Engineering the supply chain of BarCo Corporation

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**Introduction**

The report pertains to a response to a notification from Max Energy about the rapid depletion of natural gas, one of the production components used by BarCo Corporation. Noteworthy, the unprecedented heatwave/bushfires during summers in 2019 contributed significantly to the natural gas shortage. Besides, electrical generating plants operated at capacity to supply the power needed to run the air conditioning and refrigeration units during the unprecedented heatwave and bushfires during the summer, leading to increased depletion of the natural gas. Despite the long-existing plans called for the utility companies to convert to coal, oil, or nuclear fuels, natural gas remains the most dominant fuel used by the companies. Similarly, the extensive exploitation of natural gas has prompted the evident depletion of natural resources. BarCo Corporation is one of the company’s that uses natural gas in the production process. Thus., following the announcement by Max Energy, the General manager needed to have a contingency plan that would help the company tackle the anticipated natural gas shortage that would affect the company’s production process and the corresponding profitability of the company. The report developed various scenarios using a linear optimization model to help maximize the utilization and the consequent profitability, thereby making recommended supply chain action that would help promote the corporation’s sustainability.

**Business Problem**

The most challenging issue for the general manager BarCo’s revolved around determining the products that would have the most negligible effect on the natural gas curtailment plan. Based on the operation analysis and available data, BarCo’s use natural gas in the operation process; thus, a reduction in the commodity supply would culminate in severe operational issues. The shortage required that Max Energy supplies natural gas in three main categories. The company demanded that the consumers initiate a reduction process to help minimize the impact of their industrial processes. The category by the MaxEnergy, the leading producer and distributor of the natural gas in the region in the statement, noted that it would allocate gas to consumer based on the provision of the Federal commission noting that

1. The first priority: would include residential and commercial heating and cooling.
2. The second priority: would include the commercial and industrial firms that use natural gas as a source of raw material.
3. The third priority: would include the industrial firms that use natural gas as boiler fuel.

From the communication, it is apparent that most of Barco’s uses of natural gas fell in the second and third priority classification, implying that BarCo would become subject to “rolling brownouts,” including temporary and periodic curtailments of natural gas supplies.

**The Curtailment Plan**

Noteworthy, in the event of a brownout, all the BarCo complexes would be in the category of the curtailment region. The company used the purchased gas as the boiler’s fuel except for the ammonia operations from the case study. The ammonia plant uses natural gas as a raw material because it is less pollutant than other boiler fuels and aligns with BarCo’s future sustainability plan. Based on the available information, it is apparent that BarCo’s falls in the second and third priorities defined by Max Energy in the allocation procedure for natural gas in the region.

The table below illustrates the contribution to profit per product reported to the general manager BarCo’s Corporation.

Table 1: the table illustrates the contribution to profit ($ /Ton) per product

|  |  |
| --- | --- |
| **Product** | **Contribution to profit($/Ton** |
| Ammonia | 134 |
| Ammonium phosphate | 80 |
| ammonium nitrate | 100 |
| Urea | 122 |
| Hydrofluoric acid | 96 |
| Chlorine | 110 |
| Caustic soda | 75 |
| Vinyl chloride monomer | 85 |

The table below illustrates the operation data indicating the max capacity (tons/day), the production rate (% of capacity), and the natural gas consumption (1,000 cu. ft/ton) by the company in the production of each of the products.

|  |  |  |  |
| --- | --- | --- | --- |
| **Product** | **Max Capacity (tons/day)** | **Production rate (% of capacity)** | **Natural Gas Consumption (1,000 cu.ft./ton)** |
| Ammonia | 600 | 90 | 19 |
| Ammoniun phosphate | 1,600 | 80 | 13 |
| ammonium nitrate | 800 | 70 | 20 |
| Urea | 1,400 | 60 | 12 |
| Hydrofluoric acid | 200 | 80 | 19 |
| Chlorine | 1,500 | 80 | 11 |
| Caustic soda | 700 | 70 | 14 |
| Vinyl chloride monomer | 1,500 | 80 | 12 |

**Main Objective for the Development of a Contingency Plan**

The specific objective of BarCo following the announcement is to develop a contingency plan that would help minimize the impact on profit and overheads contribution through the supported allocation of the natural gas among the firms’ product if the curtailment materialized and became a reality in the region. Therefore, the primary focus of BarCo management is profit maximization as the contingency plan under the selected situation associated with the reduction of the natural gas supply.

The primary challenge for BarCo is coming up with a production level for different products that would minimize the impact of the shortage in natural gas supply while maximizing the company’s profit. In this case, the process would involve developing a production model that would enhance the maximization of proceeds under the selected operational constraints.

**Linear Program for Optimization**

Cohen, Leung, Panchamgam, Perakis, and Smith (2017) pointed out that linear programming is one of the most used techniques for optimizing a linear objective function, based on corresponding constraints that may depict linear equality or inequality. Using the linear programming model enhances finding a point where the function has the smallest or largest value if such a point exists, whereby linear programming aid in promoting the attainment of optimum use of productive resources. Besides, linear programming enhances decision-making by employing practical factors by selecting and allocating resources based on the optimization aspect, improving the quality of adopted decisions.

In BarCo’s scenario that involves the possible curtailment of natural gas, one of the company’s components in the production process, linear optimization would allow the company’s general manager to make supported production decisions. In this case, linear programming would minimize natural gas reduction while maximizing the company’s profitability, necessary to guarantee the future sustainability plan. The linear objective function will maximize the contribution or profits from the different production lines, focusing on changing the production rate (% capacity) in linear programming performed on Ms. Excel solver. The anticipated results would be a significant change in the production, profit contribution, and natural gas consumption, whereby the constraints will include the limit of the supply of the natural gas consumption.

References

Cohen, M. C., Leung, N. H. Z., Panchamgam, K., Perakis, G., & Smith, A. (2017). The impact of linear optimization on promotion planning. *Operations Research*, *65*(2), 446-468.