



2016 Simplified Methodology for Economic Appraisal of Electricity Projects in the Kurdistan Region



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1. PROLOGUE AND OVERVIEW

In the context of public policy, governments face the problem of allocating scarce resources (natural, human and capital) to infinite uses, to satisfy certain needs and with the goal of obtaining the maximum social and economic benefit. On the other hand, standardization and systematization of public investment processes have demonstrated important advantages in terms of increasing the profitability and productivity of public investment. In general, developing economies should allocate their scarce resources to the most productive investments. The public investment projects financed through increases in tax revenue or foreign debt should generate increased economic benefits to justify their implementation.

From this perspective, the purpose of this simplified electricity methodology is to assist in benefit valuation the Kurdistan Regional Government (KRG) agencies involved in the selection of new energy-sector projects. These guidelines are intended for different types of user in KRG. They serve as a technical reference for public-sector authorities responsible for making public-sector investment decisions. This group includes public officials (project evaluators) within the Ministry of Planning, Ministry of Finance, line ministries (LM), departments and agencies (DAs), public enterprises (PEs) and all others institutions involved in the formulation, evaluation and implementation of public investment projects.

International best practices and the review of textbooks and methodological guides from different countries and international organizations have been taken into account when structuring this methodology and addressing the issues in its scope.

The document is divided into five chapters. Chapter 2 describes the scope of projects that increase electricity outputs in Kurdistan. Chapter 3 lays out the analytical framework for this simplified methodology. This chapter familiarizes the project sponsor and project analyst with the basic concepts of the financial and economic analysis of electricity projects.

Chapter 4 is devoted to project preparation and analysis. An integrated financial, economic and uncertainty analysis must be carried out for new electricity projects on the network in order for alternatives to be compared and ranked according to their economic net benefits.

Chapter 5 lays out the basic concepts for allocating the limited budgetary funds between different alternative electricity projects. This chapter helps to establish an economically sound balance between rival spending alternatives. Chapter 6 presents final comments.

2. INTRODUCTION

Evaluation tools are essential for making decisions for selecting about projects. Comparing the total costs (investment and operation) of a project with its benefits allows analysts to decide if that project will make a true contribution to the wealth of the country.

Many developing countries show a lack of modern procedures and techniques for making the process of selecting public investment projects (PIPs) for implementation efficient enough. The provision of basic infrastructure facilities such as roads, water, electricity, education and telecommunication – among others – is the key to the development of the country, and is fundamental to the creation of a strong private sector.

In this context, the proper evaluation of previous initiatives is essential in avoiding past mistakes and to enable us to learn “from experience”. Project evaluation allows us to:

- i) Identify those criteria for investment policies that maximize social welfare.
- ii) Stop "bad projects" and promote those that are "good".
- iii) Define whether the public or private sector should implement the project.
- iv) Establish agreements for desirable cost recovery.
- v) Assess their impact on the environment, regional development and poverty, among other things.

2.1. Scope of Project Appraisal

The existence of a formal set of tools for project appraisal provides a framework within which to guide the efforts of government systems (which tend to run projects, which is good!), preventing the society as a whole from being harmed (which is bad!). Project appraisal allows us to answer the following questions: *What is the aim of the project? What happens if the project is implemented and what happens if it isn't? Is the project the best alternative? Does the project have separable components? Who benefits and who pays the costs of the project? Who are the stakeholders that may affect the investment decision or the performance of the project? Is the project financially sustainable (feasible)? What is the environmental impact of the project? What are the sources and magnitudes of the risks? Does the project contribute to economic growth? Is the project a source of political risk?* And finally, to answer the big question: *Is the project the most desirable relative to others competing for the same budget?* (Belli, P., et al, 2001).

The investment appraisal phase of PIPs is to ensure projects' economic feasibility and sustainability over time. The utilitarian approach and applied welfare economics provide a conceptual framework to estimate the goodness of public policies in terms of social welfare, thus answering the above questions. To estimate the contribution of the projects, it is then necessary to identify, measure and assess their costs and benefits. To identify costs and benefits is to determine, qualitatively, the positive and negative impacts generated by the project.

Appraisal of PIPs using either cost–benefit analysis (CBA) or the cost-effectiveness analysis (CEA) approach will allow the directing of scarce economic resources toward most productive investments and will provide for the sustainable long-run economic growth of Kurdistan Region.

2.2. Scope of Proposal Methodology

The objective of this document is to provide a uniform pattern for preparing, assessing and evaluating electricity projects running for public funding, applicable to all projects that include the supply of electricity, both residential and public sector and production systems.

As indicated by the Asian Development Bank in their publication “Cost-Benefit Analysis for Development. A Practical Guide” (2013, pp.278), “a key step in identifying the economic benefits of an energy generation project is to distinguish between incremental and non-incremental output. Incremental output refers to the additional output produced by the project over and above what would be available in the without-project situation. Non-incremental output is output produced by the project that displaces high-cost or unreliable supplies available without the project. The economic values of incremental output and non-incremental output are referred to as incremental benefits and non-incremental benefits, respectively”.

Another important distinction is the size of projects. In the case of small projects, it can be assumed that they face a perfectly elastic demand and therefore that the economic benefits can be measured from the project revenues (the financial benefits). On the other hand, in the case of large projects, the usual downward-sloping demand curves are relevant, and benefit estimation should consider both revenue and consumer surplus effects.

This document presents a simplified methodology for the preparation and evaluation of electricity projects that allows for the economic profitability of the following types of project to be determined:

Projects That Increase Electricity Outputs

It refers to projects that produce additional outputs compares with the without project situation.

- Energy generation projects that add capacity in the system trough:
 - Expanding supply for meeting growing demand;
 - Improving the reliability of electricity supply.
- Energy generation projects that supplies electricity:
 - To serve a new market where no electricity is available;
 - To reduce a shortage in existing markets where supply is inadequate to meet growing demand;
 - Combination of the above situations.
- Energy generation carried out in a rural area with no prior access to electricity;

Projects That Displace High-Cost or Unreliable Supplies

This refers to projects that keep the total outputs of the system constant.

- Projects displacing or rehabilitating old generation facilities to reduce high generation and operating and maintenance costs.
- Projects reducing costs to the utility by displacing old facilities, or rehabilitating aging, poorly-functioning facilities.

In each of these cases, different forms of incremental and non-incremental benefits will occur. Understand that for the main purpose of the project, it is imperative to identify the corresponding benefits and costs.

Normally, conservations of existing electricity do not require an economic evaluation, because these activities are planned and considered in the original project appraisal. However, this methodology can support the analysis of conservation policies.

Conservation activities on electricity projects consist of all those actions that are intended to prevent the rapid deterioration of the system. For example:

- Substation improvements
- Replacement of sub-transmission lines
- Replacement of distribution lines
- Capacitor maintenance
- Secondary network improvements
- Conservation and improvement of voltage regulators
- Conservation and improvement of metering equipment
- Conservation and improvement of vehicles and equipment

3. ANALYTICAL FRAMEWORK

One of the objectives of project evaluation is to ensure that a project makes efficient use of a country's scarce resources. The economic analysis provides a methodological framework for estimating economic benefits and costs. The benefit is measured by the net present value (NPV) of incremental net economic benefits. Only if NPV is positive can a project claim to reallocate resources efficiently.

3.1. Incrementality of Projects

One of the important problems in project appraisal is ensuring that the project's benefits and costs are being measured on an incremental basis. When conducting a project appraisal, is important to conceptualize **two states of nature**: *one that includes the project (with-project situation) and one that does not include the project (without-project situation)*. The costs and benefits of the "without" situation should be subtracted from the costs and benefits of the "with" project situation to derive the incremental resource-flow statement.

An important element in the appraisal is to ensure that the "without" situation is properly defined. The "without" project situation does not mean that nothing is done to the current situation (if an electricity project is not undertaken). Even without a major rehabilitation of the existing electricity system, there will be some regular maintenance activities performed on the system. In other words, the "without" project situation should be still technically optimized in order to be compared to the "with" project situation. A simple before-and-after comparison would not be enough to avoid this pitfall¹.

3.2. Economic Benefits

The approach undertaken in this manual is called *Integrated Project Analysis (IPA)*. It was developed by Prof. Glenn Jenkins and Prof. Arnold Harberger, and it is the most advanced methodology for modeling investment projects. The approach estimates the impact of the project from various perspectives in one integrated model; effects on the private investor, government tax revenues, fiscal expenditures, consumers, and the environment are quantified and estimated in one integrated simulation model. IPA uses financial, economic and risk analyses of a potential investment project within a single consistent model.

The main economic benefits of electricity projects correspond to:

- A higher consumption of energy and/or lower acquisition costs for users.
- Release of resources. For example, implementation of rural electricity projects allows people to reduce consumption of candles, paraffin, gas and batteries, while reducing the time associated with their purchase.
- In both cases, the benefits affecting all sectors where the project has influence should be considered, i.e. residential, public, commercial sector, etc.

The methodology for estimating benefits through measurements of the willingness to pay (WTP) for incremental energy consumption is usually the simplest approximation.

Schematically, the potential benefits of the project for the electricity supplier and for each type of stakeholder are as follows:

¹ Jenkins, GP., Kuo, C.Y. & Harberger, A.C. (2013). Cost-Benefit Analysis for Investment Decisions. Chapter 1.

Table N°3.1: Benefits by Type of Stakeholder

Stakeholder	Benefit
Supply company or organization	Revenues on electricity sales
Residential	Release of resources
	Higher consumption
Public light	Release of resources
	Higher level of safety
	Increase in social activities
Productive sector	Release of resources
	Increase in productivity
Public service	Release of resources
Others	Release of resources
	Increase in productivity

Source: International best practices.

The financial benefits of electricity projects correspond to sales revenue, which can be broken down into fixed income and variable, both regulated and incorporated into the tariff system. The fee charged will correspond to the area where the project is located; if there is no concession in this area, the value applied in the nearest concession area with similar characteristics should be used.

Benefits of Projects That Serve New Residential Markets²

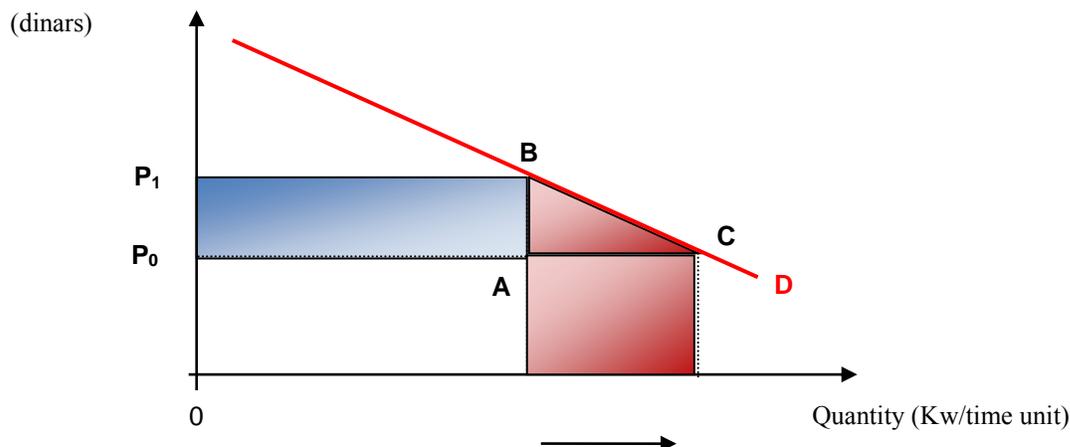
For the purpose of estimating the benefit of an electricity project that serves a new market, it is assumed that a new market is a market where the provision of electricity is done by other energy sources (for example, kerosene, gas or fuel).

Line D in Figure N°3.1 represents the demand function by electricity. The vertical axis denotes the price (cost) of each successive unit of electricity, per period of time. Without the project, the price/cost per unit is P_0 , and the equilibrium consumption level is Q_0 . Under the project, costs will fall to P_1 and electricity volume will now expand to Q_1 . For simplicity, it is assumed that electricity is used only for lighting and that currently kerosene oil is used for this purpose. The project displaces the current use of kerosene and induces additional use of electricity due to its lower cost. Initially, kerosene consumption is Q_0 (electricity equivalent) and its cost is P_0 .

Supplying electricity to a new market involves incremental and non-incremental benefits. The project displaces this use of resources and increases electricity consumption by $Q_1 - Q_0$. The non-incremental benefit is represented by area P_1BAP_0 , which is the resource cost savings on kerosene. The area Q_0BCQ_1 represents incremental benefits and it is composed of sales revenue from incremental output (area Q_0ACQ_1) and the consumer surplus (area ABC). Figure N°3.1 illustrates this.

² Asian Development Bank: “Cost-Benefit Analysis for Development. A Practical Guide” (2013).

Figure N°3.1: Benefits of Supplying Electricity in a New Market



Source: International best practices.

The information required to undertake benefit estimation, such as kerosene price and quantity purchased (equivalent to the electricity quantity Q_0), can be collected through a survey in the project area. The price of electricity (P_1) corresponds to the long-run marginal cost of electricity supply. In the new market the incremental output is unknown and should be estimated by sponsor agency. It is usual to have undertaken a survey in similar, recently-electrified areas to identify incremental consumption in order to be able to assume that a similar increase will take place in the project area. The above figure assumes that the demand function is linear; however, the analysis can be extended to relax the linearity assumption.

In addition, the project could produce an additional effect: improving lighting quality by replacing kerosene lamps with electricity lamps. However, it is difficult to home-owners for example to value the improvement in light quality. Also, using electric lighting to substitute for kerosene lamps could produce other benefits such as cleaner indoor air and improved safety through reduced fire risks. Therefore, cost savings estimated by using the expenditure on kerosene provide only a lower band for the non-incremental benefits of electricity. Finally, the costs saved on car batteries and similar alternatives should be included in the estimation of non-incremental benefits.

Benefits of Projects That Serve New Production Markets

In certain kinds of project, electricity is used for agricultural, industrial, and commercial purposes. For such uses, electricity is used as an intermediate input. Therefore, benefits are equal to the marginal revenue product of electricity (the physical marginal product times the price of produced output).

To estimate these benefits, it is necessary to know the marginal product of electricity in various agricultural, industrial, and commercial production activities. Because of difficulties in obtaining this information, the benefits of electricity production can be measured in terms of costs of potential substitutes. As Asian Development Bank (2013, pp. 284) indicates, "... carefully designed surveys can generate data on actual use of alternative

sources of energy which will be replaced when electricity is available and the resource cost savings can be considered as the benefits of electricity supply”.

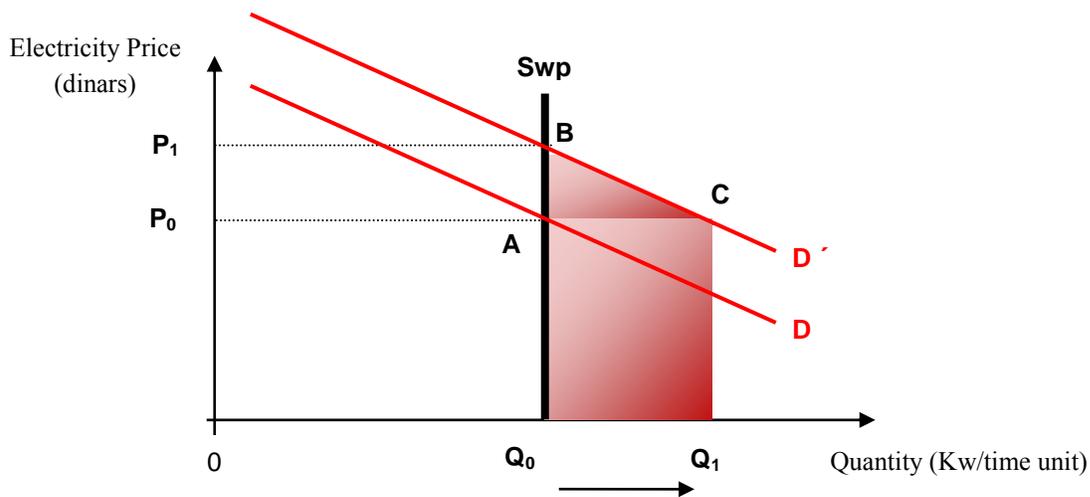
Benefits of Projects That Reduce Energy Shortages

The above examples assume that the demand function does not shift due to income effects during the project period. However, it is unrealistic to assume that demand remains the same in a growing economy. Therefore, the basic model needs to be extended to accommodate the impact of a shift in the demand curve.

Consider a project that adds energy generation capacity to the system, where an energy shortage is present. In Figure N°3.2, S_{wp} is the fixed supply without the project. The electricity price is set at P_0 , which is equal to the long-run marginal cost. Supply is constrained at the current level of output, Q_0 . As the demand for electricity shifts to the right in the absence of a price control, the without-project price will increase from P_0 to P_1 .

Now, assuming a new project that removes the supply constraint by adding an energy plant that produces $Q_1 - Q_0$ units of electricity, the gross incremental benefits are Q_0BCQ_1 . In this case, there is no resource cost saving because the electricity supply was not displaced by the project. Figure N°3.2 illustrates this example.

Figure N°3.2: Benefits of Supplying Electricity in a Market With a Shortage



Source: International best practices.

To estimate these benefits, the project sponsor should know the electricity price (P_0), the without-project output (Q_0), and the with-project output ($Q_1 - Q_0$). Total benefits can be divided into two: i) Project revenue (area Q_0ACQ_1); and ii) consumer surplus (area ABC). Estimation of project revenue is straightforward but the area ABC cannot be estimated without knowing the demand function. In some practical applications, project revenue can be assumed as a proxy for benefits, but this is an underestimate.

To simplify the analysis, consumer surplus (area ABC) can be computed as half of $P_1 - P_0$ times project output. P_1 can be estimated as the cost or price of alternative energy sources or the cost of current alternative energy sources in areas where electricity is unavailable

without the project. However, the theoretically correct approach for estimating the total WTP (area Q_0BCQ_1) is to integrate the demand function over Q_0Q_1 .

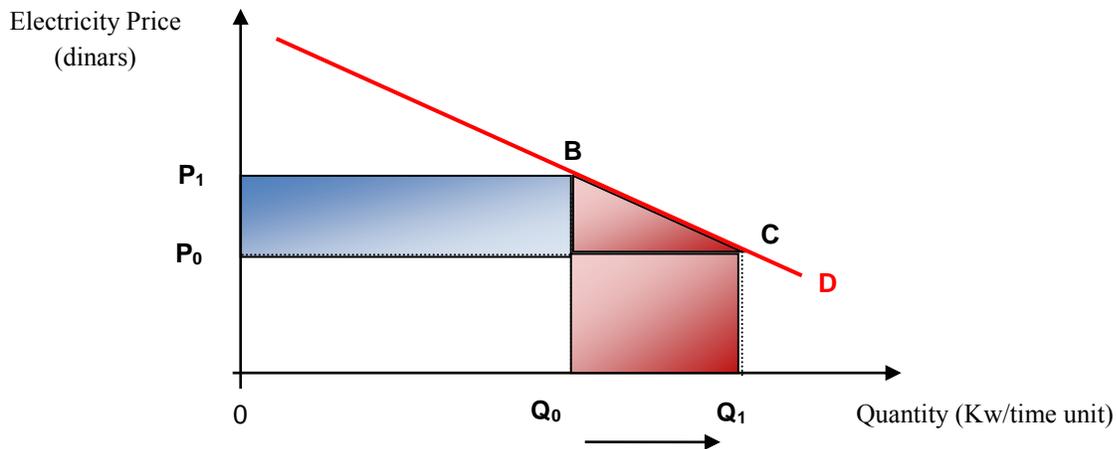
Benefits of Projects That Reduce Generation Costs

Energy projects are also built to reduce generation costs by displacing or rehabilitating old facilities that possess low-generation efficiency, higher generation loss, or higher operating and maintenance (O&M) costs.

If the tariff remains fixed and the output keeps constant, project benefits are solely non-incremental (resource cost savings), as illustrated by the shaded area (P_1BAP_0) in Figure N°3.3. In this case and because tariff is fixed, the benefits accrue to the electricity company, not to users.

If the tariff is reduced to P_1 after replacing the old or higher cost plants, there will be incremental output (Q_1-Q_0). The incremental benefit will be equal to area Q_0BCQ_1 , which has a revenue component [$P_0*(Q_1-Q_0)$] and a consumer surplus component (area ABC). In such a case, total benefits are equal to the sum of non-incremental and incremental benefits. Here, non-incremental benefits (area P_1BAP_0) accrue to consumers.

Figure N°3.3: Benefits of Supplying Electricity on Cost-Reducing Projects



Source: International best practices.

Data issues in the application of these methods are similar to those described earlier. The cost-savings benefits of the saved resources, such as fuel, equipment, and labor, should be measured in economic prices. Non-traded goods (and labor services) are valued at market prices, adjusted by the appropriate conversion factors to take into account market distortions and government interventions.

Summary of the Benefits of Electricity Projects

The economic benefits of electricity projects are incremental and non-incremental, i.e. the following shaded areas:

- Non-incremental benefits of projects that serve new residential areas; area $P_1BA P_0$ in Figure N°3.1 corresponds to the release of resources or increase in consumer surplus associated with costs savings.
- Incremental benefits of projects that serve new residential areas; area Q_0BCQ_1 in Figure N°3.1 represents sales revenues from incremental output (area Q_0ACQ_1) plus the consumer surplus (area ABC).
- Incremental benefits of projects that reduce energy shortage; area Q_0BCQ_1 in Figure N°3.2 represents sales revenues from incremental output (area Q_0ACQ_1) plus the consumer surplus (area ABC).
- Incremental benefits of projects that reduce generation costs; area Q_0BCQ_1 in Figure N°2.3 is the revenue component $[P_0*(Q_1-Q_0)]$ plus the consumer surplus (area ABC).
- Non-incremental benefits of projects that reduce generation costs; area P_1BAP_0 in Figure N°3.3, which is the consumer surplus.

Externalities

It is appropriate, in the analysis of any project from the point of view of society as a whole, to take into account external or indirect benefits and costs. For example, a particular concern is that if the cost of carbon and other environmental pollution effects of energy generation are incorporated into the economic analysis, economically viable projects may fail cost–benefit tests with this type of proxy, which underestimates the benefits of the project.

3.3. Economic Costs

In order to receive the benefits of the project, it is necessary to incur some costs. Obviously, the most important costs are related to the expenditures to be made by companies that provide energy supply. In general, these costs can be separated into investment, operation, maintenance and administration.

Investment costs are associated with the acquisition and installation of generation systems: transmission lines, distribution transformers, switches, fuses, lines, civil works, joints, and other indoor facilities. For non-conventional energy projects, investment costs are considered to be civil works, supporting structures, equipment uptake of renewable energy, protection, distribution lines, transformers, joints and outdoor facilities. In general, all inputs are involved in enabling the energy supply system.

Operating and maintenance costs are those that occur when the system is ongoing. Among other things, cost are related to fuel costs, energy purchase and power purchase. Unit values are determined by node prices³, while the amount to purchase includes residential demand

³ The node price refers to the maximum price applicable to electricity supply regulated customers, considering the cost of generation and transmission, without consideration of distribution cost. The node price is set by the appropriate authority (resulting from the bidding process to supply energy to regulated customers). In economic terms, this price corresponds to the marginal cost of supply, consisting of two components: i) *basic energy price* which is the average marginal costs of energy operating at minimum cost; ii) *basic peak power price* which is the annual marginal cost of increasing the installed capacity of electricity system, considering the most efficient generating units, selected to provide additional power during the annual peak demand at the system.

plus electricity losses. Other operating and maintenance costs should be also considered. Maintenance costs correspond to the resources used to repair or replace the network.

When looking at non-conventional energy-project operating and maintenance costs, consider:

- Personnel costs and materials designed to operate, maintain and manage the system.
- Losses of energy and power.
- Training costs and/or dissemination of unconventional technology to ensure smooth operation.

In general, these costs can be represented by the following expression:

$$Op.C = Energy\ Costs + Maximum\ Power\ Costs$$

The total amount of maximum power and energy demanded by the supplier are obtained from the amount of maximum power and energy demanded by all users, plus their corresponding transmission losses between the place of purchase and the selling place.

Administrative costs are related to consumption readings, billing, ticketing and payment collection.

Indirect costs will be considered only if the markets are distorted. With regard to the intangible costs generated by the project, these should be indicated in a list.

In practice, what is commonly done is to determine the total resources that would be needed each year to maintain the technical standard of the project. The cost of the project is given by the additional amount of resources required in the *with-project* situation to the *without-project* situation.

4. PROJECT PREPARATION AND ANALYSIS

For optimal allocation of public resources, the process of economic evaluation of projects should ensure the correct selection of projects. This process should start with the identification and analysis of the problem situation: a bad coverage of a service, a bad service delivery, lack of assets, lost opportunities for improvement, among other factors. The definition and evaluation of a range of alternatives that may provide solutions to the problem must follow, ending with the selection of the alternative that maximizes social welfare.

In the context of public-sector investment, a project may be viewed as an instrument for achieving the planning objectives and development goals of a country or region, available to planners and policy-makers. Often, a project may be considered a series of activities and tasks with a specific objective, to be completed within certain specifications and a given timeframe. Usually, it will also have funding limitations, consume resources and may be evaluated as an independent unit. It may be possible to break down a project into various components, but these cannot be operated independently of each other, nor can each one fulfill a purpose without the others.

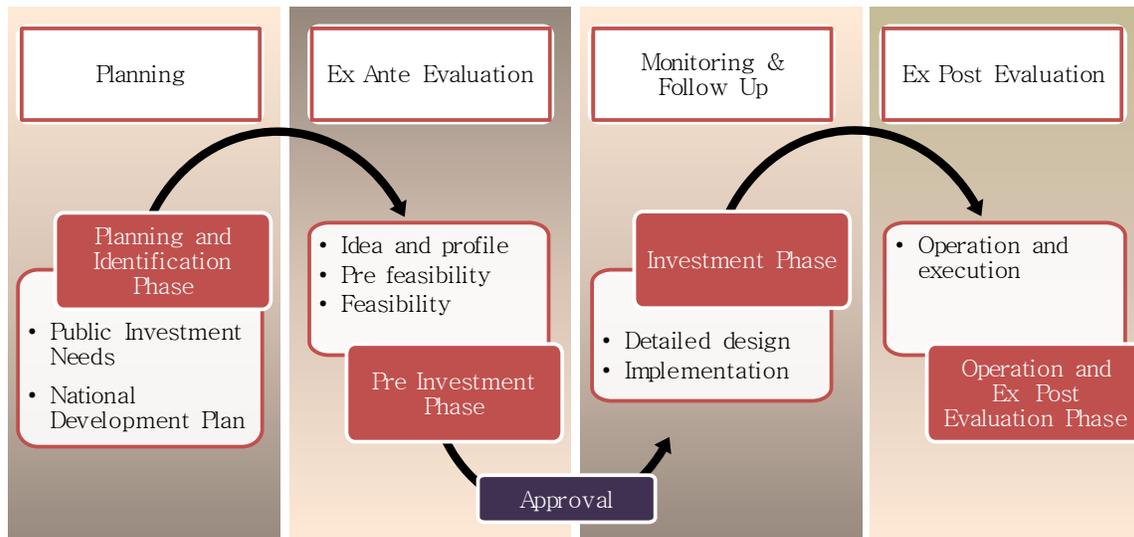
4.1. The Project Lifecycle

The project lifecycle is the process by which an idea is transformed into a concrete solution through the analysis of alternatives and the choice of the most profitable alternative from the economical point of view. Every project has certain phases in its development and implementation. These phases are very useful in planning a project, as they provide a framework for budgeting, resource allocation, the schedule of project milestones in implementation and the establishment of a monitoring system. The purpose is to provide a basis for organizing the project in order to establish resource requirements and set up the management system that will ultimately guide project activities.

Although the exact division of a project's life into its different phases is somewhat sector-specific, project lifecycle phases may broadly be broken down into different steps. Figure N°4.1 shows the project lifecycle.

As the project moves through its lifecycle, the focus of managerial activities shifts from planning to operating and controlling activities. It should be emphasized that these phases only represent a natural order in which projects are planned and carried out. Also, none of these phases becomes really final until the project approaches its termination stage.

Figure N°4.1 – The Project Development Cycle



Source: *international best practices.*

To obtain a more detailed view of the project cycle, please review the following document: “*Simplified Methodology for Economic Appraisal of Public Investment Projects in Kurdistan*”.

4.2. The Project Background

The pre-investment phase is a gradual process of elaborating on project ideas, following the project lifecycle until an appraisal conclusion is reached. This corresponds to the process of preparing the necessary studies and analysis for the identification, preparation and evaluation of the project that can solve the problem or meet the needs that triggered it, so reducing the degree of uncertainty about investment decisions.

Idea and Project Profile Definition

At this point there should be a description of the problem to be solved. For example, in most cases, the problem is the poor quality of life of the inhabitants in the absence of electricity and/or the high costs of acquiring substitute energy sources such as candles, flashlights, lamps (gas or kerosene), batteries or other things.

The **project profile** requires a rigorous identification process, which implies undertaking the identification of gaps in the economy and the definition of investment priorities for the public sector. A typical description of a problem requires definitions of:

- (1) The area of influence of the project.
- (2) The target population.
- (3) The present and projected demand, supply, and deficit of the service to be provided by the project.

The purpose of this description in a project profile analysis is for the sector, promoting a given investment initiative, to answer the various questions in terms of base-case optimization, alternative projects, redefinitions, etc.

The sponsoring agency must first clearly identify the problem that gives rise to the idea of a given project. After that, the problem must be framed as a negative state affecting a population, and not as the “lack of a solution”. In any situation that is analyzed, several problems can be distinguished; however, it is necessary to focus on the root problem, establishing the causes that originate it and the effects it produces. To achieve more details on the project cycle, please review the following document: “*Simplified Methodology for Economic Appraisal of Public Investment Projects in Kurdistan*”.

Areas of Interest: Study and Influence Area

The **study area** is defined after the geographical analysis and gives a context to the problem being studied. It also delivers the limits for analysis. The **influence area** corresponds to that area where the problem directly affects the population and where the alternative solutions should be considered. Typically, the influence area is a subset of the study area, but there are also situations in which the study area and area of influence are equivalent.

The project’s file should include:

- Project's name.
- Geographical description of the urban area of influence, nearest localities that have electricity services.
- Legal and regulatory framework to access energy resources, such as water rights, easements, concession areas, etc.
- Define the problem to be solved.

In addition, it should briefly describe the institutions/agencies in charge of the project. This will determine if operation and maintenance is carried out by a public or private company. The existence of schools should be noted (indicating the number of students and school subsidy received), along with health institutions, community centers, religious institutions, public lighting, etc.

Referring to the source of information, data can be addressed from:

- The project department at the Ministry of Energy.
- The electricity department at the Ministry of Public Works.
- The investment department at the Ministry of Planning.
- Municipalities.
- Energy companies, cooperatives.
- Geographic charts, census of population and housing maps.
- Directorate General of Water.
- Interviews with local organizations.
- Local leaders and NGOs present in the area.
- Others.

Any additional information deemed relevant should be included.

Affected and Target Population

Inside the influence area analysis, the recognition and description of the **affected and target population** is critical to understanding the current situation and to finding solutions to problems.

For the purposes of identification, it is recommended that efforts be concentrated on the identification of the affected population. To do this, information about their social and economic, demographic and cultural characteristics must be collected. Also, it is necessary to forecast the growth of the affected population in the project-evaluation horizon.

Project preparation should include a diagnosis of the current situation, which is necessary to address the following issues:

- Population and housing, income levels of the population and types of activity that are currently being developed.
- Main economic activities (agriculture, fisheries, trade, handicrafts, etc.).
- Economic productivity problems linked to energy activities.

Referring to the source of information, data can be addressed from:

- The project department at the Ministry of Energy.
- The electricity department at the Ministry of Public Works.
- The investment department at the Ministry of Planning.
- Municipalities.
- Energy companies, cooperatives.
- Geographic charts, census of population and housing maps.
- Directorate General of Water.
- Interviews with local organizations.
- Local leaders and NGOs present in the area.
- Others.

Identification and Description of Alternative Solutions

To identify possible solutions, the first step is to visualize the expected situation once the central problem is solved; this provides strategies for action and, therefore, the set of alternatives to be analyzed.

It is recommended that the analysis of alternatives be carried out during pre-feasibility studies, using the modules approach (developed in the next section). As the sponsoring agency is involved in the study details, the chance of choosing the best alternative for solving the problem is increased.

The aim at this stage is to provide background to determine through a preliminary analysis the feasibility of using different energy options for the electricity supply (extension of the electricity network, water resources, wind energy and solar generator sets). As a result of this analysis, unsuitable alternatives can be discarded quickly.

The study of local conditions is essential to making an accurate inventory of energy resources. In general, the evaluation of unconventional resources is complex, so it must be done by qualified personnel. For example, the following technical studies should be taken into account (if they are relevant):

- Distance from geographic urban centers to distribution lines.
- Estimated water flows by season (cubic meters/second) and the height of fall (meters).
- Average solar radiation by period (kWh/square meter/day).
- Estimated average wind speed in meters/second.

This information and data could be addressed from:

- Electricity companies
- National Energy Commission (or similar)
- General Water Directorate (or similar)
- Agricultural Research Institute (or similar)

The project file should describe all the alternatives that provide solutions to the problem that are technically feasible to perform. It is possible to generate different alternatives from different combinations of the following items:

- Voltage (KV).
- Line length (km).
- Conducting inputs.
- Number of poles.
- Poles per km.
- Unit value of poles.
- Costs of micro or mini distribution networks.
- Costs of individual self-generation systems (mainly photovoltaic and wind).
- Different times to begin the project, in order to determine the optimal time investment for each.

Also, it is important to analyze different project sizes in order to determine the optimal size, if applicable. Study electricity requirements, including losses and pointed coincidence factors and the required maximum power. The project must be designed to meet the horizon for the end of the demand assessment. In the case of modular projects (such as photovoltaic ones), they must specify the years in which new generating capacity is added.

Pre-feasibility studies may rule out some alternative solutions, based on findings at the profile level. At times, some alternative solutions can be ruled out for technical, institutional or other reasons in addition to economic reasons.

An alternative solution to all types of problem to consider in project appraisal is what is known as the "optimization of the base-case situation". The sponsoring agency must take this into account in the comparison of alternatives.

Optimizing the Base-Case Situation and the Concept of Incremental Analysis

An important concept when defining a project is that of ensuring that project benefits and costs are being measured on an incremental basis. An investment opportunity entails incremental net benefit flows that occur over and above what would have been there in the absence of that investment. When applying this to public investments, one should carefully identify the benefits and costs associated exclusively with the project in question.

The **optimization of the without-project situation** should always be considered as an alternative solution, especially in the case of brownfield projects (or incremental projects). Optimization investments apply to all low-cost measures that can improve the current situation, partially or completely eliminating the problem. In this case, they allow for improvements without the need for a fully-fledged project, which involves many financial resources.

If, after the evaluation of the optimized base-case situation, the conclusion is that there is no solution to the given problem, it will be necessary to evaluate alternative solutions, considering the optimized “without-project” situation as a base-case situation. It is from this starting point that the project promoter should measure the incremental benefits and costs of each alternative and then choose the most profitable from the economical point of view. *It should be remembered that the evaluation of projects is always a comparison between different alternatives (including, of course, doing nothing!).*

The without-project situation corresponds to the optimized current situation, which is determined by executing works under investment or feasible and cost-effective management measures to improve the operating conditions of the electricity systems obviously profitable.

It should be noted that if there is no cost-effective alternative solution, the project sponsor must run the above optimization.

Demand Module

The energy demand forecast is the starting point for the economic analysis of power projects. Electricity demand assessment provides basic information for CBA. The price elasticity derived from demand equations constitutes key information for the estimation of benefits. This module examines demand by type of user. The function of this module is not only to assess current demand but to undertake the more difficult task of forecasting future demand.

The demand for electricity is highly correlated with the economic performance of a country, which in turn is determined by a variety of factors. In the electricity sector, a distinction is made between demand for energy (electricity expressed in terms of kilowatt-hours, megawatt-hours, etc.) and for power (capacity to deliver energy expressed in terms of kilowatts, megawatts, etc.). Meeting demand for electrical energy at all times requires power or capacity to meet peak demand. The load or capacity factor – the ratio between total energy produced and delivered and the capacity to deliver that energy (also specified as the ratio of average load to peak load) – is an important variable in demand forecasting. Generation losses, transmission losses, distribution losses, and theft (in some countries) should also be taken into account in forecasting electricity demand, particularly the demand for power.

Demand forecasting is normally done using one of three methods:

- (i) Trend analysis.
- (ii) End-use models and customer surveys.
- (iii) Econometric methods.

Trend analysis extrapolates future demand using time-series data on peak demand for power (kW) and annual demand for electricity (kWh). This method extrapolates future electricity demand based on past growth trends, assuming there will be little change in the pattern of major determinants of demand such as prices, incomes, and consumer tastes.

Demand for electricity can also be derived from economic growth, applying income elasticity of demand for electricity to forecast economic growth. The income elasticity of demand for electricity – defined as the ratio of the percentage change of electricity consumed to the growth rate of gross domestic product (GDP) or income – quantitatively measures the relationship between electricity demand and economic growth. The elasticity of demand for electricity can be calculated using historical observations.

As indicated by the Asian Development Bank in their publication “Cost-Benefit Analysis for Development. A Practical Guide” (2013, pp. 295–296), “the main advantage of this method is its simplicity and modest requirements of both data and analytical skills. The major disadvantage is that this method does not attempt to understand the causes of past trends and may simply assume that the same trend will continue in the future”.

Estimation of demand and consumption in with-project and without-project situations can be made through *surveys* applied to different types of user (residential, commercial, industrial). These values should be compared to and validated using similar locations, where demand and consumption has been stabilized.

The *econometric method* is theoretically the most rigorous, identifying with significant statistics the relationship between demand and its determinants. Using historical observations, econometric models estimate the relationship between electricity consumption and a variety of other variables such as population, per capita income, prices of electricity and its substitutes, stock of appliances, industrial output, and weather conditions.

To determine the economic viability of a electricity project, it is necessary to perform the following:

- An estimation of the demand forecast with and without the project.
- An estimation of the benefits of the project as the difference between benefits in the with-project situation compared with those in the without-project situation.

Current and Forecasted Demand. Theoretically, the demand for electricity depends on its price, expressed in the following form:

$$Q = aP^e$$

Where:

Q is the energy consumption in the equivalent in unit of kWh/month.

a is a constant that represents other variables than energy price, such as income level, consumer preferences, etc.

P is the price of energy in dinars/kWh.

e is the price elasticity of demand.

Parameters a and e are obtained from the following relationships:

$$e_t = \frac{\ln(Q_{\text{WithoutProject}_t} / Q_{\text{WithProject}_t})}{\ln(P_{\text{WithoutProject}_t} / P_{\text{WithProject}_t})}$$

$$a_t = \frac{Q_{\text{WithoutProject}_t}}{P_{\text{WithoutProject}_t}^{e_t}}$$

If energy is supplied by an alternative system (e.g. a generator) and it is being restricted, the price and quantity in the without-project situation must be obtained from similar places where consumption is not being restricted. These values should be used in calculating the parameters e and a .

Estimating demand using econometric models is the ideal scenario. However, in most cases, certain simplified methods – such as the ones presented below – can be used to estimate the demand.

Residential Demand

The residential demand of a project is the sum of the individual consumption of all users, which should be considered a growth rate of consumption itself, plus the natural growth rate. The monthly electricity requirement is given by the following expression:

$$AR_n = r_x v$$

Where:

AR_n is the monthly requirement of electricity in the residential sector in kW/month.

r is the stabilized housing requirement, in kWh/month.

v is the number of existing houses in the area.

For subsequent periods, it is necessary to increase this value with the growth rate being considered.

The demand for houses is estimated as follows. In the case of a **project that serves new residential markets**, in the *without-project situation* consumption should be calculated using the following table:

Table N°4.1. Estimation of Residential Demand in Non-Electrified Areas

Source of Energy	Technical Conversion Factor to kWh ⁴	Average Monthly Consumption by User	Unit Price [Dinars/Source]
Candles (units)	0,0031		
Loaded Batteries (units)	0,576		
Batteries (units)	0,003		
Kerosene (liters)	0,16		

⁴ Suggested in base to Chilean experience (“Methodology on Project Preparation and Evaluation of Rural Electrification”, Chilean Ministry of Planning, 1996).

Bottled Gas (units)	1,333		
Others			
Without-Project Consumption (Qwop, in kWh)			
Total Expense (G, in dinars)			

Source: *international best practices.*

To estimate without-project consumption (Q_{wop}), it is necessary to multiply the equivalent consumption in kWh/monthly by technical conversion factors. To estimate total electricity costs (G), it is necessary to multiply the unit price of each source by the amount of energy used monthly by each family. The average price of electricity in the without-project situation ($P_{WithoutProject}$) is calculated using the following formula:

$$P_{WithOutProject} = \frac{G(\text{dinars / month})}{Q_{WOP}(\text{kWh / month})}$$

The information on consumption is obtained by surveying homes in the area. Sampling must be done in the area to determine whether or not they are applicable.

If the area is currently being supplied with an alternative source (e.g. a generator), consumption and price should be considered using this system.

In the ***with-project situation***, demand information should be obtained from municipalities, electricity companies or surveys that have been taken in similar areas for the last five years at least.

In the case of **projects that reduce energy shortages** and **projects that reduce generation costs**, information should be obtained from municipalities, electricity companies or surveys that have been taken in similar areas for the last five years at least for both the ***without-project situation*** and the ***with-project situation***.

Public Lighting Demand

To estimate public lighting demand, the procedure is similar for **projects that serve new residential markets**, **projects that reduce energy shortages** and **projects that reduce generation costs**. For example, if there is street lighting in the area in the ***without-project situation*** and the service is provided by a generator, it is necessary to obtain the following information:

- Total hours in which lights are on [hours/year].
- Total lighting power [W].
- Investments to replace the generator [dinars/team].
- Annual cost of operation and maintenance for the existing generating equipment [dinars/team/year].
- Residual value (at market price) of generating equipment [dinars/team].

In the *with-project situation*, demand information should be obtained from municipalities, electricity companies or surveys that have been taken in similar areas for the last five years at least.

The amount and type of lighting is determined by a specialist, who must consider local standards for the design of public lighting.

Industrial, Commercial and Productive Demand

To estimate industrial, commercial and productive demand, the project should include “productive systems of local character”, such as small-scale agriculture, fishing villages, handicrafts and “other relevant sectors”. In both cases, the *without-project situation* equals zero demand. In the *with-project situation*, the requirement for industrial, commercial and productive demand can be obtained from the corresponding consumption in electrified areas without rationing and where consumption is stabilized, or from specific projects designed in the same area if any such exist. This amount shall be expressed as an additional percentage of residential energy consumption. In the case of craft activities, only the current requirements for electrical equipment should be considered. The consumption of refrigerating systems in fishing coves will depend on the volume of catch. For other purposes, the procedure is similar to **projects that reduce energy shortages** and **projects that reduce generation costs**.

Public Utilities Demand and Other Types of Utility

The project should include all public utilities such as public schools, health centers, community centers, police units, etc. For these services, two scenarios should be considered in the without-project situation: *with or without electricity supply*. To estimate public lighting demand, the procedure is similar for **projects that serve new residential markets**, **projects that reduce energy shortages** and **projects that reduces generation costs**.

Information on user requirement can be obtained from municipalities, electricity companies, schools, health centers, community centers, or from surveys that have been taken in similar areas for the last five years at least. For example, information on user requirement can be obtained by looking at corresponding consumption in areas that have an unrestricted electricity supply and where consumption has been stabilized.

Handle the case of there being other types of user as you would that of there being productive activities going on.

Demand Losses and Growth in Demand

As already mentioned, the electricity requirement is the amount of energy necessary to meet the needs of a locality. That amount is obtained from the projection of the current situation and its development potential, which translates into electricity requirements that make this development possible.

A projection of future demand typically incorporates the following factors: growth in population; growth of economic activity and income; number and magnitude of new tourism, industrial, commercial and agriculture projects in the area; public-sector initiatives such as expansion of hospitals/health centers, schools, police stations; and so on.

The following recommendations are for those projects in which "activity systems" become evident, i.e. in each sector independently:

- Use census data.
- Conduct a specific analysis for those activities that are relevant.
- Estimate the development of each sector through simple and clear criteria; it is not necessary to complicate the analysis.

In addition, it should be noted that the above requirements *do not include losses of electricity*. These losses must be added when designing a specific supply project.

Finally, if there is no specific data to estimate a growth rate for users, the growth rate in similar areas should be used. Such information can be obtained from population and housing censuses (conducted by respective municipalities or other official agencies).

Engineering Module

The electrical layout should consider avenues, streets, roads and paths, using the criterion of minimum distance. The ratio of energy losses in the system is also used as a criterion in the design of the network. These should be minimized depending on the voltage supplied in the town (generally this is medium voltage).

The technological definition of alternatives is another key issue. As a result of the above steps (idea and profile definition, demand estimation), a set of appropriate technologies will be presented to potentially-feasible projects. If the required level of service is not technically or economically feasible, justifications for why the project cannot meet these standards must be put forward.

The blueprints of projects along all sections are prepared. The outputs of the engineering module are the design plans for all system elements and the estimated costs of their construction. Expected future maintenance and periodic and rehabilitation costs are estimated using information on previous such costs from different sources.

Project description. This should include information on project energy sources, equipment, costs, facilities, supplies, labor, etc. It should distinguish domestic from imported inputs and the degree of qualification of the workforce that the project will require (skilled, semi-skilled, unskilled, and a corresponding market wage for each category).

Project Location. Ideally, sketches of geo-referenced locations must be submitted. Detailed drawings of street lines, houses and works must also be submitted. Of particular importance are geo-referencing connection points for the existing network and extension network, as well as the location for hydropower plants, wind power, photovoltaic panels and other things.

Physical Works. Refer to the construction of buildings, administrative offices, workshops, warehouses, road access and any other additional work required for the operation of the project. This section should provide a description of such works, including a cost analysis. In it, present a detail of the main inputs to be used in the execution of the works, indicating quantity, origin (domestic or imported) and unit price. Similarly, an analysis of equipment, machinery and tools required for the execution of the works should be performed.

For labor to be used, the project description should indicate numbers, occupations, qualifications and market wages for various trades and specialties.

All components of the project should be sized according to consumption at rush hour or peak demand.

Environmental Module

Several projects have a negative impact on the environment, which may affect a group of people in the society adversely. This is an externality generated by the project and is not reflected in the private costs of the project. Failure to consider these actions in the ex-ante evaluation of the project may lead to the selection of an alternative that is not necessarily the most profitable in economic terms.

In this context, any electricity project should basically avoid spoiling the environment. Modern technologies attempt to minimize such negative interactions; however, every project should develop a proper environmental assessment.

If redirection is neither possible nor technically feasible, it is important to estimate the amount of environmental damage caused by this project. The environmental assessment team may be able to produce an estimation of damage in monetary terms.

For example, if mitigatory expenditures and compensation costs of resettlement are not already incorporated in the project's capital and operating costs, they should be included as external effects. Also, environmental and social programs should be included (loss of future eco-tourism potential, operating costs related to environmental and social programs), along with all other environmental improvement, mitigation and compensation programs to prevent significant social and environmental costs.

Financial Module

The financial analysis assesses the impact of a project on the financial costs and funding of the organization that makes the decision to carry it out. This type of analysis requires the construction of cash flows based on different points of view. For example, if the project does not yield private investors a sufficient return to attract them, the minimum amount of public assistance that would be needed to induce them to undertake the investment must be measured in a related function of the financial analysis.

Project implementation involves the use of resources to build, install, upgrade and/or equip infrastructure, facilities or other investments. The financial analysis of a project helps to determine the financial sustainability of the project and its overall success. From a country's point of view, a project will increase the country's net wealth if it has net positive economic returns. Conversely, a project that yields negative economic returns should not be undertaken as it would lower the net wealth of society as a whole.

This module provides the first integration of the financial and technical variables estimated in the demand, technical and manpower modules. A cash-flow profile of the project is constructed that identifies all the receipts and expenditures expected to occur during the lifetime of the project. For the financial analysis, the difference between project sales revenue and capital and operating costs at financial prices (with the capital cost of the transmission line excluded) gives net financial benefit.

Financial Outflows

The financial costs of the project from both the utility and project viewpoints include the investment cost and operating and maintenance costs. This means initial investment costs, regular and periodic maintenance expenditures, and rehabilitation costs. All these outlays will be borne by the sponsoring agency and will be incurred during the lifespan of the project (in most cases, 20 years). This cash-flow profile will belong to the with-project situation.

Among other items, financial outflows include:

- Substation improvements
- Sub-transmission lines
- Primary feeders
- Supervisory control equipment
- Distribution lines
- Capacitors
- Reclosing equipment
- Secondary network improvement
- Voltage regulators
- Vehicles and equipment
- Metering equipment
- Computer equipment
- Other equipment
- Buildings
- Maintenance

Financial Inflows

The project could have many sources of financial benefit, depending on its purpose. If the project's objective is to expand access to electricity (in urban and rural areas), a source of financial benefit is the incremental sales from increased electricity consumption arising from new connections to customers previously without electricity.

In other cases, financial benefits will also arise from the cost savings derived from the replacement of old technologies or from the reduction of technical losses at distribution. For example, a distribution network faces different types of technical loss, ranging from transformer and sub-transmission line losses to maintenance and outage losses.

Thirdly, when meters are installed, some consumers who previously pilfered electricity will reduce their demand for electricity, and the utility will no longer have to provide this electricity. The electricity supplier will benefit financially from the resulting savings in capacity and fuel.

Finally, financial benefits come from a combination of the above. For example, if the project involves the replacement of certain technology (i.e. thermal generation) with another less costly alternative (hydro plant), financial benefits will include the avoided cost of replacing the power supplied by the new technology (hydro plant) and the incremental sales revenues at the current tariff structure, occurring as a consequence of the project (for

example, in the case of the plant providing power in shortage events to customers who would otherwise remain unserved).

The following financial data is needed to conduct a financial analysis in order to determine the financial viability of the project:

- a. Tariff policy for residential, industrial, commercial and rural areas.
- b. Inflation.
- c. Interest during construction and capital costs. Accrued interest during construction is not a cash-flow item and hence does not enter the project analysis directly. It is, however, an important financial item for any electric utility because of the way electric tariffs are set for a regulated utility. For utilities whose rates are based on rate-of-return regulations, omission of the interest during construction in the capitalized cost of the assets would result in the underestimation of the rate base, and hence future tariffs and revenues.
- d. Income tax and sales taxes.
- e. Project and economic life. Period of analysis (i) is the time over which benefits and costs are compared. An analysis period of 20 years is recommended (when estimating the useful or economic life of the main types of equipment, it is usual to assume an average of 20 years). Initial calendar year (j) is the first year of the analysis period. Also note that the last year of the analysis should be used to determine the residual value of the project and its assets.
- f. Accounts receivable, accounts payable, cash balance. The accounts receivable can be determined by the length of the billing cycle, the length of the collection period, and bill-collection efficiency (often assumed to be a fixed percentage of sales)⁵. The amount of bad debts written off each year will mean a net reduction in the potential cash flow for the year; hence bad debts written off during the period are reflected through a negative adjustment to cash inflows for the period.
- g. Construction period. The total real construction costs are allocated proportionally to each year of the construction period.
- h. Financial discount rate (in real terms).
- i. Construction, regular maintenance, and rehabilitation costs in the without-project situation.
- j. Construction, regular maintenance, and rehabilitation costs in the with-project situation.
- k. Forecasts of demand by type of user for the “with” and “without” project situation.
- l. Initial calendar year.

⁵ In cash-flow analysis, accounts receivable is equal to unpaid sales, whereas in accounting, accounts receivable refers only to unpaid bills. Unpaid consumption is always greater than unpaid bills.

Real Versus Nominal Prices

One of the core concepts in financial modeling is tied up with the differentiation between “nominal” and “real” prices. “Nominal” prices are easily observed in the marketplace while underlying “real” prices are not. The difference between the two accounts for the movement in general price level over time.

The nominal price of an item is its real price plus the cumulative effect of inflation. If the “real” value of a good or service is constant over time, it follows that in order to project the “nominal” price of a good or service into future periods the analyst needs to know the inflation rate(s).

To simplify the financial analysis, the analyst might use only “real” costs of construction and maintenance. If the real cost of a commodity or service changes, for any reason other than inflation, the projected future nominal cost will also adjust.

Incremental Financial Cash Flow and Sensitivity Analysis

Once the amount and timing of financial expenditures for both “without” and “with” project situations are established, the analyst can derive an incremental financial cash flow.

The incremental financial cash flow of the project is derived by subtracting each and every value of the “with” project situation from the corresponding values of the “without” project situation.

The sensitivity analysis is conducted to identify key variables and to assess their impact on the project’s financial NPV. Among other variables, it is usual to analyze the following.

- a. Electricity Tariff Policy: Long-Run Marginal Cost Adjustment Lag.
- b. Electricity Tariff Policy: Inflation Indexing Lag.
- c. Electricity Tariff Policy: Customer Class Tariffs. Sometimes electricity prices for residential and rural customers are highly subsidized.
- d. The Number of Pilfering Customers Metered. For example, when a major source of additional revenue is the metering of previously pilfering customers and the annual addition of new customers.
- e. Number of New Customers.
- f. Inflation. The real financial NPVs is sensitive to inflation because it directly affects the real amount of cash balances required and the real value of accounts receivable and accounts payable.
- g. Cost Overrun. Cost overruns are likely to occur for any large and time-consuming construction project.
- h. Fuel Costs.
- i. Billing Period. A clear tradeoff is apparent between the costs of issuing bills more frequently and the losses from less frequent billing.
- j. Gross Domestic Product (GDP) Growth.

- k. Real Exchange Rate. A devaluation of the dinar will tend to increase the debt burden of the project in local currency and diminish the project's financial NPV. At the same time, a real devaluation increases the level of real electricity tariffs through its impact on real fuel costs and the long-run marginal capacity costs.
- l. Transformer Loss Reduction.

Economic Module

The economic analysis is similar to the financial analysis in the sense that it also measures changes in the wealth generated by a project. However, economic analysis is concerned with society as a whole and not only with the welfare of the owners of the project. Here, the starting point for economic analysis is the incremental expected net cash flows to total capital from the financial analysis.

In this module, the project is being examined from the entire economy's point of view to determine whether or not its implementation will improve the economic welfare of the country or of the province. An economic appraisal is of exactly the same nature as that of financial analysis except that now the benefits and costs are measured from the point of view of the whole country or the entire region. Instead of relying on market prices to measure the economic cost of expenditures, the economic analysis estimates the economic prices of goods and services, foreign exchange, cost of capital and labor.

At this stage, all the benefits generated by the project to society are recognized. The sponsoring agency should consider not only those benefits that are generated in the same market for services or products (direct benefits) but the benefits generated in a related market (secondary and indirect benefits and positive externalities). Similarly, all the costs should be recognized, considering the direct costs plus the costs imposed on the rest of society (secondary and indirect costs and negative externalities).

The first step in making an economic appraisal is to convert all financial expenditures into their corresponding economic costs. This implies that to arrive at economic costs all taxes, subsidies, market imperfections, impact from foreign exchange premium, and labor market distortions must be removed from financial expenditures.

The true economic values of costs and benefits are not accurately reflected in market prices in the presence of various market distortions such as import tariffs, value-added taxes, subsidies, minimum wages, and price controls. Market distortions refer to externalities like taxes, subsidies, trade tariffs, price controls, monopoly markets, environmental impacts (such as pollution or congestion), and open-access or common-property situations. Also, it is necessary to take into account externalities in the price of capital (discount rate), in the price of foreign exchange (because of trade distortions and controls in the foreign exchange markets), and in the labor market (where the financial wage rate may be different from the economic price of labor).

Benefit items must be estimated in terms of their magnitude and timing over the duration of the project. These include maintenance-cost savings, vehicle operating-cost savings, and time savings.

In practical terms, the incremental economic resource-flow statement consists of two parts: economic benefits and economic costs. Ideally, on the benefit side, four types of benefit

should be counted: i) Release of resources; ii) increase in consumer surplus; iii) sales revenues; and iv) external effects.

Conversion of Financial Expenditures into Economic Costs

Economic prices account for the real resources consumed or produced by a project and hence exclude tariffs, taxes and subsidies, as these are the financial transfers between consumers, producers and government within the same economy. An economic conversion factor (CF) is the ratio of the economic price of a commodity to its financial price.

Market distortions drive a wedge between the financial and economic prices of goods and services⁶. The concept of the conversion factor, defined as the ratio of the economic price to the financial price, is a handy way to express the relationship between the economic and financial values of the same commodity or service. Hence, the economic price of any commodity can be determined by multiplying the CF for that commodity by its financial price:

$$CF = \frac{\text{Economic Cost}}{\text{Financial Cost}}$$

Practically, the procedure of transforming financial expenditures into their economic equivalents is very straightforward once all conversion factors have been estimated.

Investment and O&M costs in financial prices are adjusted to reflect the economic resource cost of project inputs in terms of the domestic price *numeraire*. Costs are allocated to traded goods, non-traded goods, foreign skilled labor, local skilled labor, local unskilled labor, fuel, and transfer payments, and are adjusted by the appropriate conversion factors. Non-traded goods and skilled labor are assumed to reflect their economic prices, hence no conversion is applied. Traded costs (including fuel) are multiplied by the shadow exchange-rate factor, and unskilled labor costs are multiplied by the shadow wage-rate factor. Transfer payments and price contingencies are excluded from the economic analysis.

If there are no distortions in the supply and demand market of a commodity, the CF will simply be 1, because economic and financial prices are the same. If the market for foreign exchange is distorted, the market exchange rate (Em) or the official exchange rate will not accurately reflect the economic value of a unit of foreign exchange in relation to the domestic currency. Thus, it is essential to make an adjustment for the divergence between the market or official price of foreign exchange and its economic price, also referred to as the economic exchange rate (Ee) or sometimes as the shadow exchange rate (SER).

Data and Economic Benefits

As mentioned above, there are five types of benefit that can reasonably be estimated:

- Non-incremental benefits on projects that serve new residential areas: release of resources or increase in consumer surplus associated with costs savings.
- Incremental benefits on projects that serve new residential areas: sales revenues from incremental output plus consumer surplus.

⁶ Jenkins, G.P., Kuo, C.Y. & Harberger, A.C. (2013). "Cost–Benefit Analysis for Investment Decisions". Chapter 7: Principles Underlying the Economic Analysis of Projects.

- Incremental benefits on projects that reduce energy shortage: sales revenues from incremental output plus consumer surplus.
- Incremental benefits on projects that reduce generation costs: sales revenues plus consumer surplus.
- Non-incremental benefits on projects that reduce generation costs: consumer surplus.

The Economic Value of Electricity. The measurement of the economic value of the output of a project differs markedly between a competitive industry and a regulated industry.

In a *competitive market*, when a project increases the industry's supply of electricity, the price of electricity falls, the quantity of electricity demanded rises, and the production of existing producers decreases. In a competitive power market, however, a new power project by a competitive supplier may cause the power supply price to fall. This may lead existing suppliers to reduce production and the demand for power to rise. The economic value of the project's output is the sum of the increase in consumer welfare and the resources released by the reduced production by existing firms. In such a case, the weighted average of the supply price and demand price for electricity should be used to value the electricity.

In the case of a *regulated electric utility*, the increase in supply from one of its new projects does not cause the price to change, because the price is regulated. A regulated utility typically increases its supply to meet a potential power-shortage situation at a given price. When a power-shortage situation arises and persists for some time, some firms and residential customers may decide to install their own generators; others may decide to manage without electricity, while still others may simply cut back on activities that require electricity. Furthermore, some firms that would otherwise have located in the country or state may decide not to.

A power project that provides electricity to customers during power shortages or to customers without a connection to the power supply will have a direct impact on consumers affected by the power shortages and an indirect impact on the economy by eliminating the deterrence to potential domestic and foreign investment in the state. The direct benefits of providing electricity are measured by customers' willingness to pay for power. In addition to the direct benefits accruing as a result of the elimination of power shortages, additional benefits arise from the reduction in deterred demand.

The highest value a customer is willing to pay can be estimated by the cost of the alternative power supply available to this customer, which usually means owner-generation with a small gasoline or diesel electricity generator. For example, for a rural farmer the fuel cost of running a diesel water pump may provide an estimate of the highest level of willingness to pay.

Non-incremental benefits on projects that serve new residential areas: release of resources or increase in consumer surplus associated with costs savings; and incremental benefits on projects that serve new residential areas: sales revenues from incremental output plus the consumer surplus. The without-project situation is defined by B in Figure N°4.2; the with-project situation is defined by C in same figure.

The gross economic benefit per family in period "t" is given by:

$$BSB_{res_t} = P_{withoutproject} Q_{withoutproject} + e_t \cdot \frac{Q_{withproject}^{(1+e_t)/e_t} - Q_{withoutproject}^{(1+e_t)/e_t}}{(1+e_t)a_t^{1/e_t}}$$

Where:

e is demand elasticity, which corresponds to:

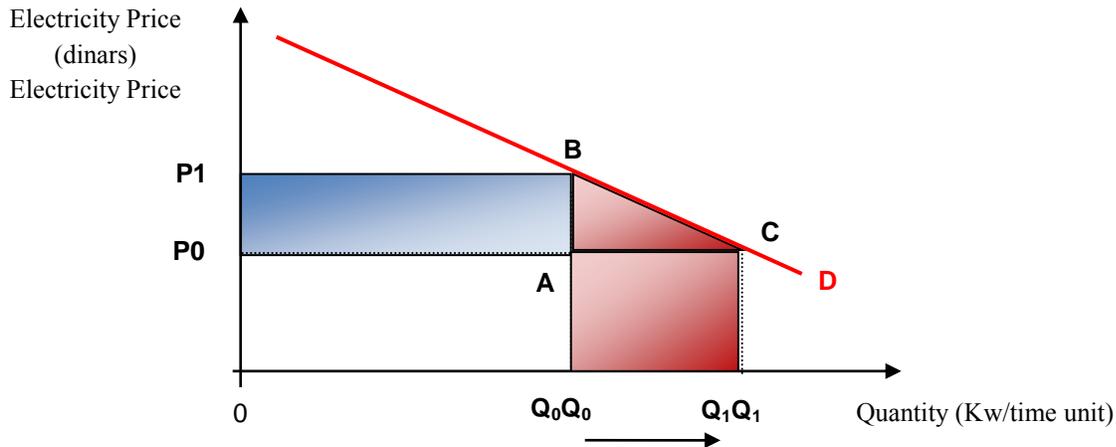
$$e_t = \frac{\ln(Q_{withoutproject} / Q_{withproject})}{\ln(P_{withoutproject} / P_{withproject})}$$

a is the constant parameter, given by:

$$a_t = \frac{Q_{withoutproject}}{P_{withoutproject}^{e_t}}$$

The total gross benefit in each period is estimated by multiplying the *gross economic benefit per family* in the period "t" by the number of beneficiary families (or users).

Figure N°4.2: Benefits of Supplying Electricity in a New Market



Source: International best practices.

Incremental benefits on projects that reduce energy shortage: sales revenues from incremental output plus the consumer surplus and non-incremental benefits on project that reduce generation costs: consumer surplus. To estimate these cases, the same procedure as the one shown below should be followed.

Nontechnical Losses: Pilfered Electricity. Some electricity will always be pilfered from any power system. This means that a portion of demand should be metered as pilfered demand or pilfered electricity. Consumers are likely to consume pilfered electricity until the marginal utility for their electricity consumption becomes zero. The willingness to pay for the electricity consumed by these consumers is given by the entire triangular area under the demand curve until $P=0$.

When meters are installed, these consumers will behave like any other electric consumers. Two things will happen. First, these newly-metered consumers will continue to consume electricity, but only to the point where power price is equal to marginal willingness to pay. To the utility company, this will mean new paying customers and increased sales at no added costs, except for the meters and metering costs. As the consumers were already consuming this portion of pilfered electricity prior to the installation of new meters, this portion of “retained” pilfered electricity consumption adds no economic benefits to consumers. What has occurred is the transfer of monetary payment from consumers to the utility company.

Secondly, because the newly-metered customers must now pay for the electricity they consume, they will no longer consume the portion of electricity that they previously consumed but valued at less than the price. The newly-metered consumers will lose the value of this portion of power previously available to them at no cost. The average value or willingness to pay for this “curtailed” pilfered electricity, assuming a straight-line demand curve that intersects the horizontal axis, is equal to one half of the electricity tariff now charged.

Technical Loss: Transformer Losses. If the project reduces previous power losses caused by transformer overload, this will result in savings in fuel and generation capacity to the utility. A financial gain accrues to the utility equal to the marginal generation cost times the reduction in power losses.

Transformer losses are of two main types: iron loss and copper loss. At a given level of voltage, the iron loss is constant while the copper loss is a function of the square of the current. An overloaded transformer means that more current is passing through it, and therefore more copper is lost. One can reduce transformer losses in overloaded substations by installing new transformers. By doing so, the reduced loads of transformers decrease copper loss, while iron loss remains constant. As iron loss remains constant, the incremental benefits come only from reducing copper loss.

To evaluate their loss, the overall running cost of the transformers before and after the project should be calculated. The overall annual running cost of a transformer equals annualized capital cost plus fuel cost.

Economic Parameters

Investment and operating cost components consist of individual items such as freight, insurance, non-tradable and tradable materials and equipment, and tradable fuel costs. Before calculating the conversion factors for the investment and operating items, it is necessary to determine the basic conversion factors of the above individual items.

- Import tariff.
- Local freight and handling.
- Non-tradable materials.

For each component of investment-cost items, it is necessary to break down the investment cost into tradable and non-tradable materials and skilled and unskilled labor. The operating costs consist of such items as wages, maintenance and repair materials, but exclude

generating costs such as fuel costs. The conversion factor for operations and maintenance is the weighted average of the conversion factors for labor and material as estimated for maintenance. Generation cost items consist mainly of fuel and capacity costs. The conversion factor for generation is calculated based on shares and available conversion factors.

Economic conversion factors are required to estimate the economic costs of electricity project construction, maintenance, and rehabilitation. It is suggested that a database of economic conversion factors for all commodities under a harmonized tax system (HST) be developed, organized into a single database⁷. To arrive at economic costs, the analyst should examine the outlays on domestically-produced inputs, imported inputs, cost of services (i.e. design, supervision, etc.), and cost of labor by skill⁸.

The economic cost of foreign exchange (foreign exchange premium, or FEP) is extensively used in the calculation of economic conversion factors. FEP represents the difference between the market value and the economic value of foreign exchange⁹.

The labor markets of many developing countries are characterized by high rates of unemployment of unskilled labor and close-to-full employment of skilled labor, and are generally highly regulated, unionized and distorted. In such a situation, the wage rate paid by a project for a particular skill or occupation will usually be significantly different from its economic opportunity cost.

The economic opportunity cost of capital (EOCK) is the appropriate discount rate, to use when estimating the economic NPV of an electricity project¹⁰. From the point of view of the economy, funds are generally drawn from three sources. Firstly, some funds would have been invested in other investment activities and have now been displaced by the project (the cost of these funds would be the return that would have been earned on the alternative investments that are now foregone). Secondly, funds come from different categories of saver in the economy, who postpone consumption in the expectation of getting a return on their savings (the cost of this part of the funds is the cost of postponing consumption, and this is reflected in the interest rate that the savers earn). Finally, some funds may be coming from abroad, that is, from foreign savers (the cost of these funds would be the marginal cost of foreign borrowing). The EOCK will simply be a weighted average of the costs of funds from the three sources outlined above: rate of return on postponed investments, the rate of interest on domestic savings, and the marginal cost of additional foreign capital inflows.

⁷ It is suggested that a user-friendly, online-based software be used for the database. This software should be open-access and available to analysts, including private companies and international bilateral agencies and development institutions. An example of such an open-access database can be found at <http://rwanda-cscf.minecofin.gov.rw>. The conceptual framework and actual estimation procedures are presented in “Cost–Benefit Analysis for Investment Decisions”, *Chapter 10 and Chapter 11*.

⁸ For the methodology underlying the estimation of the economic conversion factors for labor, refer to “Cost–Benefit Analysis for Investment Decisions”, *Chapter 12*.

⁹ Jenkins, G.P., Kuo, C.Y. & Harberger, A.C. (2013). “Cost–Benefit Analysis for Investment Decisions”, Chapter 9: Shadow Price of Foreign Exchange and Non-Tradable Outlays.

¹⁰ The theoretical arguments have been developed by Harberger, A.C., “On Measuring the Social Opportunity Cost of Public Funds”, in *Project Evaluation – Collected Papers* (Chicago: The University of Chicago, 1972).

For developing countries, the 12-percent EOCK is generally adopted if a more accurate estimate is not available.

External Effects

The introduction of electricity or its increasing supply will improve living conditions and productivity in the area of interest. These improvements can be identified from limitations imposed by lack of electricity, poor supply or deficiencies related to energy and equipment that provide alternative services to electricity (e.g. candles for lighting, oil pumps for irrigation, etc.).

In addition, electricity allows new activities to be done and improves people's domestic, production and commercial conditions. It:

- Improves lighting conditions.
- Improves cooling procedures in perishables.
- Allows the use of television and radio.
- Allows the use of appliances.
- Improves security conditions due to public lighting.
- Improves the functioning of public services.
- Reduces cooling losses of fish.
- Increases wholesale crop irrigation.
- Increases productivity in the handcraft sector through the use of power tools.
- Improves the marketing of perishable products (milk, meat, etc.) in commercial establishments.

If the information is available, the project sponsor should include these variables in project appraisal, as well as the problems encountered in formulating the project.

Uncertainty (Risk) Analysis Module

Generally, when evaluating investment projects, it is assumed that the variables used have a deterministic character. However, there are a number of variables in all infrastructure investment projects that do not behave this way. There are variables whose value cannot be accurately predicted, but whose estimation involves some uncertainty.

A traditional cash-flow analysis assumes single (deterministic) values for all of the variables. The outcome of that analysis is a point-estimate of a project's indicators, as NPV or IRR, and a decision on whether to accept a project is made on that basis. More realistically, however, we know that the values for most project variables are subject to change and are difficult to predict. While the previous values of a particular variable are known with certainty, predicting future values is a different matter. It is more likely to correctly forecast the range of future values for a variable than its exact value. Given that there are probabilities attached to the possible values of a variable in a given range, there is a good chance that the value that occurs will be other than the one we have chosen.

Uncertainty and its consequences are very significant issues in electricity-project appraisal because project costs and returns are spread over time. Estimates of prices and operating-cost savings are tentative due to uncertainty in demand forecasts. In turn, this makes the outcome of projects uncertain.

Typically, analysts use three types of analysis to deal with uncertainty: sensitivity tests, scenario analysis, and Monte-Carlo risk analysis.

Sensitivity Analysis

Appraisal of electricity projects involves a degree of uncertainty. Appraisal analysts simply do not know with certainty what will happen in the future. Sensitivity analysis is a way of testing how sensitive a project's outcomes (whether cash flows, economic NPV, gains and losses to different groups in the economy) are to changes in the value of one parameter at a time. Sensitivity analysis is typically conducted to identify the impact of input variables on the economic outcomes of a project. Sensitivity analysis is often referred to as "what if" analysis, because it allows the analyst to answer questions, such as "What would happen to the NPV if a variable were to change by a certain amount or percentage?". To conduct this analysis, it helps if spreadsheets are organized in a systematic way starting with a table of parameters, which can easily be adjusted.

The economic NPV is affected by similar variables to those that affect the financial NPV. However, because the economic values of different revenue and cost items are measured differently from their financial prices, the resulting economic NPV will differ substantially from the financial NPV. In the economic sensitivity analysis, it is important to take a look at how various variables affect the economic NPV.

- **Construction Cost Overruns.** This test measures the response of the economic NPV to an unexpected escalation of construction costs, keeping all other project parameters constant.
- **Inflation.** Items such as cash balance, accounts receivable, accounts payable, and electric tariffs will be affected by inflation, and will in turn affect the economic NPV¹¹.
- **Fuel Costs.** Higher fuel costs will increase savings and hence improve the economic NPV. However, higher fuel costs also mean higher tariffs that depress demand. A smaller demand means smaller benefits for newly-connected customers.
- **GDP Growth.** Higher GDP growth will increase the demand for electricity and the per-customer consumption of electricity, which will in turn affect economic benefits to the newly connected customers, as well as the gain from reliability improvement.
- **Real Exchange Rate.** An increase in the real exchange rate will also increase the dinar cost of tradable investment items. This effect will reduce the economic NPV. However, as fuel costs are linked to the exchange rate, an increase in the real exchange rate will raise fuel costs, and hence savings from reduced power generation caused by loss reduction and curtailed pilfered consumption.
- **Alternative Power Supply Cost.** The economic value of electricity supplied to newly-connected customers depends on the estimate of the cost of an alternative power supply.

¹¹ Inflation affects the economic NPV because of its impact on the real amount of cash balances, accounts receivable, and accounts payable. Also, because of the impact of indexing lag, a higher inflation rate reduces real electric tariffs, which lower the average willingness to pay but increase the quantity of electricity demanded. The combined effects of these factors on economic NPV are uncertain.

Scenario Analysis

A one-at-a-time testing of variables is not a realistic way of making an account of the interrelationships between variables. Scenario analysis recognizes these interrelationships by allowing analysts to take account simultaneously of a number of variables.

Scenario analysis allows for interrelationships between variables, but it does not usually take into account the probabilities associated with each scenario. Probabilities can be assigned, but they are likely to be highly subjective and could be biased either in favor of or against a project.

Scenarios are based on a set of parameters, values of which are pre-defined by the analyst. There could be a number of scenarios, built on the “base” scenario but ranging from the “worst” to the “best” scenario. Even under the worst set of circumstances, the project has a marginal negative NPV (close to break-even), which suggests that the proposed project is indeed a robust project. Obviously, the “worst” and “best” scenarios are two extremes that are very unlikely to happen in practice.

The main limitation of this method is that it does not allow a representation of the probability of occurrence of each of the proposed scenarios, so that while delivering as much information as the sensitivity analysis (considering the correlation between different variables), it cannot be enough, since the number of variables and values for each that can be tested is limited.

What sensitivity tests and scenario analysis do not embrace is a probabilistic expression of a project’s returns. The two extreme sets of condition formulated in the “worst” and “best” scenarios are unlikely to occur, and most of the time some combination of parameters within the vicinity of the “base” scenario will materialize. The chance that the values of project outcomes will materialize exactly as estimated is practically zero. In order to look at project returns from a probabilistic point of view, the analyst should undertake a Monte Carlo simulation.

Final Comments

The project lifecycle and its phases play a key role in the success of a project. In these phases, information is gathered and necessary studies for the identification, formulation and appraisal of a project are done. The studies reduce the degree of uncertainty about investment decisions, thus allocating fiscal resources efficiently.

Given the importance of these phases, a series of recommendations and obligations to ensure that the project is formulated correctly is listed below:

1. The definition of the problem is essential in determining possible alternative solutions. Framing the problem as the lack of a good or service leads invariably to a unique solution and prevents the analysis of more than one alternative to the root problem.
2. It is necessary to understand that a problem in itself is not a project. A project comprises courses of action that arise from a given problem and provides a rational response to the problem.

3. When doing the diagnostic of the current situation, it is helpful to set a baseline for comparisons and benchmarking. This is essential for the ex-post evaluation of the project, which aims to verify whether the project has been a real solution to the problem.
4. The optimization of the base case (or without the project) should always be considered as one of the alternative solutions to the problem.
5. Always more than one alternative should be analyzed as a solution to the problem.
6. For the calculation of the benefits and costs of each alternative, the situation “without project”, or the optimized base case, should be considered the baseline for comparisons, thus avoiding over- or underestimation of benefits or costs.
7. It is recommended that the analysis of project alternatives be performed in the pre-feasibility study, as this involves looking at each alternative in greater detail and therefore increases the probability of choosing the best alternative to solve the problem. A modular analysis for each alternative is recommended.
8. The general criterion that governs this type of project is to meet demand by maximizing social NPV. This criterion also applies to self-generation systems or systems where there is rationing power for a certain number of hours a day.

In addition, financial analysis can be broken down into two parts: (i) Carrying out financial analysis to assess financial viability; and (ii) carrying out budget/resource analysis to assess financial affordability and sustainability. From the financial viability point of view, financial analysis is particularly important, when the decision involves the alternative of financing the project through the mechanism of private-sector participation (financial analysis from the perspective of ‘a project’ or ‘a project entity’). On the other hand, financial analysis from the financial affordability and sustainability point of view is important in ensuring sufficient resources for the correct operation of the project (budget/resource analysis from the perspective of government). This document is focused exclusively on the first point of view. The project’s financial viability in terms of budget/resource affordability will be part of later, updated versions of this tool.

This chapter has highlighted some key issues relating to project evaluation. The conceptual principles involved do not differ from those of other sectors, but particular features of the power sector mean that specific adjustments may need to be made in practical appraisals.

5. PROJECT EVALUATION

The financial and economic attractiveness of a project is determined by the net present value of its incremental net cash or resource flows. The NPV criterion is widely accepted by accountants, financial analysts, and economists as the only one that yields correct project choices in almost all circumstances. However, some investors have frequently relied upon other criteria such as a project's internal rate of return and the benefit–cost ratio.

The incremental net economic resource flow is the difference between total benefits and total costs, on a year-by-year basis. The values of the resulting annual net economic flow are then discounted to the initial year of analysis at the EOCK to compute an economic NPV of the project. If the economic NPV of the project is greater than zero, the project is potentially worthwhile to implement. This implies that the project would generate more net economic benefits than if the resources had been used elsewhere in the economy. On the other hand, if the NPV is less than zero, the project should be rejected on the grounds that the resources invested could be utilized better by the capital market.

When selecting among several alternatives, economic NPV criteria make it possible to choose the best combination of projects. Alternative projects with the highest NPVs should be selected first to maximize net economic benefits over time.

5.1. Evaluation Period

A period of analysis should be assigned when evaluating a project. This evaluation horizon will depend on the particular characteristics of the project. However, there are some recommendations to facilitate their determination.

- If there are several alternative solutions, a single analysis period must be set, for comparison purposes. If the most convenient alternative is chosen, a shorter period of analysis may be required in order to determine the profitability associated with the initial investment.
- It is recommended that a period equal to the life of the most important or representative items of the project be chosen (activities or equipment, for example).

Some items complete the analysis period with a surplus of life. It is necessary to incorporate this surplus life into the residual economic value (often considered a benefit received during the last year of analysis).

In the case of many electricity projects, it is suggested that an evaluation horizon be used equal to twenty (20) years; but in other cases, for example those of extension of the conventional network and self-generation projects based on hydro power, it is recommended that the project be evaluated in a thirty-year horizon (30).

Finally, it is suggested that a horizon of 10 years be used for other self-generation technologies:

- Generation by solar panels
- Generation with diesel generators
- Generation by wind turbine
- Hybrid generation, by a combination of the above.

5.2. Net Present Value Criteria

The NPV is the algebraic sum of the present values of the incremental expected positive and negative net cash flows over a project's anticipated lifetime. If this sum is equal to zero, investors can expect to recover their incremental investment and to earn a rate of return on their capital equal to the private discount rate used to compute the present values¹².

A NPV greater than zero means that investors can expect not only to recover their capital investment and to earn a rate of return equal to the discount rate but to receive an addition to their real net worth equal to the positive amount of the NPV. Only projects with positive NPVs are going to be beneficial and hence attractive to private investors. They are unlikely to pursue a project with a negative NPV unless there are strategic reasons.

The formula for computing the NPV of expected incremental net cash flows over n time periods with annual discounting is:

$$NPV = \sum_{t=0}^n \frac{CF_t}{(1+r)^t}$$

Where:

The incremental net cash flows (CF_t) could be negative, zero, or positive.

r is the discount rate equal to the cost of capital.

The sigma sign (Σ) is the symbol for summation.

The NPV formula can be written out in its component present values of the annual net cash flows, as follows:

$$NPV = C_0 + \frac{CF_1}{1+r} + \frac{CF_2}{(1+r)^2} + \dots + \frac{CF_n}{(1+r)^n}$$

The net present value criterion can be stated in the form of a set of decision rules.

Decision Rule 1: Do not accept any project unless it generates a positive NPV when discounted by a discount rate equal to the opportunity cost of the funds.

Decision Rule 2: To maximize net worth, choose among the various projects, or scenarios of projects, the one with the highest NPV. If investment is subject to a budget constraint, choose the package of projects that maximizes the NPV of the fixed budget.

Decision Rule 3: When there is no budget constraint and when a choice must be made between two or more mutually exclusive projects, e.g. projects being considered for the same building site, investors who seek to maximize net worth should select the project with the highest NPV.

¹² The recovery of the invested capital is anticipated when $NPV \geq 0$ because the incremental capital expenditures are included in the initial negative net cash flows.

These rules follow from the definition of the NPV, namely the algebraic sum of the present values of the incremental expected positive and negative net cash flows over a project's anticipated lifetime.

5.3. Internal Rate of Return Criteria

By definition, the internal rate of return (IRR) is the discount rate (ρ) that sets the NPV = 0 in the following equation:

$$\sum_{j=1}^n \frac{CF_j}{(1+\rho)^j} - I_0 = 0$$

Where:

CF_j = the incremental net cash flow in year j to total, or equity, capital.

I = the initial investment.

ρ = the IRR. We have to solve for ρ .

This definition is consistent with the meaning of a zero NPV as explained in the previous section, namely that investors recover their invested capital and earn a rate of return equal to the discount rate, which is the IRR. The internal rate-of-return criterion can be stated in the form of a set of decision rules.

Decision Rule 1: Do not accept any project unless its IRR is greater than the opportunity cost of the funds (accept project if $\rho > r$, the opportunity cost of capital; otherwise, reject). The opportunity cost of capital is measured by the cost of funds or the expected rate of return offered by other assets equivalent in risk to the project being evaluated.

Decision Rule 2: When a choice must be made between two or more mutually exclusive projects, investors should select the project with the higher, or highest, IRR.

5.4. Final Comments

Beyond the scope of this technical document, when there is inter-dependence in the system, the electricity investment program has to be analyzed as a package (known as the systems approach). In such a case, isolating the benefits is difficult because of the interdependency of various components in the system to produce final outputs.

Finally, it should be noted that financial and economic analysis represents a guide for decision-makers and does not represent a decision in itself. The evaluation approaches proposed in the chapters above are just an input to the policy process that the projects undergo.

6. FINAL COMMENTS

This document is a simplified tool to technically guide the process of project formulation and project evaluation for electricity projects. Therefore, and because it is a technical document, the methodology does not describe the roles and administrative responsibilities of the public investment process. This description must be part of the rules and procedures of the PIM system.

Project evaluation is a tool for decision-making that allows a determination of how suitable it is for society to invest in various initiatives when resources are scarce. Usually, this "convenience" is understood from the economic point of view as a measurement of the costs and benefits of competing projects, leading to the prioritizing of those projects whose expected economic benefits are the highest.

Comparing the total costs (investment and operation) of a project with its benefits allows public authorities to decide if that project has the potential to make a real contribution to the wealth of the country. Thus, project evaluation allows them to: i) Identify the criteria for investment policies that maximize social welfare; ii) stop "bad projects" and promote those that are "good"; iii) define whether it is the public sector that should implement the project, or the private sector; iv) estimate the fiscal impact of the project; v) establish agreements for desirable cost recovery; and vi) assess their impact on the environment, regional development and poverty, among other things.

Finally, it is important in many cases to conduct a financial analysis in order to obtain the economic (efficiency) prices on which to conduct an economic analysis. For this reason, it is recommended that both analyses (financial and economic) be made in order for good information to be provided on decision-making about public investment projects.

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