

Energy Economics and Policy
PPHA 36921 – Fall Quarter, 2022

PROBLEM SET #1

Distributed: October 6th

Due: October 13th, 5:00pm (submitted on Canvas or to our TA)

TA Session: October 11th, 4:00-5:00pm, Keller 2054

You must submit your own solutions.

If you collaborate with your classmates, please indicate who you worked with.

Question #1: Generators' Earnings Under Rate-of-Return Regulation

Assume a fully regulated market structure where the allowed ROE is 10% for all generation technologies and each plant is built with 50% equity and 50% debt. Also assume Lazard's estimates for the parameters of each technology (assuming the mid-point values).

- a). Calculate the *allowed* annual profits for 800 MW Nuclear, Coal, and CCGT plants in the first year after they are built. (NB., this does not come straight from the model.)

<https://powcoder.com>

Question #2: Generators' Earnings in an Energy-Only Deregulated Market

Now, assume an Energy-Only Deregulated Market where the natural gas plants are marginal 100% of the time, the market heat rate is 8,000 Btu/kWh on average and 9,000 Btu/kWh when CCGT plants are running. (Recognize that since CCGT plants are often marginal, they will only run when prices are above their marginal cost and so the marginal price-setting power plant is less efficient than them.) Also assume Lazard's estimates for the parameters of each technology. (Note that the model is pre-populated for this case; make sure you take the recently revised version from Canvas that unhides this functionality.)

- a). How much money per year does an existing 800 MW plant earn in a given year (revenue less cost not accounting for taxes or depreciation) assuming \$2.50/MMBtu natural gas prices and no CO₂ regulation? Calculate for Nuclear, Coal, and CCGT. (NB., this does not come straight from the model.)
- b). Make the same calculation at \$8.00/MMBtu natural gas prices (still no CO₂ regulation).
- c). Comment on the differences between your calculations for (a) and (b). Historically, natural gas prices did fall from \$8 / MMBtu in 2008 to \$2.50 / MMBtu today; how would a plant owner react to such a transition?

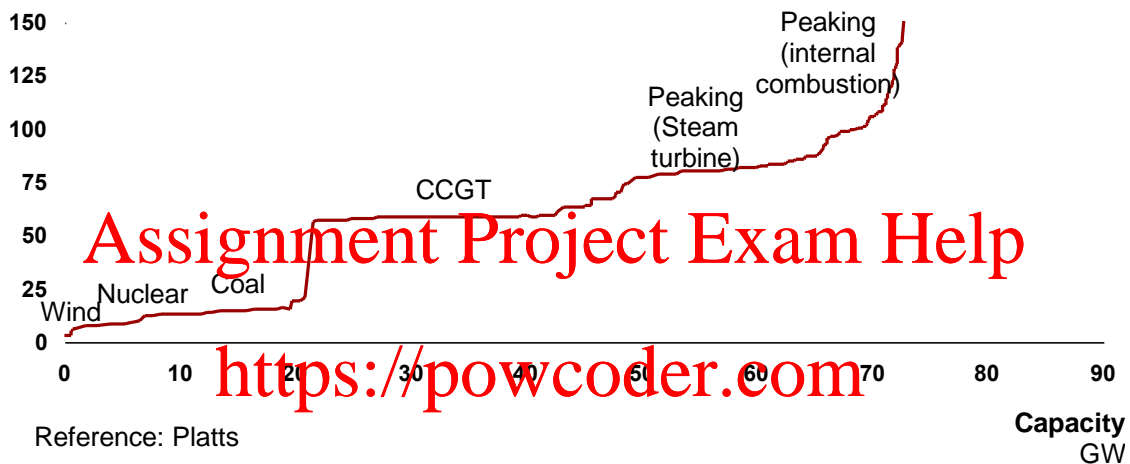
- d). Comment on the differences between your answers to Question #1 and Question #2 for the three technologies. How do the incentives for power plant owners differ between regulatory models and across price environments?

Question #3: Planning a New Build Project

Wind back the clock to 2005 when the Texas (ERCOT) power market was fully deregulated and energy-only, natural gas prices were ~\$8/MMBtu, a U.S. CO₂ tax was a live discussion, and the supply curve in Texas was as follows:

ERCOT Supply Curve (2005)

\$/MWh



Demand in 2005 ranged from 22 GW to 58 GW (base load to peak) and average demand fell in the middle such that the market heat rate was 8,000 Btu/kWh. For our purposes, you can assume that both the base load and peak demand grow by 2% per year and that the market heat rate will remain constant (given the flat CCGT portion of the curve shown in the chart above). For your calculations, taking rough values from the Supply Curve by reading the chart will work fine.

Assume you control a company that believes it can build high performing coal 800 MW plants at \$1,100 / kW with a build time of 48 months and a heat rate of 9,100 Btu/kWh **and that it can run the plant 93% of the time once built**. This is the scenario TXU faced in the case study.

- a). What is the average power price base load power plants will earn in this scenario?
- b). What is the LCOE of TXU's proposed power plants? Discuss how that compares to standard-model nuclear and coal plants (you can use today's Lazard scenarios), as well as to ERCOT power prices at that time (see below).

LOAD-WEIGHTED AVERAGE REAL-TIME WHOLESALE ENERGY PRICES IN ERCOT 2002 - 2016



These prices represent load-weighted average settlement point load zone prices, which include 15-minute wholesale energy prices and reflect the effects of transmission congestion in affected load zones.

- b). What would your investment per plant be (in \$) and what return would you expect per plant (in terms of PV/I and \$)? (Use the LCEO model)

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Question #4: Texas Today

The reserve margin in Texas has fallen dramatically since the TXU power plants were considered (and some built).

- Describe the options facing the regulator for increasing reserve margins on a reasonable timeline.
- Discuss the attractiveness of Warren Buffet's proposal to invest \$8.3 billion in new CCGT technologies in the state. Characterize the regulatory model he is proposing and discuss why you believe he is suggesting that model.