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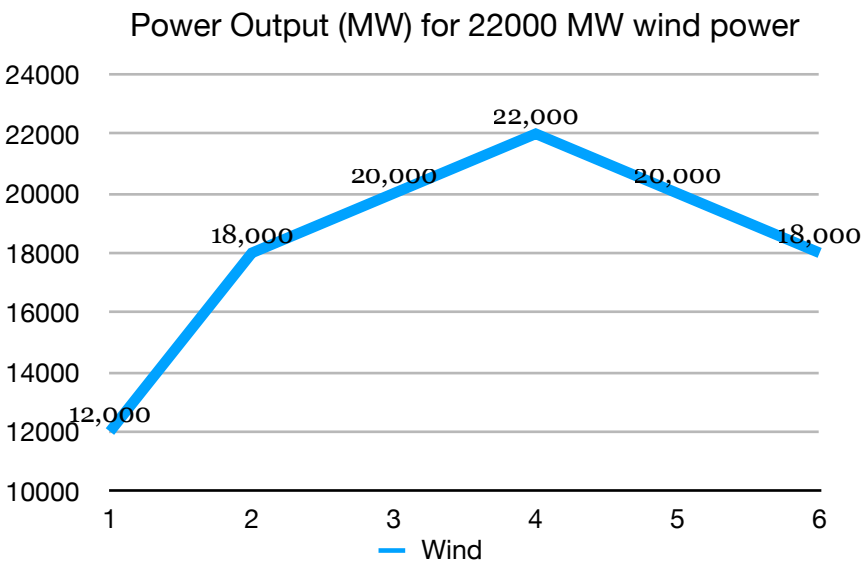
Report for EPower

High Profit & Environmentally friendly

EPower has five power sources: gas, coal, nuclear, wind and interconnect. Each type of source might be utilized in six continuous periods of one day to maximize profit and satisfy three constraints: emission limits (Units/MWh), demand (MW), and maximum output (MW) of each power source. The income only comes from the sale of the electricity produced to satisfy demand, so it always is £15,120,000. Costs are made up of running cost (£/MWh) and increase cost (£/MW).

1 TheCurrent situation on the "Base Case."



In the best scenario, the full wind power output is available all day, which is 22000 MW. And the peak demand is 22000 MW in period 4. Then EPower can only use wind power to satisfy all the market as the left table shown, and make no pollution. The total profit is £14,246,000.

Source	1	2	3	4	5	6
Gas	6000	6000	6000	6000	6000	6000
Coal	1000	3592.59	3592.59	3592.59	3592.59	3592.59
Nuclear	5000	5000	5000	5000	5000	5000
Wind	0	0	0	0	0	0
Interconnect	0	3407.41	5407.41	7407.41	5407.41	3407.41

Table 1 : Power output (MW) of 5 sources

However, in the worst scenario, no wind power output is available. Although all gas and nuclear power have been utilized to generate 11000 MW power, EPower still needs to use coal source and buy energy from other countries at a higher running and increase cost compared to the wind power which results in losing £9,019,259.26 every day. Besides, as a consequence of using gas and coal, two pollutants, carbon dioxide (CO_2) and sulphur will be created. In this case, EPower's sulphur pollution is under the limitation with 1733.33 units spare room; CO_2 pollution has been limited by the daily emission level, which violates our environment protection goal.

Maximun wind power output	Total Profit (£)	Total Cost (£)	CO_2 Emission (units)	Sulphur Emission (units)
22000 MW	14,246,000	874,000	0	0
0 MW	-9,019,259.26	24,139,259.26	28,266.67	200,000

The comparison between two extreme cases shows that exploiting wind power can reduce cost and pollution significantly.

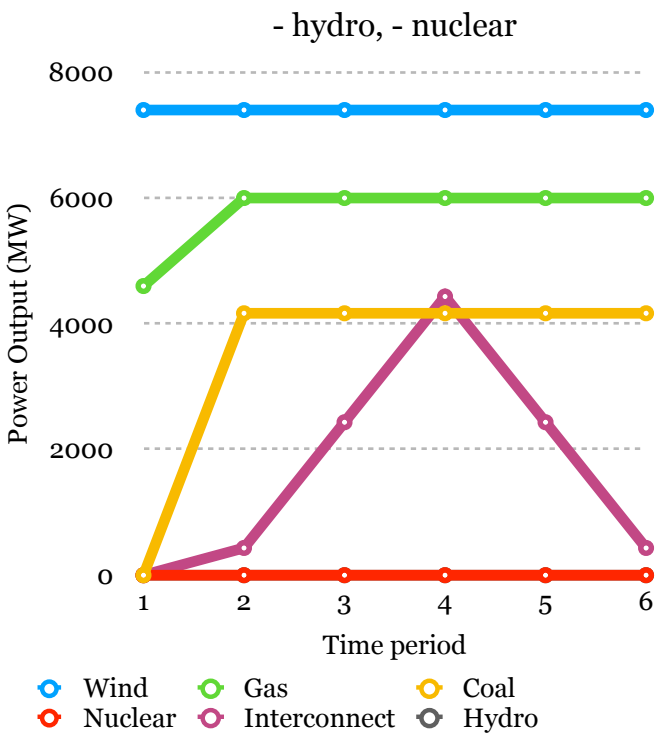
2 Build a pump storage system

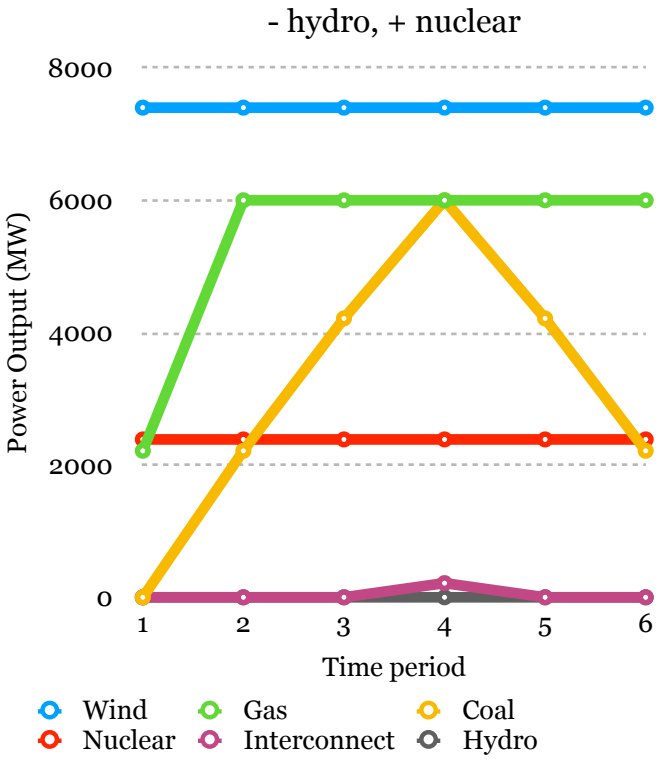
The company plan to build a reservoir upper in the hill, which will have a natural flow of 400 MW. Also, repositories can be used to store more potential energy than naturally by using power generated at times of low demand to pump water up. At peak times, the water in the upper reservoir will be released and transferred into electricity energy at 80% efficiency. We need to decide the power demand for pumping water at each period whilst the reserve in the reservoir cannot exceed the capacity. Besides, out of political implication, the employment of nuclear power should be taken into account.

The effect of building a pump storage hydro-power scheme and not using nuclear power will be discussed in the following four scenarios under the assumption that the average maximum wind output is 7400 MW.

- No hydro-power, no nuclear power

As is shown in the right table, in period 1, only wind power reaches its maximum output. In period 2~6, source gas and coal are restricted by their capacities. Given that gas is a relatively greener source, if there is a method to enlarge the gas maximum output less than £480/MW, then it is preferable to augment and pay. Similarly, the enlargement price for wind power is £783/MW. In this case, the sulphur pollution meets the limitation and CO_2 emission is 198,480 units, which means this is still a polluting scheme. However, because there is no nuclear power needed, technically, there is no risk for the radiation leak.



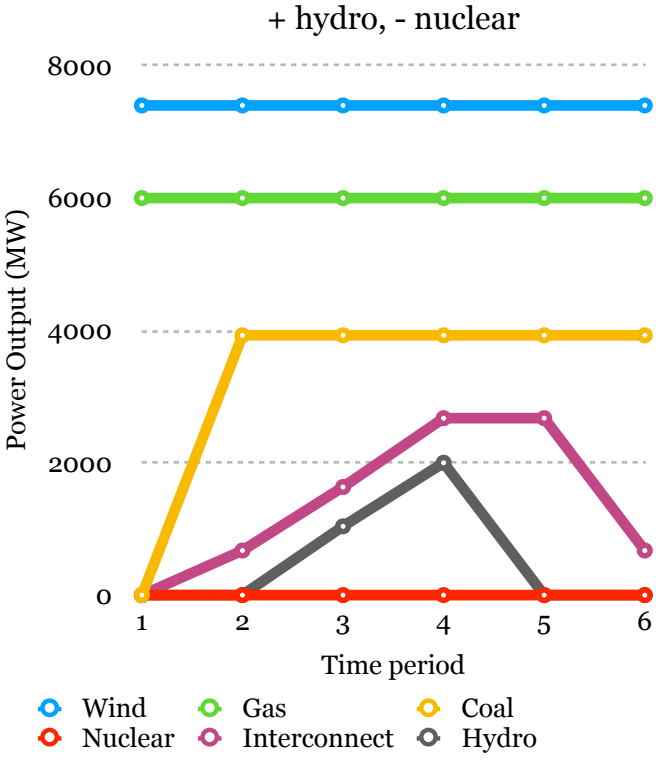


• No hydro-power, nuclear power available

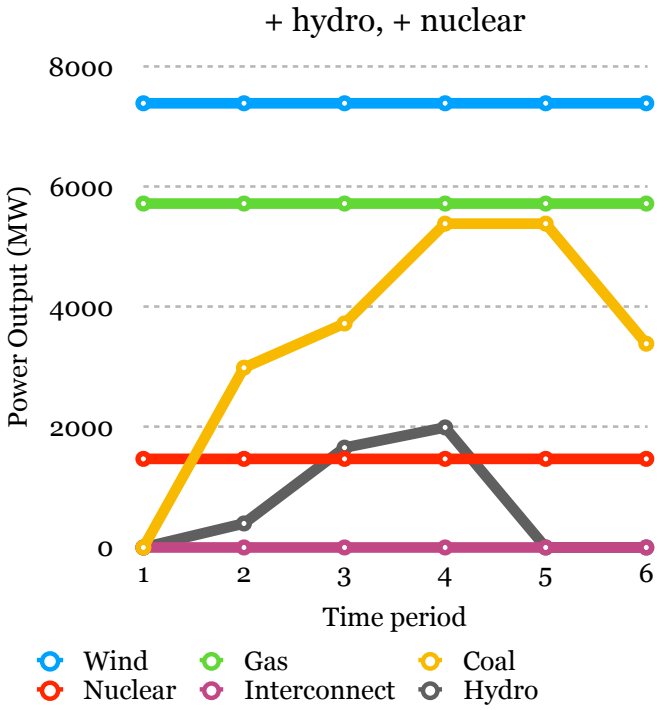
Nuclear power costs less than interconnect electricity and produces no pollution. When the nuclear plant has been built, it is reasonable to exploit more atomic power rather than interconnect sources and coal sources. By doing so, the profit will be increased nearly 1 billion, and CO_2 emission lessened. Hence, if the political risk for building a nuclear power plant is less than £914,095, it is suggested to develop and pay. Notice that in the peak period, since the increase cost of coal is low, we recommend the company use more coal sources to fulfill the demand.

• Hydro-power available, no nuclear power

The pump storage system has been imported and EPower can exploit hydro-power generated by this environmentally friendly system. Since the fixed cost to build a reservoir system is at £1 billion, the total profit decreased instead. Nevertheless, the profit in this scheme is still higher than the first scenario: no hydro and no unclear power. Therefore, we advise building the pump storage system.



Although it costs little to enhance the hydro source supply, the power output from the hydro system is limited by the reservoir capacity; ideally, the pumping mode will be turned on in low-demand periods and pump water up to the upper reservoir. Thus, if there is an approach to increase the hydro reserve capacity less than £90/MWh, EPower should consider expanding it and pay. Besides, the emission is still restricted by its daily limit because of the heavy use of coal source.



•Both hydro-power & nuclear power available

As can be seen from the graph, to reduce the increase cost, source wind, gas, and nuclear remain stable outputs. Compared to nuclear, coal source is more economical even it pollutes severely, so we gain the maximum profit whilst sulphur and CO_2 emissions peak.

	- hydro, - nuclear	- hydro, + nuclear	+ hydro, - nuclear	+ hydro, + nuclear
Total Profit:	£2,127,133.33	£3,041,228.57	£2,242,607.41	£3,799,273.68
Sulphur Emission:	30,000	30,000	28,266.67	30,000
CO_2 Emission:	198,480	187,028.6	200,000	200,000

Counterintuitively, the implementation of green schemes can enhance the profit but cannot decrease the pollution greatly. Instead, after building the hydro system and nuclear plant, if EPower decides to use more coal, it will cause severe sulphur and CO2 pollutions.

3 Investigation of Emission

- Ceiling on high-polluting source (coal) & floor for green source(nuclear)

To lower the pollutants as much as possible, the company could run the nuclear plant at full capacity at each period, and consider using gas source first rather than the more polluting coal source. In this green scheme, EPower can still earn a profit of £2,208,466.7 each day while only emits 2,600 units sulphur and 106,920 units CO_2.

- Reduced Emission limits

If emission limits are reduced, then sulphur is more sensitive to the reduction.