

ESD.934, 6.974

Engineering, Economics and Regulation of the Electric Power Sector

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Homework HW3

Question 1. The distribution activity in the system of your choice.

(Note that the idea is that you gradually build a document, piece by piece, on the regulation in the power system that you have chosen. At the end of the course you will be asked to place all the pieces together in a single document, without much special editing, but where you can show that you have a sufficient understanding of the functioning and regulation of this system).

Here you have to describe the distribution regulation in the power system of your choice, taking into account the topics that have been presented in module C. The following procedure is suggested:

- Find in the corresponding Electricity Act (or the highest level norm that applies) those articles that correspond with the distribution activity and its regulation. Then also find the secondary regulation (e.g. decrees, ministerial orders, technical regulations) that develops in more detail the regulation of distribution. You may comment on the following topics:
 - (Again) Distribution companies in the country: number, size (type and size of the supplied region and number of customers), private or public ownership.
 - Legal procedures that govern the exercise of the distribution activity: distribution licenses and specific conditions; accounting, legal or ownership unbundling; administrative procedures to authorize distribution installations, etc.
 - Mechanism for setting annual distribution revenues: cost of service regulation, or price cap, or revenue cap formulas. The procedures that the regulator uses to establish the remuneration in each rate case or price control period.
 - Tariffs. A first idea on how distribution revenues are reflected in the final customer tariffs. Any network connection charges.
 - Quality of service. Is there any explicit quality of service regulation? Are penalties or credits being applied to the distribution company if it does not meet or exceeds any prescribed quality standards?
 - Network losses. Is there any mechanism implemented to provide incentives to distribution companies to reduce network losses? If this is the case, what

procedure is followed by the regulator to set the level of standard network losses?

- Distributed generation. Has any specific regulation been developed to connect distributed generation to distribution networks? Do distributed generators pay connection or use-of-system charges? Which are the most relevant issues that affect distributors regarding connection of distributed generation?
- Provide the list of relevant references that you have used to answer this question.

It is understood that it may be difficult in some cases to find the documents (when they exist) that contain the necessary information to answer these questions. We have not covered tariffs in class yet, so the necessary background has not been provided. Make your best effort; explain what you have obtained and, if you have not found enough information, answer the questions by explaining what you consider that should be done, instead of what is actually done. Make it clear when you describe what exists or when you are presenting what you recommend to do.

Question 2

Propose an incentive scheme for distribution companies to optimize the level of network losses. You can obtain inspiration from the incentive scheme for quality of service that was described in class.

Question 3

The provided EXCEL spreadsheet shows a simplified version of the process of computation of the remuneration of a regulated electricity distribution utility under a method of RPI-X with revenue cap. The time interval for the price control is 5 years.

INPUT DATA:

The input data for the spreadsheet are in red colour in the spreadsheet itself:

- Equity: % of the rate base of the firm that is owned by its shareholders.
- Debt: % of the rate base of the firm that has been borrowed.
- Rate of return on equity: r_e
- Rate of return of the debt: r_d
- Tax percentage: % of taxes that is applied to the benefits before taxes (BAI, beneficio antes de impuestos).
- Rate base on the initial year.
- Economic life of every item in the rate base: this is the number of years that are assumed to be needed to depreciate the assets.
- Investments: estimated increments of the rate base.
- RPI: estimated retail price index (inflation) in %.
- Δ Demand: estimated percentage of annual increment of the volume of distributed electricity.
- Estimated annual Operation & Maintenance costs (O&M costs).

THE COMPUTATION PROCESS:

The annual costs for year n are computed with the equation:

Total costs (n) = O&M costs (n) + Depreciation (n) + Rate Asset Base (n-1) x WACC (before taxes)

To start the process, one has to fix or compute the remuneration (revenues) for the first year (year 0), which can be assumed to be equal to the annual costs for that year. Next, the revenues (or the revenue caps) for the following years 2 to 5 are computed using the equation below:

$$R(n+1) = R(n) \times (1 + RPI - X) \times (1 + \alpha \times \Delta Demand)$$

where you have to discuss what is the proper utilization of the parameter α and the increment in demand $\Delta Demand$ in this spreadsheet.

The adjustment parameter X (named the “efficiency factor” in most of the literature on RPI-X) is determined so that the total net present value (NPV) of the maximum allowed annual revenues (the “revenue cap”) for all years of the price control period is equal to the NPV of the annual costs estimated by the regulator for the same period.

Next, the spreadsheet (*for illustrative purposes about the basic features of accounting of a company and to describe some of the assumptions in the Excel spreadsheet*) presents the Profit and Loss account of the firm. It can be verified that the NPV of the benefits after taxes (BDI, “beneficios despues de impuestos”, in Spanish) coincides with the NPV of the remuneration of the equity with the established rate of return before tax ($r_e=10\%$).

Finally, the spreadsheet shows the annual financial situation of the distribution company: Note that the cash flow generated each year by the company is devoted to pay for the costs of new investments and to reduce debt (while maintaining the same equity to debt ratio). Any remainder is devoted to pay dividends.

THE QUESTIONS TO BE SOLVED:

1. Examine the role of the factor $(1 + \alpha \cdot \Delta D)$ in the equation above. Is it used properly here? How should it be used, if at all? How do you think that an appropriate value of α (0.41 in the spreadsheet) should be determined for a correct utilization of this equation?
2. Modify now the spreadsheet by setting α to zero, so that the term $(1 + \alpha \cdot \Delta D)$ does not have any effect on the outcome. Determine the value of X by playing with the Excel spreadsheet (it has been given an initial value of 0). Which is the rate of return of the equity (benefit of equity after taxes / equity) for the company?
3. What do you think of the equation that has been used in the spreadsheet to determine the Operation & Maintenance costs? Assume now that the regulator estimates that efficient O&M costs should be 50, 50.5, 51.0, 51.5 and 52. Which should be the value of X? Would you expect X to be larger or smaller now? Why?
4. In the spreadsheet of the preceding point 2, which is the correct value of X if the regulator establishes that the economic life of the assets should be 20 years? Would you expect X to be larger or smaller now? What is the new value of X?

5. Assume that the regulator establishes a value of X that is equal to what was determined in bullet 2 above. However, in reality the demand growth is different from what was estimated a priori (4.0, 3.5, 3.0, 3.0 and 3.0 percent), with the actual values being 4.0, 4.5, 4.0, 4.0 and 4.0 percent. Then what should the allowed revenues of the distribution company be for each year of the control period? Which is the new rate of return of the equity (benefit of equity after taxes / equity) for the company?

DIRECTIONS:

- The answers to the questions (not your excel spreadsheets) above have to be handed in. Provide clear and concise answers, with some explanation on how you have reached the solutions, but not the spreadsheet with numbers.

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