DEVELOPMENT TOOL FOR REGULATORY EVALUATION OF INVESTMENT IN EXPANSION OF BRAZILIAN DISTRIBUTION SYSTEMS

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ABSTRACT

This article presents a methodology that evaluates the distribution system investments in a regulatory point of view. The objective is providing to the planner real economic and financial indicators associated with the works and investment plans. This could support the decision making of the company as it shows different scenarios and investment options. The system analysis the regulatory profitability determined by the methodology of ANEEL (Brazilian national agency of electric energy). Furthermore, it takes into account the remuneration rules of investments set out in the current regulation, which are points used as inputs for the payback calculation of investment (with accounting and financial concepts). Additionally, the works budgeting is performed through the costs associated as construction modules methodology. After the investments technical and economic analysis, it is determined the distributor's investment plan. The proposed environment was validated in a case study for the "Porto Velho" area (RO- Brazil).

INTRODUCTION

The recent technological advances with regulatory requirements demand process improvement. The increase of new techniques and new evaluation procedures are important to ensure tools for system planning.

The ARIES system was developed in Java comparing the existing methods with the rules of the new regulatory environment.

It was assessed the minimum requirements for application of the models, as available data, regulatory definitions, etc.

The developed module comprises the comparing costs of company standards with the costs of ANEEL, proposal of better work alternative, considering technical and financial parameters and preparation of the investment plan.

Among the input data to be processed, there are: the work alternative; construction company standards; loading, voltage, losses, ENS (energy not supplied), indicators (SAIDI and SAIFI); the company's price bank and works cost; alternatives to be analyzed; technical register - georeferenced system (GIS); constructive modules standardized by ANEEL; prices bank defined by ANEEL; e recognized value by ANEEL for each alternative, with reference to the constructive modules and the prices bank established by ANEEL, if any.

To support the analysis of this module, it was made available to all Eletrobrás companies, a SINAP tool, containing analysis modules and electrical calculation, with diagnostic functions, losses calculation, expansion of the distribution system and technical and economic analysis.

METHODOLOGY

ARIES

The developed system aims to build the company's investment plan, based on the evaluation of alternative works that address fully or partially the technical problems encountered in this.

Therefore it was necessary to develop models using the data available within a framework that considers technical aspects, the planned costs and the costs recognized by ANEEL. The result is the evaluation of the alternatives that generate the highest technical and economic benefit.

Module Overview

Figure 1 shows the investment plan overview of development module. This module is divided into sub-modules as the description presented below:

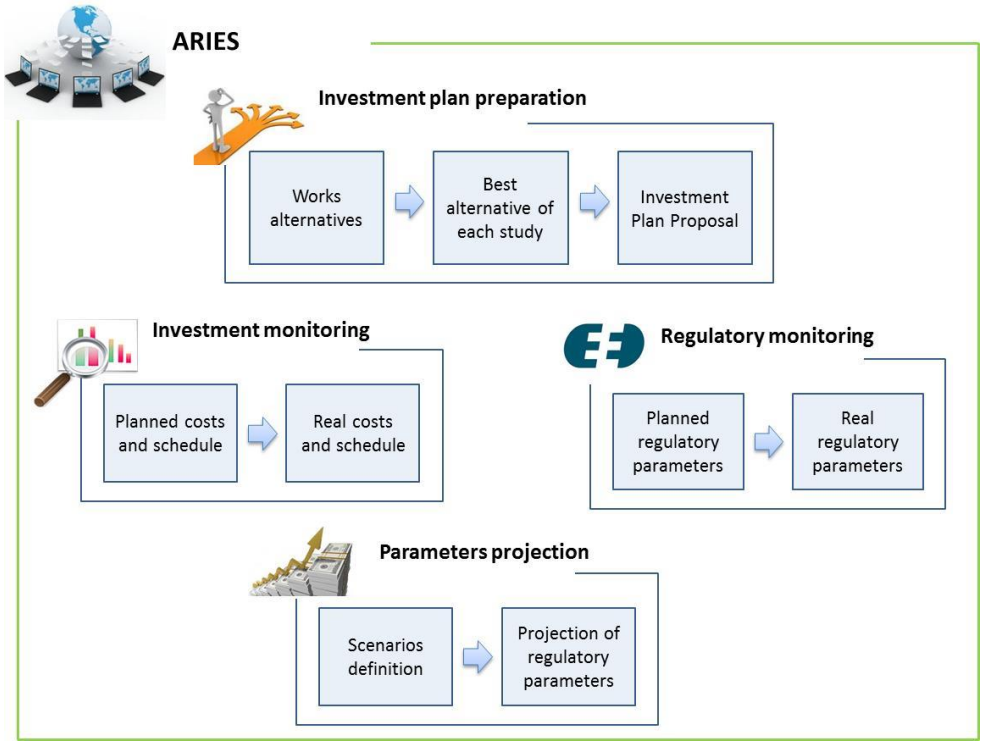

Figure 1. Planning Module Overview

- Technical Evaluation of Planning Alternatives: In Eletrobrás case, the systems used are the ANAREDE, owned by CEPEL, and the SINAP system, owned by Sinapsis. This last one consists of georeferenced system that allow the technical evaluation of planning options through the benefits related to technical losses, system reliability, voltage profile, Energy Not Supplied (ENS), etc. The ARIES system was integrated to these technical tools.
- Regulatory profitability: In this sub-module it is registered building standards used by the distributor. Furthermore, it is registered the prices bank and financial parameters required for the calculation of regulatory revenue.
- Budgeting: This sub-module is responsible for the budget of the alternatives works based on the purchase and installation price of equipment. This model is based on building standards for future comparison with regulatory costs.
- Investment Plan: This sub-module performs the formation of the concessionaire's investment plan based on the information provided by other sub-modules. Therefore, the technical, economic and regulatory evaluation of each alternative work is performed by comparing the benefits and costs associated with each study carried out by the company. The user in possession of all this information, select the alternatives that should make the investment plan.

The flowchart of Figure 2 shows the sequence of steps to perform the analysis and subsequent formation of the concessionaire investment plan. The formation of the building standards is made in advance and thus does not compose the main flow of activities.

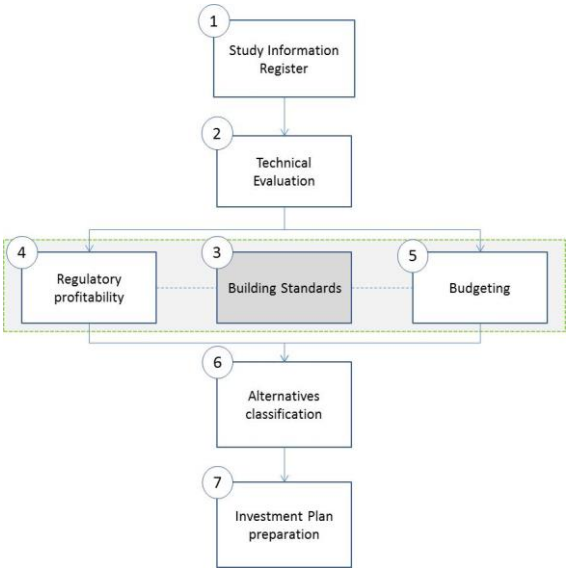

Figure 2. Planning module flowchart

The first step corresponds to the planning studies register, the alternatives for each study and works for each alternative. The second step is the alternatives technical evaluation using the ANAREDE and SINAP tools. The alternatives that solve the technical problem must proceed to the economic and regulatory review. On the

next step it is conducted regulatory analysis and budgeting of planning alternatives (interconnected by the methodology of building standards). From these analysis, it is inferred the planning options classification for each study. Finally the user defines which planning alternatives comprise the company investment plan.

Step: Information Register

Each technical index or operational need on the grid should be analyzed through a study. Figure 3 illustrates the process of conducting a study by the concessionaire.

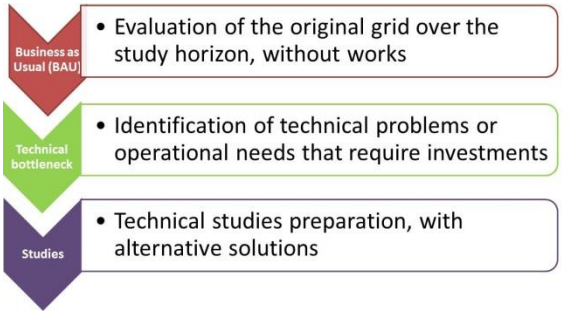

Figure 3. Technical studies flow

Each study consists of solution alternatives, and each alternative is made up of a works list. Figure 4 illustrates the hierarchy of a study.

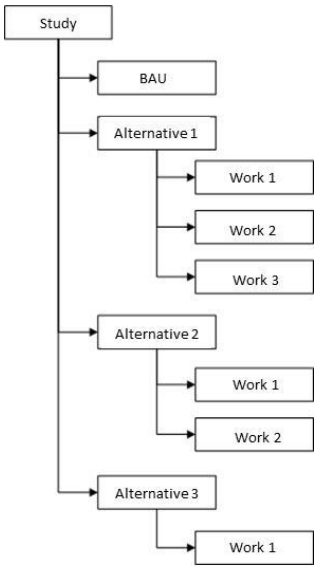

Figure 4. Study hierarchy

The grid BAU (Business as Usual) corresponds to the original grid (without works inclusion).

The first task is the studies and alternative works registration. The study must be related to technical problems or grid expansion to meet new consumers.

The studies and alternative register may be made in the planning system or SINAPgrid tool, and then imported into the ARIES system with the technical reviews of the alternatives, with the installed equipment and the schedule work activation.

Step: Technical Evaluation

The first task for works technical evaluation is to prepare the grid by SINAP system.

Figure 5 shows the representation of this task.

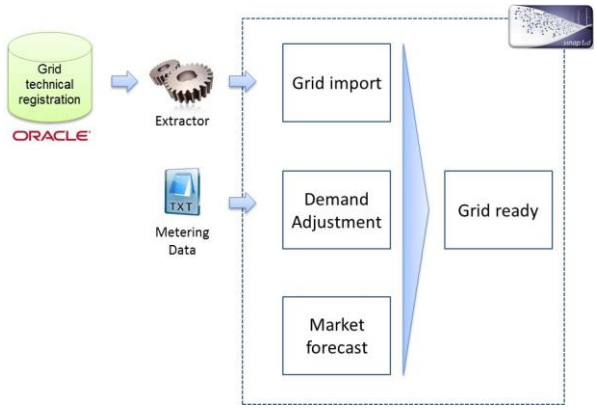

Figure 5. Grid preparation

The second task is the grid analysis. Within the SINAP, it is possible to build, simulate and implement the technical evaluation of alternative works, serving one or more specific technical criteria.

For each work registered, it should be reported the work identification, the work type, the special obligation percentage, the dates for kick off and operation works and building standard that will be installed on it.

The data export from SINAP is sent through Web Services to ARIES.

This integration should contain the following required information for each study: study, alternatives and work description; work date; special obligations; standard list of each piece built, action identifying, among others that are needed for the calculations in ARIES environment.

Step: Building Standards

The equipment quantification must be performed considering the diverse systems to which ARIES integrates, the revenue evaluation model and works costs.

For the evaluation of regulatory revenues and the distributors costs, it is used the concept of ANEEL constructive modules, which aggregates equipment for the evaluation of works regulatory costs.

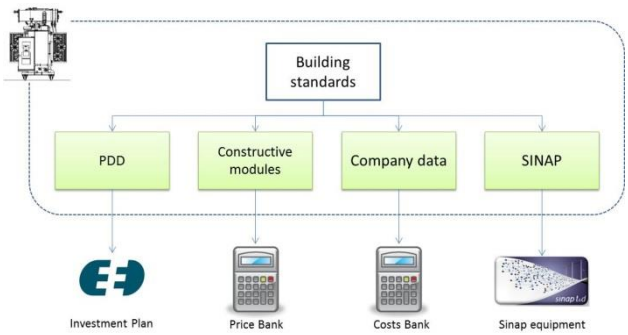

Figure 6. Required information for building standards

For each module, it is provided: the technical characteristics of the register units that make up the module, the module illustrative design, and the table with the list of main equipment and its registration units, minor components and additional charges.
Constructive module consists of:

- Equipment of each registration unit;
- Minor components percentages;
- Construction sub-modules
- Additional costs percentage
- Activities related to additional costs, formed by work teams.

The formation of Building Standards will be conducted through instances representing the aggregation level and the relationship between systems and external variables.
The first instance is the maximum aggregation level and it is named as "Building standard". Usually this instance will be linked to equipment and SINAP grids. Still, the connection with SINAP does not prejudice the other equipment registration that is not related to SINAP.
The second is related to modules classification types in PDD (Distribution Development Plan) and it is named as "PDD Standard". This instance is linked to the first and it is a lower aggregation level ("Building Standard" may contain one or more "PDD Standard").
The third is related to the constructive modules and it is named as "Constructive Module". This instance is linked directly to PDD Standard, and one PDD Standard may be related to one or more Constructive modules.
The fourth is related to the equipment of the Constructive Modules and therefore it is named as "Module Equipment". This instance is linked with the Constructive Modules in a ratio of one to many, that is, a module will consist of one or more of Module Equipment.
This instance will be linked to the Benchmark Price Bank for Electricity Sector (SISBASE), assessing the regulatory cost of assets. Moreover, it is linked to the modular costs bank of the company that will value the real cost of installation of the distribution assets.
Figure 7 presents a summarized version of all proceedings in the formation of a building standard of a distribution grid.

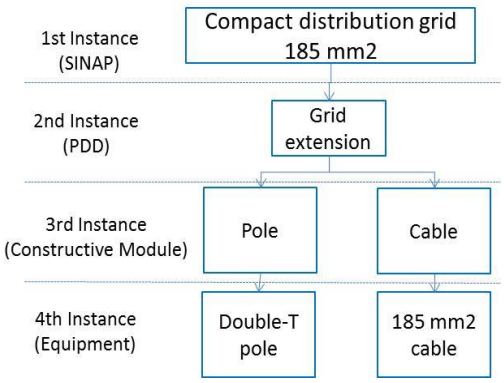

Figure 7. Instances of building standard of a distribution grid

Step: Profitability Regulatory
This step serves to determine the regulatory costs of the works.
These costs are determined by the methodology of constructive modules ANEEL and are used as input for the calculation of the regulatory asset investment. This calculation includes asset depreciation, new replacement value (VNR), market value in use (VMU) and regulatory return rate.
The equipment depreciation rate is defined in the Asset Control Manual of the Electricity Sector (MCPSE). It is calculated from the expected useful life of the equipment. This depreciation will set the velocity in which investments are amortized, which is operationally realized through the regulatory asset share.
Each depreciation rate is linked to a unit type.
Furthermore, the regulatory return on investment is calculated for each work involving substations, the substation utilization index (IAS), which assesses the prudence of the investment and their respective incorporation into the regulatory asset base of the company.

Step: Budgeting
The works budgeting will be conducted through modular costs related to methodology of constructive modules.
Each equipment must have its value obtained from purchase records entered in the accounting systems of the company. The minor components, additional costs and interest on works in progress will be treated individually in each module.
The distributors should determine disbursement schedule of the actual company costs.

Step: Alternative classification and Investment Plan
These steps will be performed the profitability evaluation of the work for each alternative and study. After, the alternatives that had the best performance should be chosen to form the company works plan (investment plan).
The evaluation of each alternative will be made through a cash flow, incorporating the revenue from the sub-module "Regulatory Profitability" and costs from the sub-module "Budgeting" dealing with the real costs of equipment acquisition.
Assets that have not yet been fully depreciated in the study horizon will be treated through its residual cost, which includes the market value of the asset in use at the end of the horizon. This methodology allows designs to be evaluated with different values lifetime and removes the effect of a limited horizon.
The evaluation of an alternative will be performed using the Net Present Value (NPV) and Internal Rate of Return (IRR).
The company must then define the planning options for each study that will comprise the works plan. After the investment plan formation, it is calculated a new cash flow evaluation of the plan's profitability as a whole.

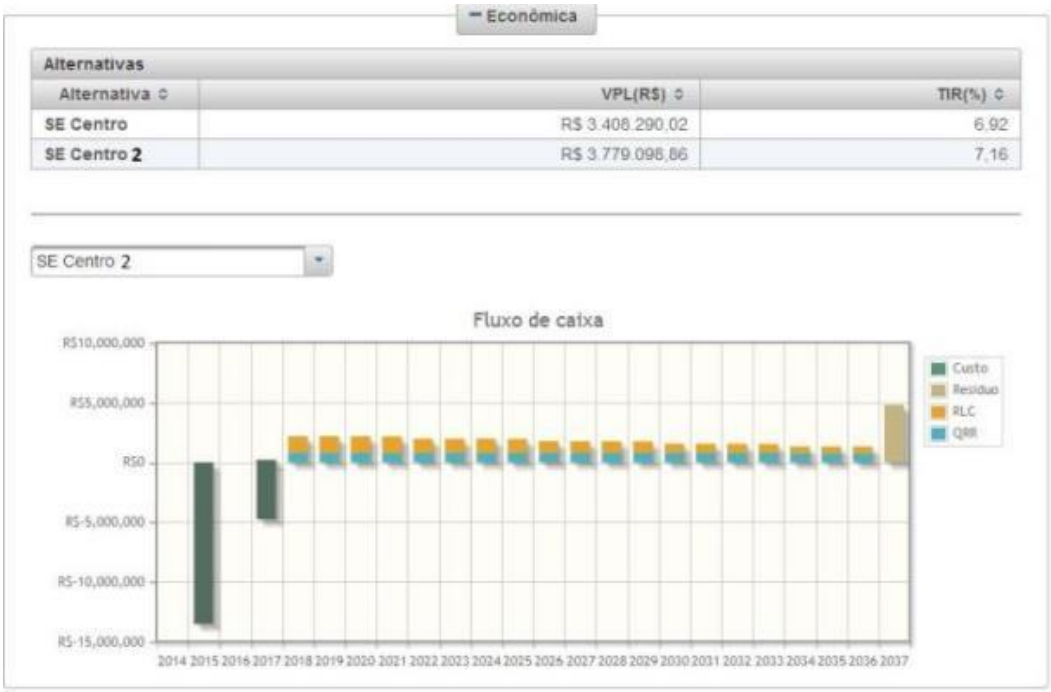

Figure 8. Evaluation of Porto Velho in ARIES tool and cash flow for alternative 2 (the best)

Case Study

Porto Velho (Rondônia-Brazil), in the covered area of Eletrobrás distribution company was chosen to a pilot application.

First of all, it was drawn up the substations of Porto Velho city. Subsequently, it was held the data diagnosis and raised the input files for the SINAP simulation environment.

Then there were two alternative proposals: Construction of Center Substation (3 transformers of 20/26,6MVA) with charge transfer suggested by Eletrobras (Alternative 1); and construction of the Center Substation (2 transformers of 20 / 26,6MVA) with transfer load map suggested by the influence map (algorithm from Sinap) and the third transformer entering in 2017 (alternative 2).

Finally, the same input data were taken into consideration in ARIES. It can be seen in Figure 8, that the alternative 2, where the main difference is the offset in time of the third transformer, has the advantage in view NPV (VPL in figure) and IRR (TIR infigure).

CONCLUSION

Distribution companies are subject to regulatory rules that define the required revenue to pay the investments made in the expansion and improvement of the system. These rules follow methodologies defined by ANEEL and applied in times of tariff review. It is therefore vital for ensuring the financial health of companies, conducting economic evaluations that reflect these methodologies and can give the company a precise notion of the real return on investment. This support decision making for a plan that, in addition to remedy violations of technical indexes and ensure adequate expansion of the system may allow the concessionaire to receive remuneration according to regulatory environment.

In this scenario, this paper presented a computer system that assists in the planning process of the electricity distribution company, aimed at not only technical analysis. With the system in question, it is possible to have a greater sensitivity of investments to be made by the distributor and ponder another perspective, the economic-regulatory. The software provides the user, an idea of how your investment will be recognized in accordance with ANEEL methodology and so gives conditions for a better balance in the decision of the investment plan. Finally, a case study was presented, in a region of great importance in the Eletrobras area to validate the developments performed.

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