

Management Sciences 261, Winter 2007, Project #1

Hand in at YOUR tutorial on Thursday, February 1. Please DO NOT HAND IT IN at another tutorial, because this will cause a lot of trouble for TAs who have to keep track of 465 students' papers. There will be a 10% penalty for projects handed into the wrong tutorial. Late assignments will not be accepted or marked unless your instructor gives special permission for a good reason (e.g. illness). You may talk to other students about this project, but the work that you hand in must be your own – i.e. you should create the spreadsheet.

General Description of the Problem

Your company, Watelec, is analyzing the possibility of purchasing an existing electrical power station to supply power to the Ontario grid. It is thought that the station has about 10 more years of useful life left. Watelec is thinking of purchasing only the equipment, and renting the building and land. The power station uses natural gas in turbines, which turn the generators. The price at which the power station can sell its electricity is expected to rise over the next five years, but stay constant after that. Although, in reality, the price varies hour by hour, and from season to season, for simplicity of this project, we're going to assume just one price applies during the whole year, although this price can change from year to year. The total demand for electricity in Ontario will increase in future years, but the operator of the Ontario grid, the Independent Market Operator (IMO), is expected to call upon this station to produce electricity for the same number of hours each year, for the next 10 years. The IMO does not ask for electricity from this station during every hour of the year; only during higher demand times, e.g., mid-day during the summer, and all day during the winter.

The power station is now owned by Ontario Power Generation, which is asking a price of \$23 million to sell the station's equipment to Watelec. Your task in this project is to construct a well documented spreadsheet that calculates the present worth of Watelec's investment in the power station equipment, assuming that it is operated over its remaining life of 10 years, under the assumptions that are detailed below. You are to make a recommendation, based on your analysis.

Before presenting the data for this problem, here is a quick overview of some units of measurement and basic facts.

1. An amount of electrical *energy* is measured in kilowatt-hours (KWh) or megawatt-hours (MWh), where $1 \text{ MWh} = 1000 \text{ KWh}$.
2. The price of electricity can be measured in dollars per MWh (\$/MWh) or in \$/KWh, but here we'll use \$/MWh.
3. Electrical *power* is the *rate* of production or use of electrical energy, and is measured in megawatts (MW) or kilowatts (KW). For example, if a 10 MW generator runs for 3 hours at its rated output, then it produces $3 \times 10 = 30 \text{ MWh}$ of electrical energy.
4. Finally, quantities of natural gas are measured in volume units, cubic metres (m^3), and prices are in dollars per m^3 (\$/ m^3). Such volume measurements are made assuming a standard temperature and pressure, so that the volume of gas is proportional to the amount of energy released when it burns. The amount of *electrical* energy that will come from the gas turbine depends on the design of the turbine, as well as the amount of gas burned. A parameter called the "heat rate" relates the amount of electrical energy output of a turbine to the amount of natural gas input.

Relevant Data to Solve the Problem

Equipment purchase price = \$ 23 million

Equipment salvage value in 10 years = \$ 2 million

Price of natural gas = \$ 0.21 /m³ in the first year of operation, increasing by 2% per year each year over the previous year's value.

Heat rate = 3.44 kilowatt-hours (KWh) per m³ (this is the amount of electrical energy produced by the turbines, per cubic metre of natural gas burned in the turbines)

Nominal Output rate = 120 megawatts (MW) (This is the electrical *power* produced when the turbines are on. We'll assume that during hours when the turbines are on, the IMO asks for full power, not for a fraction of the rated output; this simplifies the analysis.)

Variable maintenance cost = \$ 1.42 /MWh (the *extra* maintenance costs that can be attributed to running the turbines)

Fixed cost = \$ 1.44 x 10⁶ per year (this is the total of all regular costs of operation per year, *except natural gas purchases and variable maintenance*, and does not include the purchase price of the power station itself; it does include, e.g., building rent, labour costs, municipal taxes, regularly scheduled maintenance and unpredictable repairs)

Major overhaul of equipment = \$ 1.5 million in year 5.

Remaining operating life = 10 years

Watelec's MARR = 14% per year

Production of electricity = 3100 hours per year

Price of electricity = \$75 /MWh in the first year of operation, increasing by 5% each year over the previous year, for the years 2, 3, 4 and 5, but then to remain constant at the year 5 values.

What You are To Do

- Construct a spreadsheet that will print out on one page (see below for some hints). Your name, section and UW ID number should be at the top. It should contain a section near the top of the spreadsheet with cells for each of the parameters (data), together with labels that identify cell contents. The spreadsheet should calculate and display: the sales revenue in each year; the gas cost each year; the variable maintenance each year; the fixed cost each year; the overhaul cost; and the net revenue in each year. Make the year number increase from left to right. The spreadsheet should also calculate and display the present worth of net revenues, and the overall present worth of purchasing and operating the power station. Use the end-of year approximation for cash flows: assume that all bills, e.g. for gas, are paid at the end of the year, and the same for payments to Watelec for electricity sold.
- The spreadsheet formulas should contain references to the cells containing the parameters, so that the spreadsheet can be used to do the calculations automatically for any values of the data. Your spreadsheet should be *documented*, i.e. brief explanations should be inserted about what calculations are being performed. In the business world, you would show your work to your boss, and he/she must be able to understand it, so clarity will count in the marking. Assume that your boss knows engineering economics, so you don't have to explain basic concepts or give standard formulas in your brief explanations; a few words will do. See the solution of Example 2-9 of the notes, for an illustration.
- At the bottom of your spreadsheet, after the cell where the present worth is calculated, state a conclusion – i.e. state whether the calculation indicates that it is an acceptable investment or not.
- Hints: use landscape orientation; use font size 10; make the left and right margins narrow; in the table of revenues and expenses for the 10 years, express all dollar values in thousands of dollars (to make narrower columns possible); use italics, or a different font, for cells containing units or explanations.