OPTIMISATION AND OPERATIONS RESEARCH II: PROJECT HANDOUT 3, REVISION 1.0

1. Sensitivity Analysis

As noted in lectures, no data should be taken on faith; all data contains noise. So we must perform some sensitivity analysis to understand the robustness of the results.

Below are two examples. Pick one for your project, or create your own new type of sensitivity analysis.

(1) The coefficients of the input-output characteristic functions given in your data are specific to their respective thermal generating units and do not change over time. However, the energy sources of these generating units are commodities traded on financial markets. Given the historical price volatility of commodities, it would be informative to examine the sensitivity of the solution of the economic dispatch problem to fuel price.

For instance, fix the price of diesel oil and natural gas, and consider the impact of variations in the price of coal. For example, at what fuel price does the coal-fired generating unit operate at its minimum and maximum output levels?

Report the optimum output for each generating unit and the total operating cost at these critical prices for thermal coal, as well as the percentage change in total operating cost relative to that computed earlier. Comment on the margin cost (for power production) resulting from changes in the input costs.

Then repeat this analysis for gas and diesel.

(2) The previous analysis simplified power generation in many ways. We consider only conventional thermal power plants — fossil-fuelled plants which do not use co-generation — to abstract from complexities arising from the intermittent generation of renewable energy sources such as wind and solar. Moreover, we ignored real-world concerns including: cost of negative externalities such as carbon emissions, transmission losses, power flow security (*i.e.,* reliability), and energy storage systems.

Now we want to start to challenge those assumptions: imagine that each type of plant generated an amount of CO_2, and that this resulted in a charge of \$X per metric tonne of CO_2 produced. Assuming carbon production numbers given in Table 1, at what point does it become uneconomic to run the coal-fired plant (*i.e.*, in our problem, we mean find the point where the coal fired plant has its minimum production).

Table 1. Carbon generation of different fuels (note that cost actually depends on efficiency, which could vary between different power plants using the same type of fuel). Note that sub-bituminous is the type of coal mined at Leigh Creek.

Energy Source	Fuel $C0_2$
Coal (sub-bituminous)	330 g/kWh
Natural gas	181 g/kWh
Diesel oil	250 g/kWh

You may want to perform some research to make your sensitivity analysis modelling or discussion more connected to the real world.

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