Three Essentials of the Electric Grid: Business, Regulation and Deregulation – Final Exam

Vermont Law School Summer Session, 2012
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Course web site: http://personal.psu.edu/sab51/vls/vls.html
Exam URL: http://personal.psu.edu/sab51/vls/final_exam.pdf
Due: Wednesday, 20 June 2012 at 12:00 noon, Registrar’s office

Student Number

Write your student number in the space below. Do not write your name on the exam!

Student Number: _________________________________

Instructions: There are five questions on the exam. Please answer the questions in the space provided or type up your answers and attach this page with your Student Number (use the back of the paper or attach additional scratch paper if you need more space). Please make sure that your answers are legible and clear. If calculations are required, you must show your work in order to receive full credit. You may use your notes from class, the textbooks, and anything posted on the course web site in completing the exam. You may not consult with other members of the class in any way. If any questions arise, however trivial they may seem, please e-mail them to me. I will be out of the country starting on June 11 but will respond as quickly as I can.

The exam is due back to the registrar’s office by 12:00 noon on Wednesday, June 20.

The Royalton Electricity Industry

Questions 1 through 3 on this exam concern the electricity industry on the island of Royalton. There are currently three generators on the island of Royalton:

<table>
<thead>
<tr>
<th>Name</th>
<th>Fuel</th>
<th>Capacity (MW)</th>
<th>Fixed Cost ($)</th>
<th>Marginal Cost ($/MWh)</th>
<th>CO₂ Emissions (tons/MWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abbott</td>
<td>Nuclear</td>
<td>150</td>
<td>75</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Eaton</td>
<td>Coal</td>
<td>100</td>
<td>30</td>
<td>40</td>
<td>1.2</td>
</tr>
<tr>
<td>White</td>
<td>Nat. Gas</td>
<td>30</td>
<td>15</td>
<td>75</td>
<td>0.5</td>
</tr>
</tbody>
</table>
Question 1

(a) Draw the supply curve for the electricity industry in Royalton.
(b) Assume that the Royalton electricity industry is served by a single vertically-integrated utility that is subject to cost-of-service regulation. The utility owns the three power plants on the island. If electricity demand is 225 MW, find the total, average and marginal cost for the Royalton electric utility.
(c) Repeat (b), but assume that demand is 270 MW.
Question 2

Now assume that the electricity industry on the island of Royalton has been deregulated. The Royalton utility has been forced to sell its power plants to profit-maximizing generation companies. Each plant is owned by a different company. The Royalton Regional Transmission Organization (RRTO) has been created to run an electricity market on the island of Royalton. The RRTO market has the structure of a uniform-price auction. In this question you do not need to worry about any differences between the “day ahead” and “real-time” markets.

(a) What is the system marginal price in the RRTO market if electricity demand is 100 MWh? 125 MWh? 255 MWh? Assume that the suppliers in the RRTO market submit competitive supply offers to the market.

(b) Suppose that demand in the RRTO market was 270 MWh. What are the profits of each generator?

(c) In part (b), which generators will recover their fixed costs? Which will not?
Question 3

Recall from class that the Levelized Cost of Energy (LCOE) is utilized to evaluate generation investments by comparing the LCOE to the average annual spot market price. What potential pitfall do you see in utilizing the LCOE in this way to evaluate renewable energy projects? (Hint: Think about valuing a solar PV panel. At what time of day is it likely to be producing the most electricity?)
Question 4

The contestable markets theory states that an industry can be competitive with as little as two firms, because each one will continuously try to gain a competitive advantage over the other. Under what conditions would you consider an electricity market to be “contestable?”
Question 5

The Vermont Yankee nuclear power plant is owned by the Entergy Corporation. The CEO of Entergy has recently asserted that his company is losing money operating Vermont Yankee. In this question we will investigate the potential profitability (or lack thereof) of Vermont Yankee.

(a) Entergy purchased Vermont Yankee in 2002 for $180 million. In this question we will calculate the LCOE for Vermont Yankee, as if we were making the calculation in 2002, when Entergy purchased the plant. In this problem please make the following assumptions:
   • The present discounted value of the capital cost for Vermont Yankee is $300 per kW.
   • Entergy uses an internal discount rate of \( r = 0.15 \).
   • \( T = 9 \) years in this problem. (At year \( t=0 \), Entergy purchases the plant, and then operates the plant during years \( t=1, 2, 3, \ldots, 9 \).)
   • The variable cost of operating Vermont Yankee is $0.015 per kWh, and does not change over the ten-year analysis period.
   • The capacity factor of Vermont Yankee is 0.9.
   • Assume that 2002 is time \( t=0 \), 2003 is time \( t=1 \), etc.

(b) Vermont Yankee was under contract to sell half of the plant’s output to Vermont utilities for $0.042 per kWh. The remainder of the plant’s output was sold to ISO-New England at an average electricity price of $0.06 per kWh. Based on your analysis, would you say that Vermont Yankee has been profitable since its purchase by Entergy in 2002? (Hint: you will need to make the calculation as if the “present” was 2002 and discount revenues back to that date.)

(c) Entergy is liable for a decommissioning cost of $900 million for Vermont Yankee (assuming that the plant is indeed shut down). If we included the decommissioning cost in the present discounted value of the plant’s capital costs, the capital cost would increase to $1,800 per kW. How would this change the levelized cost of energy for the plant? Would it change your answer to part (b)?
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