

ESD.934, 6.974

Engineering, Economics and Regulation of the Electric Power Sector

Ignacio J. Pérez-Arriaga

Homework HW6

Question 1. Transmission regulation in the system / country of your choice.

Describe the regulation of the transmission activity in the country or system that you have chosen. Organize your answer by addressing the following issues:

- Select within the corresponding Electricity Act (or the highest level norm that applies) those articles that correspond to the functioning and regulation of the transmission activity.
- Identify the secondary regulation that describes in more detail the rules and organization of the transmission activity:
 - Investment: How is the transmission network planned? Who is responsible for preparing / approving the plan? How is the transmission activity remunerated? Does this scheme correspond to any of the approaches discussed in class?
 - Pricing:
 - A) Is there any impact of the network on the energy prices? How is the transmission network taken into account in the determination of the energy prices and the dispatch of the generators?
 - B) How are the transmission tariffs computed? Is there any locational signal or time differentiation in the transmission tariffs?
 - Access:
 - A) What method of generalized (and local, if different) congestion management is used in your system?

For each one of these items include a brief description that can be sufficient for somebody who does not know this market to understand how it works, ignoring the details. Give your opinion on the adequacy of the approach with respect to sound regulatory principles.

Provide the list of relevant references that you have used to answer this question.

If, for some reason, you do not find information on your system to answer any of the items above, do your best effort in filling the gaps with your opinions (please, indicate explicitly when you are not describing what actually happens in the system of your choice).

Question 2. Transmission regulation proposals for specific case examples

There is still an on-going debate concerning some critical issues in the regulation of electricity transmission. Cost allocation (i.e., the design of transmission charges) is one of these issues. How necessary or useful it is to send economic locational signals to existing and / or future market agents? What are the criteria to design these signals?

The following case studies try to show the difficulties in adapting the general regulatory principles for transmission pricing to the specific cases of each particular case or power system and, how, in case of doubt, one should try to deviate as least as possible from those principles. You have to show that you understand the basic principles and that you have dedicated some time to think of the problem. There may be no perfect solution to any of these cases.

CASE 2A. Backbone transmission project in Central America.

The figure below depicts a major transmission corridor (the SIEPAC line) that is presently being built linking six Central American countries. A major issue related to the construction of this line was the design of the transmission charges, i.e., what the network users in the different countries have to pay to cover the total costs of construction plus operation & maintenance of the line.

The initial proposal for transmission pricing of the SIEPAC line was to charge its cost to any international transaction whose flow of power would use any fraction of the capacity of the line. Some electrical-engineering-based algorithm would be used to determine the power flows associated to any given transaction.

Question: What do you think of this pricing proposal? If applied, what do you think would be its impact on the regional market?

Central American Electricity Market

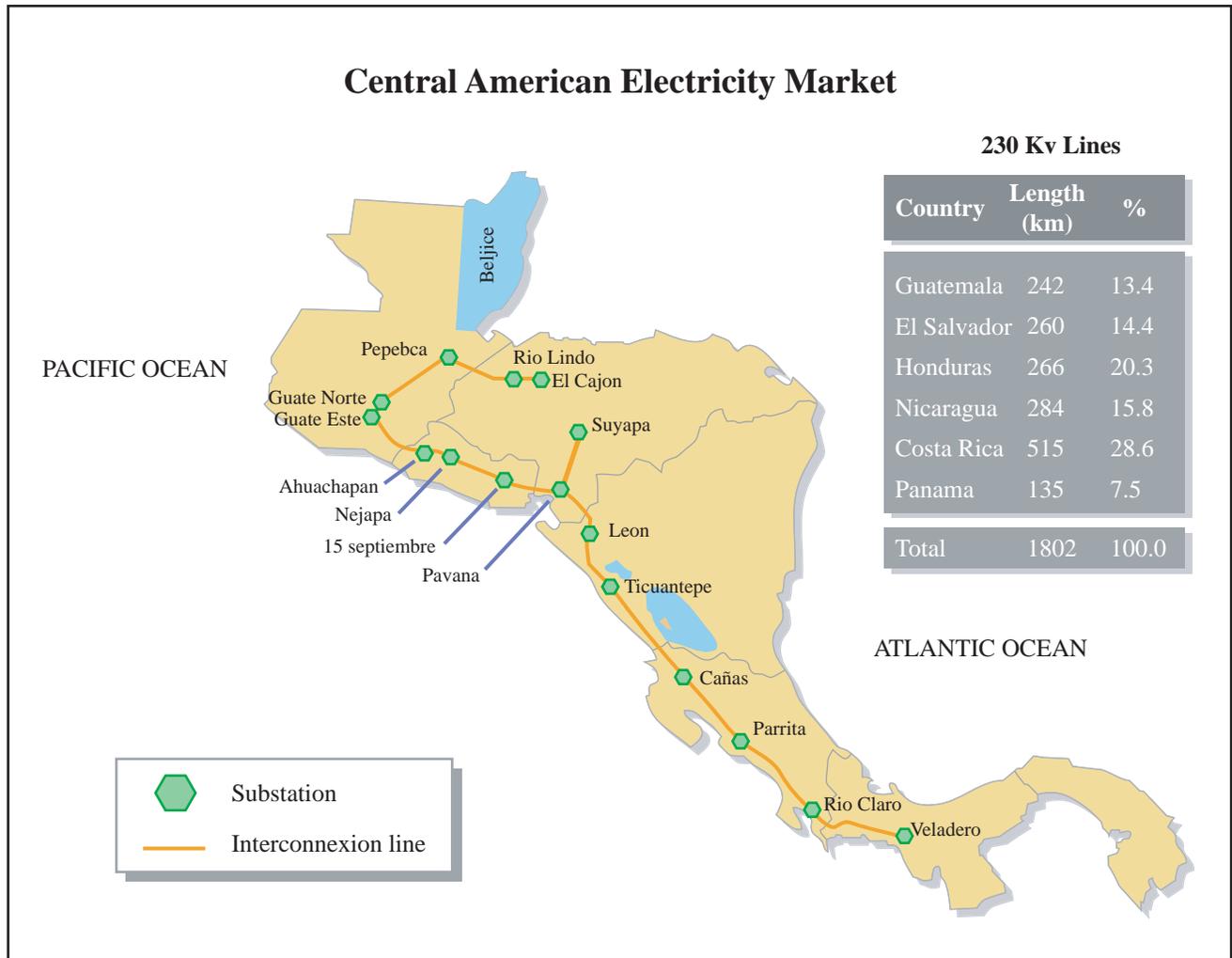


Image by MIT OpenCourseWare.

CASE 2B. Wind in the North Sea.

The North Sea Offshore grid project is estimated to connect 70 GW offshore wind and have an investment cost of €30 billion.

The following financial calculations have been made for the grid project: If it is assumed 1800 hours/year of power factor (it seems quite low) and an actualization rate of 10% for the cost of capital, the investment could be recovered in 20 years by a charge of about 30 €/MWh to any MWh that is exported from the off-shore wind generators.

The regulator decides to apply 50% of this charge to the generators and the other 50% to the consumers who import the power from the off-shore generators. Let us assume that these consumers are located in The Netherlands. However, it happens that the average price of the electricity in the wholesale market in The Netherlands is about 40 €/MWh, so the transmission charge would discourage buying from the off-shore wind generators. Is there anything wrong with the transmission pricing rule that is proposed by the regulator?

CASE 2C. Wind in MISO.

From the news in the press (Nov. 18, 2009):

"The American Wind Energy Association (AWEA) is turning primarily to Midwest governors, FERC, state regulators and other policy makers rather than the Midwest ISO (MISO) stakeholder process to rectify what the association says is a setback after FERC approved an interim transmission cost allocation proposal for the MISO market that will dramatically increase wind developers' costs of interconnecting new generation, says an AWEA official.

The official with AWEA, the national wind industry association, says the group will continue to participate in the MISO stakeholder process, but fears it is "doomed to failure" because member utilities will seek to obstruct new lines that threaten to devalue their generation assets. Thus, the wind industry group will direct the bulk of its advocacy efforts toward Midwest governors and others policy makers to influence the process. "The main goal is to get that long term policy right," the official says.

On Oct. 23, FERC approved a MISO interim proposal for spreading costs associated with network upgrades that are needed to accommodate new generation interconnection. Under the new scheme, generators will pay 100 percent of the interconnection costs for lines below 345kV and 90 percent for facilities at or above 345kV (with the extra 10 percent paid by all of MISO), a cost that is too high for the wind generators, AWEA contends.

This new cost allocation scheme dramatically changes the previous methodology in MISO under which generators paid for approximately 50 percent of the upgrade costs and the local utilities paid the other 50 percent.

© EnergyWashington.com. All rights reserved. This content is excluded from our Creative Commons license. For more information, see <http://ocw.mit.edu/fairuse>.

Question: What do you think of this new decision by FERC? What basic principles should the regulator use to address this problem?

CASE 2D. Wind in Spain.

Propose the regulation for transmission network investment that you consider is most appropriate for a country as described below:

Part 1.

- Spain has more or less a rounded shape and, although there are several major load centers, it can be assumed that the electricity demand is more or less evenly distributed. The transmission network is well meshed and in 1997 there was no need for important or very expensive new transmission investments. The cost of transmission represents about 5% of the total cost of electricity. Let us assume that demand grows 3% per year.
- Generation and supply have been liberalized, and a complete unbundling among regulated and competitive activities has been achieved. There is a Transmission System Operator that acts as System Operator and also owns transmission assets.

Question 1: The issues to be decided are: What is in your opinion the best regulatory approach to make decisions about the investments in transmission network facilities in this country, how this investment should be remunerated and the basic guidelines on how to charge this cost to the network users.

Part 2.

- A new situation appears in the early 2000s. Demand of electricity was growing fast, at a rate of about 5% per year, and the peak load was growing even faster. There were many potential investors in new CCGT power plants, all of them requesting connection to the network and environmental authorization permits. Although it was clear that most of this potential investment would not materialize, it is not known which among the new proposed new plants will be built and which ones will not.
- At the same time, as a result of a successful policy of promotion of new renewable resources, there were a very large number of applications of new connections to the network for wind farms. Again, most of them are not expected to take place, since in many cases the applicants just want to have the paperwork ready so that the site could be later sold to a wind farm developer. But it is also true that many wind farms were built at the time (and now).
- Therefore, the most adequate development and the additional cost of the transmission network will be highly dependent on the volume and location of the new CCGT power plants and wind farms that will be built.

Question 2: Would you change the recommendation on transmission investment and pricing that you gave in question 1?

CASE 2E. New hydro in Peru.

The country is large and 50% of the demand is concentrated around the capital. There are other two or three major load centers and the remaining demand is small and dispersed. The transmission network is neither well meshed nor developed and there is much need for some new lines to alleviate frequent congestions. There are several large gas fields and good hydro sites, but all of them are removed from the large load centers. The cost of transmission represents about 15% of the total cost of electricity. The government looks for foreign investment to develop the transmission network.

An investor is considering building a new hydro plant 250 km from the country's capital, where the demand is growing fast. A new line 200 km long would be needed to connect the new plant to the main transmission grid. On the other hand, a new pipeline is supplying natural gas to the capital, so that there is the possibility of building gas power plants nearby.

The country needs foreign investment to develop its energy infrastructures, such as power plants and transmission lines.

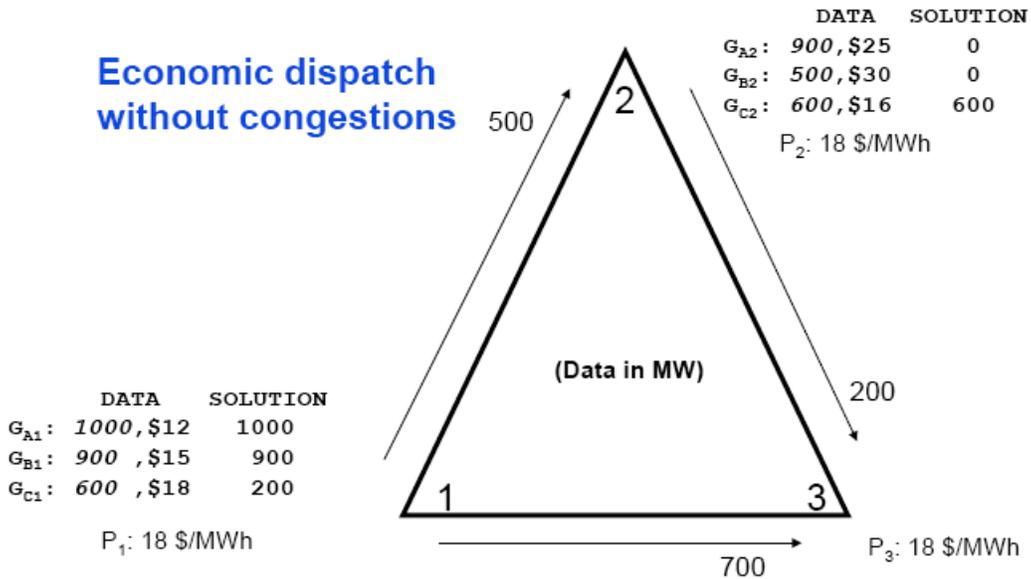
Question: How would you charge the cost of the 200 km line?

These two documents provide some background in relation to these case studies. They can also be used for further reading:

- “A comprehensive approach for computation and implementation of efficient electricity transmission network charges”, by Luis Olmos and Ignacio Pérez-Arriaga, IIT-working paper, 2008, Comillas University.
- PJM, “A survey of transmission cost allocation issues, methods and practices”, March 2010.

Question 3. Computation of nodal prices

This is the solved case of the optimal generation dispatch, electricity flows and nodal prices in a simple three-node example without any network constraints¹.



Same demand of 900 MW in the 3 nodes

Same impedance in the three lines

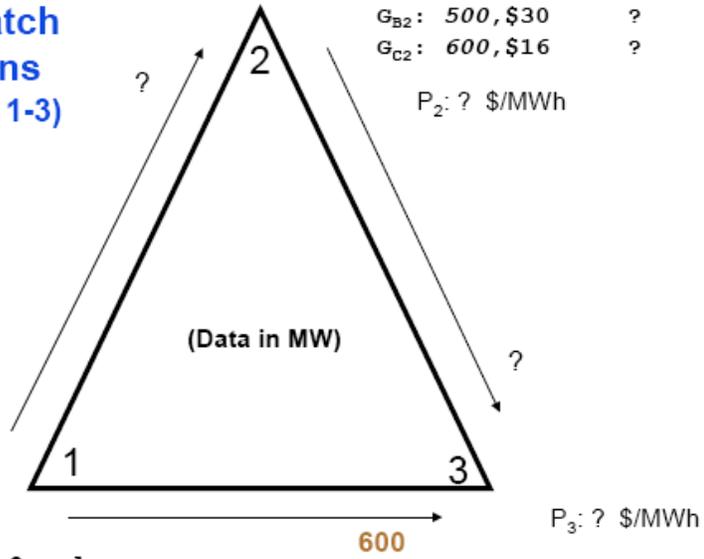
Question: Find the value of the nodal prices in the figure below, when the line 1-3 has a maximum capacity of 600 MW. Give also an intuitive explanation to the values that you have obtained.

¹ Remember that the impedance of the line is a generalization in alternating current of the concept of resistance in direct current.

**Economic dispatch
with congestions
(600 MW in the line 1-3)**

	DATA	SOLUTION
G_{A1} :	1000, \$12	?
G_{B1} :	900, \$15	?
G_{C1} :	600, \$18	?

P_1 : ? \$/MWh



	DATA	SOLUTION
G_{A2} :	900, \$25	?
G_{B2} :	500, \$30	?
G_{C2} :	600, \$16	?

P_2 : ? \$/MWh

P_3 : ? \$/MWh

**Same demand of 900 MW in the 3 nodes
Same impedance in the three lines**

MIT OpenCourseWare
<http://ocw.mit.edu>

ESD.934 / 6.695 / 15.032J / ESD.162 / 6.974 Engineering, Economics and
Regulation of the Electric Power Sector
Spring 2010

For information about citing these materials or our Terms of Use, visit: <http://ocw.mit.edu/terms>.