52. In general, projects have indicators cited in the DMF; however, there are those that require further reading of the body of the RRP and its appendixes, including the financial and economic analysis sections. Still others did not state the exact indicator, and assumptions have to be made to calculate the needed indicators. It is unfortunate that there were also some projects for which indicators could not be found in the available documents (e.g., RRP, PFR, PID) which makes it difficult to make reasonable assumptions, and the officer had to be consulted.

53. The degree of difficulty in filling out the database depended on the availability of information in the RRP. There are projects with complete information in the RRP; the projects include those in which the DMFs clearly stated the targets supported by figures, all indicators could be found in the body and appendixes of the RRP, and there was no need for additional calculation or assumptions. However, there are also projects with incomplete information that include those where the DMFs are qualitative and with RRPs not having all the indicators needed, thus requiring assumptions and calculations to be made. There is a third set of projects that lack all information needed to fill out the database of indicators. This set includes projects for which DMFs are vague and the RRPs do not support the statements with figures.

54. There are 26 projects where indicators have been filled out based on information from the RRP (Table 2). All data needed were either contained in the DMF or in the body and appendixes of the RRP. There was no need to do any additional calculation as the indicators were presented in the units required, e.g., energy savings in MWh rather than tons of fuel.

Table 2: Energy Projects with All Necessary Indicators Found in the Report and Recommendation of the President

Loan Number	Country	Board Approval	Project Name	Type of Project
2282	Philippines	8 Dec 06	Power Sector Development Program	Program
2323	India	4 Apr 07	Madhya Pradesh Power Sector Investment Program (Tranche 1)	MFF
2334	Bangladesh	26 Jun 07	Sustainable Power Sector Development Program	Program
2353	Viet Nam	2 Oct 07	Mong Duong 1 Thermal Power Project-1	MFF
7253	India	17 Apr 07	Tata Power Wind Energy Financing Facility	Project
7256	Cambodia	27 Jun 07	Cambodia Power Transmission Lines Co. Ltd.	Project
9109	Mongolia	29 Jun 07	Community-Based heating Supply in Rural Areas	Project
7271	PRC	14 Dec 07	Energy Efficiency Multi-Project Financing Program	Guarantee
2426	PRC	9 Jun 08	Guangdong Energy Efficiency and Environment Improvement (Tranche 1)	MFF
2429	Viet Nam	26 Jun 08	Song Bung 4 Hydropower Project	Project
2437	Azerbaijan	10 Sep 08	Power Transmission Enhancement Project	Project
2463/ 2464	Bhutan	29 Oct 08	Bhutan Green Power Development	Project
7276/2419	India	17 Apr 08	Coastal Gujarat Power Ltd Coal Fired Power Plant	Project
7277/2434 & 7277/2417	India	17 Apr 08	Gujarat Paguthan Wind Energy Financing Facility	Project
7285	PRC	4 Sep 08	Inner Mongolia Wind Power Project	Equity
7288	India	27 Nov 08	Rural Electrification Corporation of India	Project
2507	Philippines	29 Jan 09	Philippine Energy Efficiency	Project

Loan Number	Country	Board Approval	Project Name	Type of Project
2518/ 2519	Sri Lanka	14 Apr 09	Clean Energy and Access Improvement Project	Project
2552/ 2553	Pakistan	22 Sep 09	Energy Efficiency Investment Program (Tranche 1)	MFF
2587	Nepal	27 Nov 09	Energy Access And Efficiency Improvement	Project
2610	Viet Nam	21 Dec 09	Mong Duong 1 Thermal Power Project (Tranche 2)	MFF
7290/2504	Thailand	13 Jan 09	Biomass Power Project	Project
7291/2505	PRC	13 Jan 09	Small Hydropower Development Project	Project
7297/2512	PRC	10 Mar 09	Zhangbei Wind Power Project	Project
7300	India	28 May 09	Public-Private Partnership For Renewable Energy Development	Equity
7303/ 2612	Philippines	11 Dec 09	Visayas Base Load Power Development Project	Project

PRC = People's Republic of China, MFF = multitranche financing facility.

55. For those RRPs with incomplete data, clean energy indicators (energy savings and/or CO_2 emission reduction) were calculated for 34 projects in 2005–2007 and another 19 projects for 2008–2009 out of the 95 projects with clean energy investment. For 2005–2007 projects, the RRPs cite a general statement on CO_2 emission reduction but the statement is usually not supported by figures. The presentation was better in RRPs from 2008–2009.

56. Different types of data that lead to the calculation of clean energy indicators were given in the RRPs: (i) fossil fuel savings could be in tons of coal,(ii) the volume of natural gas to be transmitted in the pipeline or capacity improvement of a terminal could be given in cubic feet or cubic meters, (iii) energy savings in GWh could be converted to tons of CO_2 using the country emission factor, (iv) heat rate improvement due to rehabilitation of a power plant, and (v) generation passing through a transmission network and the applicable reduction in losses. Assumptions included fuel emission factors, country emission factors, load factors of power plants, and heating values. The appendixes (financial and economic analysis) were also used for historical performance and projections on sales.

57. Among the incomplete RRPs, indicators for transmission and distribution projects were the most difficult to calculate due to lack of data in the RRP. The RRP would state the percentage reduction (e.g., the DMF may have an outcome, such as technical losses would decrease to 5% by 2009) but usually it does not cite the generation that could be the basis of computation. In such cases, the generation based on the historical performance and the projected growth were used as bases of computation. Further, for those with a distribution

component, it is more the rule rather than the exception that the length of distribution line is not provided in the RRP.

58. There are two projects in the list that involve clean energy initiatives but the indicators are not available due to the nature of the investment. One is an equity investment (the Municipal Natural Gas Infrastructure Development Project[7]) that will support the investment plan of China Gas Holdings. The RRP contains the general direction that China Gas Holdings would take but there are no specific numbers, such as the length of gas distribution network or amount of natural gas to be supplied.

59. The other project (Equity Investment in Asian Clean Energy Private Equity Funds[8]) involves equity investment of $100 million divided into five clean energy funds. The five private equity funds will invest equity in clean energy projects and companies.

B. Examples of Data Presentation in the Design and Monitoring Framework

60. Below are some examples of DMFs that stood out among the RRPs reviewed. It may also be mentioned here that total project cost, although not an indicator, should be stated in the RRP. There were about 10 projects, mostly private sector projects, which did not state the total project cost in the RRP and data had to be sourced from the Private Sector Operations Department quarterly reports and the PPR. Although this is not an indicator, it is basic information expected in any project document.

1. Transmission and Distribution Projects

61. Transmission and distribution projects are generally the ones that lack basic information in the RRP, such as the energy savings or length of the line. But not all are like this; data could be presented clearly, as illustrated by the Power Transmission Enhancement Project.[9]

62. In the RRP of this project, the length of the line was described and given in kilometers. Reduction in losses was given not only in the usual percentage reduction but the baseline year was also given. More importantly, reduction in losses was converted to GWh, and CO_2 emission reduction was calculated in tCO_2/year. The DMF contained the necessary information as follows:

(i) Construction of a double-circuit 220 kV transmission line of 280 km.
(ii) Reduction of transmission line losses by 25 GWh, from 6% in 2007 to 3% in 2012.
(iii) Annual net CO_2 emission reduced by 1.3 million tons.

2. Subsectors: Transmission and Distribution, Energy Efficiency, Renewable Energy

63. The Energy Access and Efficiency Improvement[10] project consists of seven components under three different subsectors, i.e., transmission and distribution, energy efficiency, and

[7] ADB. 2006. *Report and Recommendation of the President to the Board of Directors: Proposed Equity Investment and Loans to the People's Republic of China for the Municipal Natural Gas Infrastructure Development Project.* Manila.
[8] ADB. 2008. *Report and Recommendation of the President to the Board of Directors: Proposed Equity Investment in Asian Clean Energy Private Equity Funds*. Manila.
[9] ADB. 2008. *Report and Recommendation of the President to the Board of Directors: Proposed Loan to Azerbaijan for the Power Transmission Enhancement Project.* Manila.

renewable energy, but there was no confusion here because the DMF was clear and concise. For this project, all the needed indicators could be found in the DMF. This is a good example inasmuch as it optimized the use of the DMF. Also, note that the energy savings were presented for each component of the project, including savings due to systems loss reduction. It is common in the RRPs reviewed that energy savings due to systems loss reduction are presented in the DMF as a mere change in percentage, e.g., transmission losses from 3.5% in 2009 to 3.0% in 2012, and the energy savings in megawatt-hours are not specified.

64. The DMF specified the energy savings for each component as follows:

(i) 4 GWh average increase in annual generation from Marsyangdi and Gandak hydropower plants.
(ii) Reduced system losses in the pilot areas for distribution loss reduction and private sector participation from present 25% to 22% by 2013, with an energy saving of 25 GWh per year.
(iii) Per capita lighting load to reduce by 30% by the end of 2011 against without-project scenario, saving approximately 23 GWh of energy per year.
(iv) Street lighting load eliminated in selected urban centers by the end of 2011, saving approximately 1 GWh of energy per year.

3. Multitranche Financing Facilities

65. There are several MFF loans, each with 2–5 tranches. Each of the tranches in the MFFs has a separate set of indicators that may be sourced from the RRP or the periodic financing request. The whole investment program (the MFF) has a DMF and sometimes the DMF of tranche 1 is also presented in the RRP. However, the likely situation is that the tranches were described in the RRP but no separate DMF was presented.

66. One of the good examples of an MFF is the Energy Efficiency Investment Program,[11] which has four tranches. It was easy to follow the tranches because each was described and the major components were mentioned. There was also a separate DMF for tranche1 that was clearly presented, so there was no need to go to the body of the document to look for the indicators. Further, the appendixes were comprehensive and contained the figures supporting the claims in the DMF.

67. The DMF presented the indicators clearly, as follows:

(i) 2,132 GWh electricity saved annually starting in 2011, and
(ii) CO_2 emissions reduced by 908,000 tons per year starting in 2012.

68. All four tranches were given a brief description, but the major activities were also cited. A description of tranches is important in defining the indicators for future tranches.

[10] ADB. 2009. *Report and Recommendation of the President to the Board of Directors: Proposed Loan and Administration of Grants to Nepal for the Energy Access and Efficiency Improvement.* Manila.
[11] ADB. 2009. *Report and Recommendation of the President to the Board of Directors: Proposed Multitranche Financing Facility and Administration of Cofinancing to the Islamic Republic of Pakistan for Energy Efficiency Investment Program*. Manila.

69. The RRP of the Madhya Pradesh Power Sector Investment Program,[12] on the other hand, lacks the necessary information and indicators to monitor progress. This MFF is for a series of transmission and distribution projects with four of the five tranches approved in the same year. Among the MFFs whose RRPs were reviewed, this has been the most problematic MFF. The challenging points encountered in searching data from its RRP were as follows:

(i) The descriptions of the first two tranches were provided in the RRP, however there were no descriptions for the other three. There was no DMF for tranche 1.
(ii) The DMF for the entire program was presented per target year. This was not helpful in getting the indicators per tranche. It would have been better if the outputs were also grouped per tranche.
(iii) The length of the transmission line was given in ckt-km but it was not mentioned in the description if the lines are double or single circuit.
(iv) The DMF cited reduction in transmission losses from 5.2% in 2005–2006 to 4.9% in 2008–2009 but the project outputs start in 2011.
(v) The DMF cited reduction in distribution losses in terms of percentage, which is the usual practice, but it was confusing as to which tranche this would be applied to because not all the tranches were described.

70. Weighing these two examples, it may be further noted that it would be best to describe in detail the tranches in an MFF. Also in the DMF for the investment program, the outcome and input could be presented per tranche. Presenting the DMF by target year may not be advisable unless the tranches are well described in the RRP.

[12] ADB. 2007. *Report and Recommendation of the President to the Board of Directors: Proposed Multitranche Financing Facility to India for Madhya Pradesh Power Sector Investment Program*. Manila.

DEFINITIONS AND GUIDELINES FOR MONITORING INDICATORS UNDER THE 2009 ENERGY POLICY AND ADB'S CORPORATE RESULTS FRAMEWORK LEVEL 2

Indicators	Unit	Definition and Guideline
2009 Energy Policy Indicators		
A. Outcome Indicators		Monitoring energy sector outcomes in Asia and the Pacific; to be included in energy sector road maps of CPS for the DMCs where energy is agreed to be a priority sector of operations
Share of renewable energy in total generation capacity	%	Share of RE-generated electricity (GWh) to total electricity generation (GWh) in DMCs expressed as percentage. RE includes solar, wind, geothermal, hydropower (all size), waste-to-energy, and biomass (other than current noncommercial use, such as, biogas, biofuel, and biomass).
Energy consumed per unit of GDP (energy intensity)	toe per $1,000 GDP	Ratio of energy usage (toe) in a DMC to its GDP in $1,000.
Electrification rate	%	Ratio of population with electricity to the total population of a DMC expressed as percentage. If the ratio is available at household level, it will be acceptable as a proxy with a footnote mentioning the assumed average size of households. If information is only available for the percentage of villages electrified, a suitable methodology will be developed to translate the data to population level.
Sound financial health of energy enterprises		The 2009 Energy Policy[a] requires the monitoring to be done on the basis of RRPs. Therefore, it is related to the implementing agencies (or executing agencies) only submitting annual financial statements to ADB, and does not monitor the financial health of other energy enterprises that are not identified in project agreements. The indicator will be monitored at the enterprise level as recorded in the financial statements (refer to Financial Management and Analysis of Projects, 4.4.6).[b] A suitable methodology will be developed in consultation with RSGP to aggregate the RRP-level indicators to ADB-level indicators: • Rate of return: relationship between the net operating income (after tax) and the net fixed assets in operation, and expressed as a percentage. • Operating ratio: operating expenses, including adequate maintenance and depreciation, as a percentage of revenues.
B. Output Indicators		Output indicators relate to ADB-funded projects in the energy sector, to be included in project documents—concept paper and RRP.
(i) Promoting energy efficiency and renewable energy		
Clean energy investment for RE/EE/fuel switching	$ million ADB-level target $2 billion by	ADB assistance for RE, EE, and fuel switching projects, or component of project (defined as clean energy project or component); to include loan, equity, guarantee, B-loans, and grant. These projects have a common feature—to reduce or avoid GHG emissions. The project may be in any sector

Indicators	Unit	Definition and Guideline
	2013	(transport, urban, water, agriculture, education, health) as long as the reduction of GHG is a stated output in the DMF. Methodology: • For dedicated clean energy project, 100% of ADB assistance. Transmission lines for evacuation of RE (ADB funded or other source funded) will be considered dedicated investment and included. • For distinct clean energy component, ADB funding for these components to be identified in the concept paper and RRP. • If a clean energy component cannot be separately identified and forms an integral part of the project (e.g., an EHV transmission line lowers transmission loss, a school building that used CFL lighting in a country where incandescent lamps are commonly used), the share of ADB assistance for clean energy will be estimated as follows: ADB Investment = PV of CO_2 savings x (ADB loan amount / project cost). Where: PV of CO_2 savings is determined by assuming a conservative price for CERs, the loan term, and discount rate used for FIRR analysis.
Additional installed capacity using renewable energy	MW-eq	Rated capacity of project or component involving RE technologies, includes power plants, district heating systems, and similar facilities.
Electricity saved	GWh	Electricity savings resulting from EE project or component. For the same level of output, the electricity saving will be the difference in electricity used with and without the EE project or component, or the difference between electricity loss with and without the EE project. When a project or component leads to saving of fossil fuels, the equivalent electricity saving will be determined. The fossil fuel saving will be converted to CO_2 saving, and then the proxy factor of 739.73 tCO_2/GWh used to determine the equivalent electricity saving.
Reduction of carbon dioxide emissions	tCO2-eq per year	The climate change indicator will monitor the avoided annual CO_2 equivalent emission by clean energy project of component. It will include CO_2 and other GHGs identified by the UNFCCC and the GHG potential established under the IPCC Guidelines for National Greenhouse Gas Inventories [c]. Methodology: Annual CO_2 reduction or avoidance will be calculated as follows: <u>For RE project:</u> tCO_2= GWh generated x 739.73 tCO_2/GWh [d] <u>For supply-side EE projects:</u> tCO_2 = GWh saved x 739.73 CO_2/GWh <u>For demand-side EE projects (i.e., CFL replacement, efficient motors, etc.)</u> tCO_2 = GWh saved measured at demand-side meter / (1 - T&D

Indicators	Unit	Definition and Guideline
		losses) x 739.73 tCO_2/GWh <u>For T&D loss reduction</u> tCO_2 = GWh saved x 739.73 tCO_2/GWh; loss is generally reported as a percentage, so the GWh saved will be the GWh sale x (improvement in percentage loss from before project) <u>For fuel switching projects</u> Assuming fuel switching from coal or oil to gas tCO_2 = GWh x difference in CO_2 emission factor where: Ef_{gas} = emission factor for gas: 577 tCO_2/GWh [e] Ef_{oill} = emission factor for oil: 754 tCO_2/GWh [f] Ef_{oill} = emission factor for coal: 988 tCO_2/GWh [g] The emission factors are based on a conventional thermal power station with efficiency of 35%. For District Heating and Similar Projects <u>For fuel switching or RE-based heating system</u> Determine the CO_2 emission for with and without project: tCO_2 = preproject fuel usage (tons/year) x difference in CO_2 emission factor. <u>For district heating EE projects</u> tCO_2 = fuel savings (tons/year) x Ef_{fuel} where Ef_{fuel} : coal: 1.816 tCO_2/ton oil: 3.101 tCO_2/ton gas: 2.693 tCO_2/ton
(ii) Maximizing access to energy for all		
Number of loans and grants for expanding access to energy	Number	All RRPs for investment projects, or with components, that expand energy supply will be added to monitor this indicator at ADB level. This will normally be the total number of energy investment projects (i.e., excluding programs).
Amount of loan and grants for expanded access to energy	$ million	Total of all loan amounts from RRPs and monitored at ADB level.
Total additional installed capacity	MW-eq	Refer ADB's corporate results framework level 2 indicator
Numbers of new households connected to electricity	Number	Refer ADB's corporate results framework level 2 indicator
(iii) Promoting energy sector reforms, capacity building, and governance		
Number of loan and grants	Number	All RRPs that include distinct components in project cost estimates, or program lending that supports sector reform, capacity building, and governance in the energy sector; monitored at ADB level.

Indicators	Unit	Definition and Guideline
Number of TA projects	Number	All TA project reports for sector reform, capacity building, and governance in the energy sector; monitored at ADB level
Amounts of loans and grants	$ million	Total of all loan and grant amounts from RRPs and monitored at ADB level.
Amounts of TA projects	$ million	Total of all TA project amounts and monitored at ADB level.
Percentage of PCRs rated *satisfactory*	%	Share (as percentage) of PCRs rated *highly satisfactory* and *satisfactory* to total number of PCRs for energy sector projects, expressed as percentage.
Percentage of TCRs rated *satisfactory*	%	Ratio of the number of TCRs rated *highly satisfactory* and *satisfactory* to total number of TCRs for energy sector projects, expressed as percentage.
ADB's Corporate Results Framework Level 2 Indicators		
Installed energy generation capacity Also a 2009 Energy Policy indicator	MW-eq	The total installed energy generation capacity (expressed in MW) as a result of ADB-funded projects. The indicator measures: • MW capacity of power plant projects • Incremental MW or MW-eq as a result of rehabilitation projects • MW-eq capacity of heating supply added • MW-eq of hydrocarbon-based energy added by way of production or importation capacity added [h] Methodology: • Gross capacity addition will be measured. • Conversion to MW equivalent is based on: o heating value and standard factor of 3,600 MJ/h (860 Mcal/h, 85.98 kg of oil equivalent/h,122.8 kg of coal equivalent/h), and o energy conversion efficiency of 40% for hydrocarbon production or import MW-eq = fuel quantity (tons/hr) x heating value (MJ/ton) x 40% / 3,600 Heating values of fuel in case the actual value is not available in the feasibility study, the default values will be as below: coal: 18,900 MJ/ton oil : 42,300 MJ/ton gas : 48,000 MJ/ton
Transmission Line Installed / Upgraded	km	The actual point-to-point distance covered by transmission lines installed or upgraded. Actual kilometer distance will be monitored and not circuit-kilometers. This indicator includes: • km of power transmission line installed or upgraded • km of gas transmission line installed or upgraded • km of oil transmission line installed or upgraded Note: • upgrade of power transmission line should include an increase in voltage level • upgrade of gas or oil transmission line should include an increase in pipe diameter or pressure of the fluid.
Distribution Line	km	The expansion or upgrade of distribution network. This indicator

Indicators	Unit	Definition and Guideline
Installed / Upgraded		includes: • km of power distribution line installed or upgraded • km of district heating network pipes installed or upgraded • km of urban gas supply network pipes installed or upgraded Note: • Upgrade of distribution lines includes reconductoring
Additional household connected to electricity	Number	The number of new households connected to the electrical grid as a result of electricity distribution projects.
Reduction of carbon dioxide emissions	tCO_2-eq/y	Same as 2009 Energy Policy indicator

CER = certified emission reduction, CFL = compact fluorescent lamp, CPS = country partnership strategy, CO_2 = carbon dioxide, DMC = developing member country, DMF = design and monitoring framework, EHV = extra high voltage, EE = energy efficiency, FIRR = financial internal rate of return, GDP = gross domestic product, GHG = greenhouse gas, IPCC = Intergovernmental Panel on Climate Change, PCR = project completion report, PV = present value, RE = renewable energy, RRP = report and recommendation of the President, RSGP = Public Management, Governance and Participation Division, TA = technical assistance, TCR = technical assistance completion report, T&D = transmission and distribution, UNFCCC = United Nations Framework Convention on Climate Change.

GWh = gigawatt-hour, Mcal/h = megacalories per hour, MJ/h = megajoules per hour, MW-eq = megawatt equivalent, tCO_2 = tons of carbon dioxide, toe = ton of oil equivalent.

[a] ADB. 2009. *Energy Policy*. Manila.
[b] ADB. 2005. *Financial Management and Analysis of Projects*. Manila.
[c] IPCC. 2006. *IPCC Guidelines for National Greenhouse Gas Inventories*. Japan
[d] The proxy factor of 739.73 tCO_2/GWh for ADB's DMCs can be used as an alternative to country or grid-specific emission factor that is used for registering CER.
[e] Emission factor for gas = (56,100 kg CO_2/TJ/0.35) x 3.6 TJ/GWh x 1 ton/1000 kg = 577 tCO_2/GWh
[f] Emission factor for oil = (73,300 kg CO_2/TJ/0.35) x 3.6 TJ/GWh x 1 ton/1000 kg = 754 tCO_2/GWh
[g] Emission factor for coal = (96,100 kg CO_2/TJ/0.35) x 3.6 TJ/GWh x 1 ton/1000 kg = 988 tCO_2/GWh
[h] Energy export is excluded from level 2 measurement because it does not add to the energy resources of a developing member country.

Definition of Common Terms

1. Renewable energy sources include solar, wind, geothermal, hydropower, waste-to-energy, and biomass (other than the current noncommercial use, such as, biogas, biofuel, and biomass).
2. Energy efficiency projects develop and/or use energy saving practices and technologies to reduce energy losses in the process, thus delivering the same amount of products or services with less energy inputs.
3. Clean fuel projects, including fuel switching projects, use natural gas instead of oil, coal, or similar fossil fuels.
4. Heating value is the energy or heat content of fuel. It is the amount of heat produced by combustion of fuel.

Emission factors are measures of the average amount of GHGs discharged into the atmosphere by a specific process, fuel, equipment, or source.

GUIDELINES FOR ESTIMATING ADB INVESTMENTS IN RENEWABLE ENERGY AND ENERGY EFFICIENCY PROJECTS

1. As expressed in the Strategy 2020,[1] the long-term strategic framework of the Asian Development Bank (ADB), environmentally sustainable growth is at the forefront of ADB's fight to eliminate poverty. Ensuring that infrastructure investments are made in a socially and environmentally sustainable manner is the key to meeting Asia's growing needs and aiding developing member countries in their response to climate change. To operationalize this, ADB's 2009 Energy Policy[2] has the promotion of clean energy as one of its three key pillars, and targets $2 billion in renewable energy and energy efficiency investments by 2013. To effectively monitor and evaluate ADB's progress, a methodology has been established to quantify ADB's clean energy investments.

2. The reason for this is that, for example, an investment in a wind or solar power farm can be clearly attributed to renewable energy and the whole amount of the investment can be counted towards the current $1 billion clean energy target.

3. However, for many projects it is not so simple. Often, clean energy is only a component of a project. For example, some projects address several sectors at the same time, such as those dealing with the rehabilitation of urban infrastructure. Such a project can cover poor road systems, wastewater treatment, more efficient water pumps, and reducing water losses during distribution (nonrevenue water). In such a case, there are clear energy efficiency gains from decreasing nonrevenue water, as each cubic meter of water saved represents energy conserved in its pumping, filtering, and any other processes that use energy. There are also gains from replacing old, outdated, and inefficient pumps with modern energy efficient pumps. ADB computes the percentage of efficiency gains for the investment and only counts that percentage of the ADB investment amount towards its target of $1 billion. The following guidelines provide the methodology of cost estimations for a variety of clean energy project components. As projects are implemented, these numbers are further refined to reflect actual investment values.

A. Renewable Energy

(i) For renewable energy projects (wind, solar, small hydro, geothermal, biomass, biofuel, biogas, landfill gas, and municipal waste) the entire ADB assistance is its renewable energy investment.

(ii) For transmission lines dedicated to transmitting power generated by renewable energy, the ADB loan/assistance is its renewable energy investment.

B. Demand-Side Energy Efficiency

(i) For dedicated energy efficiency projects (projects whose sole purpose is energy efficiency improvement), the entire ADB loan/assistance is its energy efficiency investment.

(ii) For other energy efficiency projects in other demand sectors (water supply and sanitation, transport, multisector such as central heating system, etc.), the energy

[1] ADB. 2008. *Strategy 2020: The Long-Term Strategic Framework of the Asian Development Bank 2008–2010. Manila.*
[2] ADB. 2009. *Energy Policy*. Manila.

efficiency investment is proportional to improvement in efficiency or to the reduction of emissions due to improvement in efficiency.

For example an existing pumping system operating at 62% efficiency (baseline) is replaced by another system that operates at 70% efficiency (project), the percentage of energy efficiency (EE) investment is calculated as follows:

Percent EE investment = (70 – 62)/62 = 0.129 or 12.9% (say 13%)

(iii) For assistance provided to energy service companies (ESCOs) and manufacturers of energy efficient appliances and industrial equipment, the entire ADB loan/assistance is its energy efficiency investment.

(iv) For railways, the total energy efficiency investment is the present value of the total energy savings over its economic life; the percentage of this savings proportional to ADB loan/assistance is ADB's percent energy efficiency investment in railways.

(v) ADB's energy efficiency investment equals the present value of energy savings proportionate to ADB loans at a discount rate equal to the financial internal rate of return (FIRR) of the project.

(vi) For projects with clearly defined energy efficiency components, the project estimates for such components are taken as the energy efficiency investments. In such cases, because the costs of the energy efficiency components have been calculated and presented in the project documents, there is no need for energy efficiency percentage calculations.

For example, in a multisector project composed of road rehabilitation, water supply nonrevenue water reduction, and wastewater treatment, the cost estimate for nonrevenue water reduction (if clearly separated from other cost components) is taken as the energy efficiency investment. Each cubic meter of water saved represents kilowatt-hours (kWh) of energy saved in pumping and other production processes.

C. Supply-Side Energy Efficiency

(i) For new power plant, the clean energy investment is proportional to the carbon dioxide (CO_2) reduction relative to a defined baseline.
For example, a combined cycle gas-fired power plant is to be constructed and a single cycle gas-fired power plant has been defined as the baseline, the clean energy investment is 53.6% of the total investment as calculated below. In the absence of a defined baseline, a default baseline (Table A2.2) is used instead.

CO_2 emissions (Table A2.4):
Combined cycle plant: 0.404 kgCO_2/kWh
Single cycle plant (baseline): 0.871 kgCO_2/kWh
Percent clean energy investment = (0.871–0.404)/0.871 = 0.536, or 53.6%

(ii) For power plant upgrading projects, similar to new power plant projects, the energy efficiency investment is proportional to the reduction in CO_2 emissions as a result of efficiency improvement.

For example, a conventional, oil-fired steam power plant with current efficiency of 29% is upgraded to have an efficiency of 34%, the clean energy investment is 15% of the total investment (see calculation below).

CO_2 emissions: before upgrading (baseline) = 0.961 kgCO_2/kwh
after upgrading = 0.820 kg CO_2/kWh

Percent energy efficiency investment = (0.961–0.820)/0.961 = 0.1467, or 14.67% (or 15% rounded off number)

Alternatively, based on efficiency numbers alone, the percentage of energy efficiency investment may also be calculated as follows:

Percent energy efficiency investment = (34%–29%)/29% = 17.24% (say 17%)

(iii) For transmission and distribution projects, the energy efficiency investment is proportional to the improvement in efficiency, similar to that in power plant upgrading.

For example, a transmission system which can use a conventional alternating current (AC) system (with 8% losses per 1,000 kilometers [km], or 92% efficient), uses an energy efficient high-voltage direct current (HVDC) electric power transmission system instead (with 3% losses per 1,000 km, or 97% efficient), the percentage of energy efficiency investment is determined as follows:

Percent energy efficiency investment = (97% – 92%)/92% = 5.43%

D. Supply-Side Fuel Switching

(i) For power plant switching from coal or oil to gas, the ADB investment is proportional to the reduction in CO_2 emissions as a result of using less CO_2-emitting fuel.

As a fuel switching example, consider an oil thermal power plant (baseline) which was retrofitted to run on gas. The percent of energy efficiency investment is calculated as follows:

CO_2 emission, oil thermal power plant (baseline) = 0.820 kgCO_2/kWh
CO_2 emission, gas-fired power plant (project) = 0.594 kgCO_2/kWh

Percent ADB investment = (0.820–0.594)/0.820 = 27.56% (say 28%)

(ii) For gas storage and pipelines dedicated to gas-fired power plants, the percentage of ADB investment follows the values that apply to specific power plants where the gas will be used. These values vary from 35% to 75% (Table A2.1)

A summary of percentage investment for various renewable energy, energy efficiency, and clean fuel projects using default values are shown in Table A2.1. For calculation details refer to Tables A2.2 and A2.4.

Table A2.1: Percentages of Renewable Energy, Energy Efficiency, and Clean Fuel Investment

Projects	Fuel	%RE/EE/ CF Investment	Remarks/Assumptions
A. Renewable Energy			
Power/energy generation using wind, solar, hydro, geothermal, biomass, biofuel, biogas, landfill gas, municipal wastes		100%	RE projects are carbon neutral
Dedicated T&D from RE sources		100%	T & D is considered part of the RE project
B. Demand Side Energy Efficiency			
Dedicated EE projects (i.e., Guangdong, EPP, etc.)		100%	Entire investment is used to improve demand side energy efficiency
Reduction of non-revenue water (NRW)		15%	Baseline is typical NRW losses of 35% (65% efficiency) with reduced losses of about 25% (75% efficiency) after the project. The factor would be (75-65/65=0.154) or a rounded number of 15%. Use actual numbers if available.
Railways		20%	Percentage represents the average proportion of the present value of energy savings attributable to ADB loans. Road transport is considered the baseline.
Assistance to ESCOs and manufacturers of energy efficient appliances and industrial equipment		100%	Entire investment is used to make energy efficient equipment available in the market
C. Supply Side Energy Efficiency			
C.1. New Power Plant			
Single cycle combustion turbines	Nat. Gas	35%	See Table A2.2
	Fuel Oil	15%	See Table A2.2
Combined cycle combustion turbines	Nat. Gas	60%	See Table A2.2
	Diesel	45%	See Table A2.2
	Fuel Oil	45%	See Table A2.2
Conventional steam turbines	Nat. Gas	40%	See Table A2.2
	Diesel	20%	See Table A2.2
	Fuel Oil	20%	See Table A2.2
	Coal	0%	Default baseline power plant
Cogeneration	Nat. Gas	75%	See Table A2.2
	Diesel	65%	See Table A2.2
	Fuel Oil	65%	See Table A2.2
	Coal	60%	See Table A2.2
IGCC	Coal	20%	See Table A2.2
Supercritical	Coal	20%	See Table A2.2
C.2. Power Plant Upgrading			
Single cycle combustion turbines		15%	See Table A2.4
Combined cycle combustion turbines		10%	See Table A2.4
Conventional steam turbines		15%	See Table A2.4
Cogeneration		6%	See Table A2.4
IGCC		10%	See Table A2.4
Supercritical		10%	See Table A2.4
C.3. Transmission and Distribution			
HVDC and superconductors		6%	Baseline is 750 kv AC transmission system with losses taken at about 8%/1000 km (92% efficient). HVDC losses at about 800 kv is about 2.5%/1000 or about 3% (97% efficient) considering the relatively small voltage difference. The factor would be (97-92)/92=0.054 or 5.4%. Use 6%. Use actual numbers if available.
T & D retrofits and upgrades		7%	The factor is based on 5% reduction in losses. (Efficiency improvement[(E_{after}-E_{before})/E_{before}). The factor could be higher depending on improvement in efficiency. Assume a typical baseline losses of 25% (baseline efficiency = 75%) and 20% losses after upgrading (efficiency = 80%). The factor would be (80-75)/75 = 0.0667 or 6.67%, use 7%. Use actual numbers if available.
D. Cleaner Fuel (Natural Gas)			
Dedicated pipelines and storage facilities for gas-fired plants		30%-75%	Values vary according to the type of power plants(assuming gas is to be used for power generation)
Note: For power plants using gas see section C.1 above			

Notes:

1. The percent RE, EE, and CF investments represents the degree of "cleanliness" of a project relative to a default baseline. For baseline other than the default baseline, please see notes in Table A2.2 and A2.4.
2. These percentages will be used only for clean energy projects in the pipeline with insufficient information. Validation of percentages will be done for each project as soon as relevant information becomes available.

Table A2.2: Percentage of EE and CF Investment for New Power Generation Projects

Technologies	Baseline Fuel	Baseline Efficiency	Baseline Emission, $kgCO_2/Kwh$	Project's Fuel	Project Efficiency	Project Emission , $kgCO_2/Kwh$	%EE/CF Investment	%EE/CF Inv. (rounded off number)
Single Cycle Combustion			1.002	Nat. Gas	32%	0.631	37%	**35%**
			1.002	Fuel Oil	32%	0.871	13%	**15%**
Combined Cycle Combustion Turbines			1.002	Nat. Gas	50%	0.404	60%	**60%**
			1.002	Diesel	50%	0.534	47%	**45%**
			1.002	Fuel Oil	50%	0.557	44%	**45%**
Conventional Steam Turbines			1.002	Nat. Gas	34%	0.594	41%	**40%**
			1.002	Diesel	34%	0.785	22%	**20%**
			1.002	Fuel Oil	34%	0.820	18%	**20%**
	Coal	34%	1.002	Coal	34%	1.002	0%	**0%**
Cogeneration			1.002	Nat. Gas	80%	0.252	75%	**75%**
			1.002	Diesel	80%	0.333	67%	**65%**
			1.002	Fuel Oil	80%	0.348	65%	**65%**
			1.002	Coal	80%	0.426	58%	**60%**
IGCC			1.002	Coal	42%	0.811	19%	**20%**
Supercritical			1.002	Coal	42%	0.811	19%	**20%**

Default Baseline
Values used in the NOTE below

NOTE: If baseline power plant is not the conventional coal fired units (default), then the emission corresponding to that baseline power plant will be used as baseline emission . For example, if a combined cycle, gas-fired combustion turbine power plant is to be implemented in a DMC and the baseline is considered to be a single cycle oil-fired combustion turbine (instead of conventional coal -the default baseline power plant), then, the baseline emission would be 0.871 kgCO2/kwh and the percentage clean energy investment would be (0.871-0.404)/0.871 or 53.6%

Table A2.3: Emission Factors of Various Fuels

Fuel	Emission Factors kg CO_2/GJ
natural gas	56.1
diesel	74.1
fuel oil	77.4
coal	94.6

Notes:

1. Conversion Factors: 1kWh = 3.6 MJ; 1 GJ = 1000 MJ
2. Emission coefficient is calculated as:
   $kgCO_2/kWh = kgCO_2/GJ/Efficiency \times 3.6/1000$

Table A2.4: Percentage Energy Efficiency Investment for Upgrading Power Projects

Technologies	Fuel	Baseline Efficiency (Degraded Efficiency),?b	Baseline Emission Coefficient, kgCO_2/Kwh, Eb	Project Efficiency (Restored/ upgraded efficiency),?p	Project Emission Coefficient, kgCO_2/Kwh, Ep	%EE Investment computed based on emissions	%EE Investment (rounded off numbers)
Single Cycle Combustion Turbines	Natural Gas	27%	0.748	32%	0.631	16%	15%
	Fuel Oil	27%	1.032	32%	0.871	16%	15%
Combined Cycle Combustion Turbines	Natural Gas	45%	0.449	50%	0.404	10%	10%
	Diesel	45%	0.593	50%	0.534	10%	10%
	Fuel Oil	45%	0.619	50%	0.557	10%	10%
Conventional Steam Turbines	Natural Gas	29%	0.696	34%	0.594	15%	15%
	Diesel	29%	0.920	34%	0.785	15%	15%
	Fuel Oil	29%	0.961	34%	0.820	15%	15%
	Coal	29%	1.174	34%	1.002	15%	15%
Cogeneration	Natural Gas	75%	0.269	80%	0.252	6%	6%
	Diesel	75%	0.356	80%	0.333	6%	6%
	Fuel Oil	75%	0.372	80%	0.348	6%	6%
	Coal	75%	0.454	80%	0.426	6%	6%
IGCC	Coal	37%	0.920	42%	0.811	12%	10%
Supercritical	Coal	37%	0.920	42%	0.811	12%	10%

Note: If the actual baseline and project efficiency values are not the same as the assumed values above, the actual values may be inputted in the above table to allow Excel to recalculate percent EE Investment
There are two formulas to calculate % EE investment: one using emissions and another using efficiency numbers

% EE Investment = (Eb - Ep)*100% / Eb
where: Ep = Baseline emissions
Ep = Project emissions

% EE Investment = (?p-?b)*100/?b
where: ?p=upgraded efficiency
?b=baseline efficiency

GUIDELINES FOR ESTIMATING ADB INVESTMENTS IN ACCESS TO ENERGY PROJECTS AND NUMBER OF HOUSEHOLDS PROVIDED ACCESS

1. The Asian Development Bank (ADB) recognizes that energy poverty remains endemic in Asia and the Pacific despite the great developmental strides achieved in the last two decades. One quarter of the region's population (822 million) still has no access to electricity, and more than half (1.8 billion) relies on wood, dung, and agricultural residues for cooking and heating.[1] Strategy 2020[2] sets ADB's commitment to increasing access to clean and affordable energy for people throughout Asia and the Pacific. This is reinforced in the 2009 Energy Policy[3] which identifies maximizing access to energy for all, as one of the three pillars for ADB's overall support to the energy sector.

2. In pursuit of universal access to energy and the realization of ADB's vision of a region free of poverty, ADB is developing new approaches for scaling up access to modern energy among the region's poor. In 2009, ADB launched the Energy for All Partnership, which brings together financial institutions, governments, civil society, and the private sector with the aim of providing access to modern energy to 100 million people in Asia and the Pacific by 2015. ADB's access to energy investments will cover a significant portion of this target. To effectively monitor and evaluate ADB's progress, a set of guidelines is established to determine ADB's access to energy investments and the number of people provided with energy access. These guidelines shall evolve and be refined as projects are implemented.

3. The following three parameters, corresponding to Energy Policy 2009 and ADB's corporate results framework level 2 indicators will be monitored:

(i) The amount of access to energy investments and total cost of projects supported.
(ii) The number of loans and grants.
(iii) The number of households.

A. Definition: What is Access to Energy?

4. Access to energy addresses the energy, environment, and poverty nexus of concerns by linking households to modern energy sources, technologies, and finance. Specifically, access to energy involves any or a combination of the following:

(i) Provision of electricity and motive power[4] to households.[5]

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[1] In 2008, over one-fifth of the world's population (1.5 billion people, 85% of whom live in rural areas in sub-Saharan Africa and South Asia, and 160 million are from the Association of South East Asian Nation (ASEAN) countries still has no access to electricity (World Energy Outlook 2009, IEA).

[2] ADB. 2008. *Strategy 2020: The Long-Term Strategic Framework of the Asian Development Bank 2008–2010.* Manila.

[3] ADB. 2009. *Energy Policy.* Manila.

[4] Motive power is defined here as the effective outcome of transforming different forms of energy sources (e.g., wind, hydro, fossil fuels, etc) to kinetic energy (to cause motion).

[5] Access to energy impact or investment will be assessed at the household level, and tracking the specific number of household connections is essential to avoid double counting. For new projects, the number of new household connections resulting from the project as well as the number of households with increased hours of service due to reduction of outages and supply interruptions must be included as an outcome indicator in the DMF. These access to energy outcome indicators (at the household or residential level) must be determined at the concept paper stage and then clearly specified in the RRP.

(ii) Improvement in the supply and delivery of energy services[6] to households.
(iii) Provision of modern fuels and/or efficient devices for cooking and/or heating to households.
(iv) Provision of finance to households to access energy.

Notes:
(i) ADB investments in the supply chain are taken cumulatively (e.g., investments in the manufacturing of efficient cooking stoves are added to investments at the household user level).
(ii) ADB investments for each energy service provided to the same household are taken cumulatively (e.g., investments in electricity grid extension are added to investments in gas pipeline extension).
(iii) The task of monitoring indicators requires in-depth examination of project documents, particularly the project cost and cost allocation tables, investments estimates, and the DMF in the concept paper and the RRP.
(iv) The following data need to be determined at the concept stage and clearly specified in the concept paper and RRP:
    (a) Access to energy cost components in the project cost tables identified according to access to energy project types.
    (b) Cost allocation by financing institution.
    (c) The indicators, i.e., amount of access to energy investments and total cost of projects supported, number of loans and grants, and number of households, clearly specified in the DMF and on a per project basis.

B. What Types of Projects, or Components of Projects, can be Considered Energy Access Projects?

(i) Rural electrification projects or household grid extension or investment program for rural areas.[7]
(ii) Off-grid and mini-grid power capacity addition or distribution.
(iii) Power sector investments and development programs involving generation and/or transmission with distribution component.[8]
(iv) Cleaner fuels and efficient technologies for cooking and heating applications.
(v) District heating distribution expansion and upgrade.
(vi) Gas distribution pipeline extension.
(vii) Multisector or non-energy sector projects with household energy service provision/enhancement component
(viii) Provision of finance to households to access energy

[6] For the purposes of these guidelines, improvement in the delivery of energy services refers to the increase in the number of hours (reliability and security of supply) the energy service is provided and does not include natural increases in consumption due to GDP or household income growth. Outcome indicators in the DMF must specify number of hours of service per service with and without the project and/or percent reduction in supply outages/interruptions and number of households served. Energy services include electricity, modern fuels such as LPG and efficient devices for cooking and heating applications, lighting, motive power, district heating, space cooling and food preservation.

[7] It is assumed that rural electrification, off-grid, and mini-grid projects reach only households unless otherwise specified.

[8] Power plant and transmission projects without a distribution component will not be considered access to energy. Those with a distribution component will only be considered energy access when the number of new households gaining grid connection as a result of the project is specified in the RRP.

C. Determining Energy Access Investment Component

5. For projects with energy access components that are clearly defined, calculated, and presented in the project documents (such as the RRP), the project estimates for such components are taken as the energy access investments. However, for energy access components that are not clearly defined, the investment could be calculated based on the following guidelines:

1. Provision of Electricity and Energy Services to Households

(i) For dedicated energy access projects providing lighting and/or other household electricity and/or mechanical power, the entire ADB assistance is the energy access investment.
(ii) For rural electrification projects, the entire ADB assistance is the energy access investment.
(iii) For off-grid household electrification projects, the entire ADB assistance is the energy access investment.
(iv) For mini-grid electrification projects, the entire ADB assistance is the energy access investment.
(v) For power projects with a distribution component, where the number of new household connections resulting from the project is specified, the entire distribution component investment is the energy access investment.
(vi) For new distribution-only and transmission and distribution projects, including district heating, the ADB investment in the distribution or distribution component thereof is the energy access investment

2. Cleaner Fuels and/or Efficient Devices for Cooking and Heating

(i) For dedicated energy-access projects involving switching to cleaner[9] fuels and/or more efficient cooking stoves and heating applications, the entire ADB assistance, excluding any forest management component or other agricultural products enhancement component, is the energy access investment.
(ii) For a distribution pipeline or extension project to supply natural gas or coal mine methane or district heating to households, the entire ADB assistance is the energy access investment.

3. Multisector or Non-Energy Sector Projects

(i) For projects with clearly defined energy access components, the project estimates for such components are taken as the energy access investments. In such cases, because the costs of the energy access components have been calculated and presented in the project documents, there is no need for energy access percentage calculations.
(ii) Projects where energy access components are not clearly defined will not be considered so as to maintain conservative estimates. Future projects must indicate energy access components and costs where applicable to be counted as access to energy investments.

[9] For example, fuel switching from kerosene to LPG and from biomass to biogas for cooking and/or heating.

4. **Financing Projects**

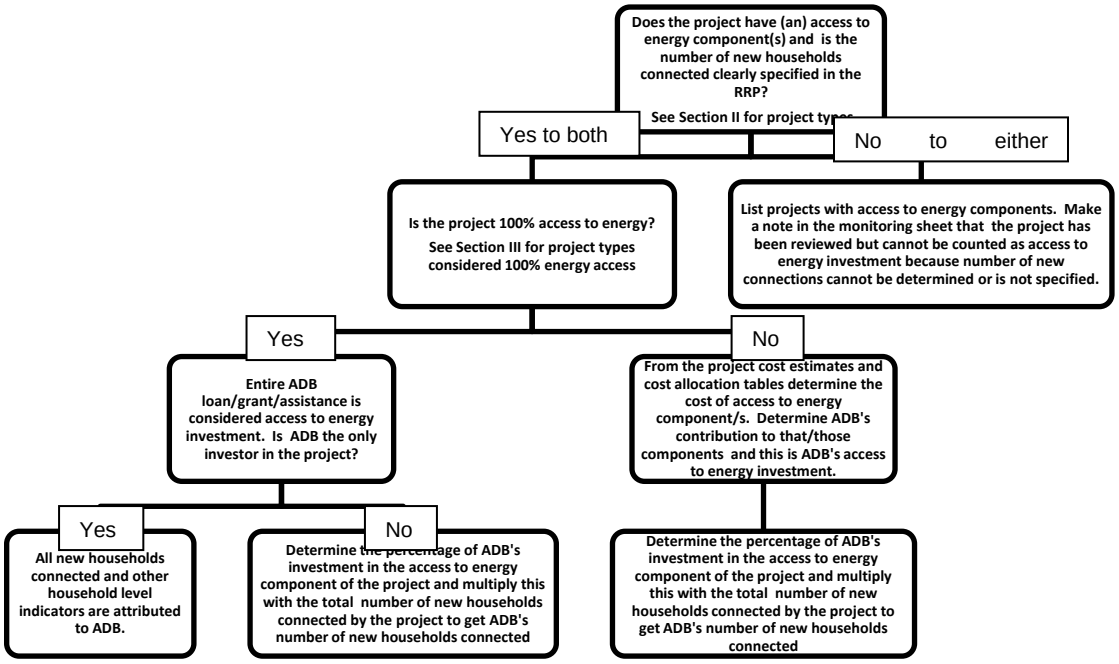
(i) For financing projects with clearly defined energy access components, the project estimates for such components are taken as the energy access investments. In such cases, because the costs of the energy access components have been calculated and presented in the project documents, there is no need for energy access percentage calculations.

(ii) Partial credit guarantees provided by ADB should be considered as access to energy investment, even when not drawn down.

D. General Approach and Methodology

6. A conservative approach is used in assessing whether a project is access to energy or has an access to energy component and in including it the monitoring of investments and other indicators. Figure A4 shows the process flow chart for reviewing project documents in monitoring ADB's investments in access to energy and the number of new households provided access. Specific calculation methods are subsequently provided.

Figure A3: Monitoring Process Flow Chart



7. **Steps to follow in determining energy access investment:**

(i) Check if project is considered access to energy or has (an) access to energy component/s using section B of these guidelines.

(ii) Check if project is 100% access to energy investment using section C of these guidelines.

An energy generation and/or transmission project, even if the DMF clearly indicates new household connections, is not counted as ADB's access to energy investment unless ADB is investing in the distribution component as well. Only the distribution component and other clearly defined access to energy investments and assistance (e.g., rural, off-grid, mini-grid, access for poor projects/project components) of ADB's investment are counted as access to energy investments.

(iii) Using project cost tables and, if available, a project cost by financing institution table, in the RRP check if entire access to energy investment is ADB-funded.

(iv) From RRP determine ADB's portion of the access to energy investment or calculate by pro-rating if not clearly specified in RRP

(v) If project is part of a multitranche financing facility or sector investment program, ensure that only ADB's portion of the access to energy investment is counted and on a per project basis

(vi) The final pro-rated access to energy component of ADB funding is ADB's access to energy investment in the project

For projects where ADB is not the sole investor, the amount of access to energy investments attributed to ADB include all ADB-funded hard costs and soft costs (contingencies, interest during construction, project management) of access to energy components. When soft costs are lumped for an entire project, these are pro-rated to the share of those ADB-funded hard costs to the total project investment considered.

SAMPLE COMPUTATIONS

Table A4.1: Conversion Factors and Assumptions

	BTU	Foot-pound	Joules	Calories	kilo-cal	Kilowatt-hour
1 BTU	1.0000	777.90	1,055.00	252.00	0.2520	0.000293000
1 Foot-pound	0.001285	1.0000	1.3560	0.3238	0.000324	0.000000377
1 joule	0.000948	0.7376	1.0000	0.2388	0.000239	0.000000278
1 calorie	0.003969	3.0880	4.1870	1.0000	0.001	0.000001163
1 kilo-cal	3.969	3,088	4,187	1,000	1.0000	0.001163000
1 kWh	3,413	2,655,000	3,600,000	859,800	860	1

BTU = British thermal unit, kWh = kilowatt-hour, kilo-cal = kilocalories.

Table A4.2: Power Plant Load Factors, %

Type of Power Plant	Load Factor
Solar Photovoltaic	20%
Wind	25%
Geothermal	70%
Biomass	80%
Biogas	80%
Micro hydro (<= 100kW)	30%
Mini hydro (101kW to 10MW)	45%
Large hydro (> 10MW)	50%
Pumped Storage	10%
Diesel/Gas Gen sets (baseload)	80%
Diesel/Gas Gen sets (peak load)	10%
Oil/Gas Combustion turbine (single cycle)	10%
Oil/Gas Combined Cycle	80%
Conventional Steam Cycle (coal, oil, gas)	80%

Source: World Bank–Energy Sector Management Assistance. Program (ESMAP)

Table A4.3: Fuel Emission Factors

Fuel	tCO_2/TJ	tCO_2/ton	tCO_2/GWh
gas	56.10	2.693	577
diesel	74.10	3.816	
crude oil	77.40	3.101	754
coal	96.10	1.816	988

tCO2/GWh = tons of carbon dioxide per gigawatt-hour,
tCO2/TJ = tons of carbon dioxide per terra Joule.
Source: 2006 IPCC Guidelines for National Greenhouse Gas Inventories

Table A4.4: Country Emission Factors

Country	Emission Factor, tCO2/GWh
PRC	927.50
India	871.70
Philippines	499.90
Thailand	508.80
Indonesia	821.80
Sri Lanka	749.00
Bangladesh	661.40
Viet Nam	621.70
Fiji Islands	656.00
Armenia	436.00
Cambodia	1152.00
Mongolia	563.00
Nepal	4.00
Pakistan	432.00
Default Value	739.73[a]

PRC = People's Republic of China, tCO2/GWh = tons of carbon dioxide per gigawatt-hour.
[a] ADB calculated and is using 739.73 tCO_2/GWh as default value, but this would be updated as necessary.
Source: Institute for Global environmental Strategies (IGES) as of September 2009.

Sample Computation 1: Calculation of Clean Energy Investment

L-2520 IND: Madhya Pradesh Power Sector Investment Program (Tranche 5)

Calculate CE Investment for Tranche-5:

Per Tranche-5 DMF, distribution losses of the DISCOMs are as follows:

	2009, baseline	2011
DISCOM-E	37.25%	23.50%
DISCOM-C	38.93%	31.00%
DISCOM-W	33.76%	24.00%

Resulting efficiency of DISCOM = (Project – Baseline)/Baseline

DISCOM-E : (37.25% – 23.5%)/37.25% =	36.91%
DISCOM-C : (38.93% – 31%)/38.93% =	20.37%
DISCOM-W : (33.76% – 24%)/33.76% =	28.91%
Average Efficiency:	28.73%

Given : ADB Assistance for Tranche-5 is $166 million

CE Investment = Average Efficiency x Total ADB Assistance ($US million)

CE Investment = 28.73% x $166 million = $47.69 million

Sample Computation 2: Calculation of Energy Savings Given Line Loss Reduction

L-2225 VIE: Northern Power Transmission Expansion (Sector) Project

Refer to Appendix 11 of the RRP:

5447.00 MW, projected peak demand in northern Viet Nam by 2010

(1) Calculate sales based on this demand if no Sales projection parameters are given
Sales projection = 5447MW x 8760hours x load factor

(2) Better to calculate sales projection given the following data:
Calculate projected sales of PC-1 (power company serving northern Viet Nam). Sales of PC-1 in 2002 was 7,439GWh (based on RRP for Loan 2128 Northern Power Transmission Project approved in 2006). 15.2% is the demand growth rate in 1999 – 2004 and 13% in 2005

Sales projection = 7,439 [(1+15.2%)^2 + (1+13%)^6] = 25,359,966 MWh

(3) Calculate Energy Savings given transmission loss reduction:

13.80% transmission losses by 2010
14.70% transmission losses before the project (2004)

Energy Savings = Generation x (difference in losses)
Generation = Sales / (1 – line lossess)

Generation = 25,359,966 MWh / (1 – 13.8%) = 29,419,914 MWh
Energy Savings = 29, 419,914 MWh x (14.7% – 13.8%) = 264,779 MWh

Sample Computation 3: Calculation of Energy Savings Given Gross Generation in a Transmission System

Reduction of distribution losses of DESCO from 16.7% in 2005 to 12.0% by 2009
Reduction of distribution losses of DESA from 30.0% in 2005 to 20.0% by 2009

RRP Appendix-2: (Table A2.2)

In GWh, Gross Generation	2005	2009[a]
Transmission (BPDB + IPP)	22252.00	27986.78
Import by DESA	5126.00	6447.07
Import by DESCO	1843.00	2317.98

[a] 2009 projection based on 5.9% growth; assumption based on RRP, p.41:
Electricity wheeled through the transmission network has been increasing steadily with growth of 9.2% in FY2004 and 5.9% in FY2005

Energy Savings:

GWh saved due to transmission system loss reduction:

951.55 TL loss in 2009 without the project = 3.4% x 27,987GWh
895.58 TL loss in 2009 with the project = 3.2% x 27,987GWh
55.97 GWh saved = difference of with and without the project

GWh saved due to distribution system loss reduction:

DESCO	GWh Savings = 2,318 x (16.7% – 12%) =	108.94
DESA	GWh Savings = 6,447 x (30% – 20%) =	644.71
	Savings due to distribution loss reduction	753.65

Total Energy Savings: 55.97 + 753.65 = 809.63 GWh

Sample Computation 4: Calculation of CO_2 Emission Reduction

From Sample 3:

Energy Savings = 809.63 GWh
Country Emission Factor (Bangladesh) = 661.40 tCO_2/GWh
CO_2 Emission Reduction = 661.40 x 809.63 = 535,486 tCO_2

Sample Computation 5: Calculation of Energy Savings in Water Supply Project

L-2331 IND. MFF-Jammu & Kashmir Urban Sector Development Program (Subproject 1)

The Program will provide water of good quality and adequate pressure, commensurate with Indian standards of 135 liters per capita per day, in all areas of the two principal cities by 2012.

Project-1 only has $5.9 million on water supply component (RRP Appendix 3, Detailed Cost Estimate) Also, according to Appendix 4, the detailed cost estimate only has water supply component for Srinagar. Thus, the DMF output should be proportioned, it is not reasonable to lump reduction in UFW into Project-1.

Population (2001)

971,357	Jammu
607,642	Srinagar
1,578,999	Total

Water Supply, lpcd

96%	Population with access to water service
80.00	consumption before the project
135.00	target consumption after the project
50%	System losses
160.00	Water production given 50% losses = 80 lpcd / (1 – 50%)
16%	Target losses if supply is 135 lpcd = 1 – (135/160)

Srinagar Water Supply Component:

583,336	population with access to water = 96% x Srinagar population
34,066,841	cu.m per year, water production = 583,336 x 160 /1000 x 365 (1,000 liters per cubic meter)
11,710,477	m^3 water savings = 34,066,841 x (50% – 16%)
12,882	MWh, Energy savings (assuming 1.1 kWh/m^3)
1,812	MWh, Energy Savings for PFR-1 = 12,882 x (42.2/300) Proportioned to (PFR-1= $42.2 million, MFF= $300 million)

Sample Computation 6: Calculation of Energy Savings in Rail Project

L-2182 PRC: Zhengzhou-Xi'an Railway Project

Conversion: (source - Energy in China 2004 by Asia Pacific Energy Research Centre)

Energy Intensity of Different Transport Modes in China (Table 19, p.34)

	Year 2000	
Railways	7.20	toe/million ton-km
Highways	96.40	toe/million ton-km

Conversion of passenger traffic volume from person-km to ton-km (p.32 of same paper):

1 tonne-km of freight traffic is equivalent to:	1.00	person-km on national railways and waterways
	5.00	person-km on local railways
	10.00	person-km on roads and highways
	11.00	person-km on airplanes

Given data in RRP:

16,000	million ton-km for freight
115,200	TOE, based on conversion = 16000 x 7.2 toe/million ton-km
5,000	million passenger-km
5,000	converted to million ton-km of freight = 5,000 x 1 ton-km/passenger-km
36,000	TOE, based on conversion = 5,000 x 7.2
151200.00	total TOE
0.151200	in MTOE
1,758,456	MWh energy savings = 0.1512 MTOE * (11,630GWh/MTOE) *1,000

CE = clean energy, DMF = design and monitoring framework, DISCOM-C = central zone distribution company, DISCOM-E = east zone distribution company, DISCOM-W = west zone distribution company, DESA = Dhaka Electric Supply Authority, DESCO = Dhaka Electric Supply Company, Ltd, GWh = gigawatt-hour, lpcd = liters per capita per day, MW = megawatt, MWh = megawatt-hour, MTOE = million tons of oil equivalent.