Name: Abdulrahman Alturki / Course: EBGN645 Computational Economics / Research Proposal

Project Tittle: Optimizing Refinery's Production Yield to Maximize the Profit by Adjusting the cuts of Gasoline and Middle Distillate (Diesel & Jet Fuel) Allocated for Processing at the Refinery in View of Market Challenges

Refineries play a major role in the petroleum supply chain as it is the single processing point for Crude Oil to produce various petroleum products, mainly Gasoline and Middle Distillate. Over the past years, Gasoline has been the main fuel for cars, but its demand sustainability or growth is currently challenged by EV adoption, in addition to other routine challenges in refinery business such as Crude Oil prices fluctuation and Gasoline inventory level coupled with demand seasonality. On the other hand, Middle Distillate demand is strongly related to agriculture activities and aviation (flight seasons and aviation expansion).

Basically, the model shows how refinery is flexible to partially adjust its product yields (quota allocated for each product) by adjusting the operating philosophy depending on the capability of downstream units of Crude Distillation Column. Optimizing this process is critical and dynamic as it requires balancing refineries profit maximization along with meeting allocated customers demand, sustaining safe inventor levels within refinery's tanks (min and max limitations) and maintaining safe operations. Therefore, our focus in this research is to **identify how single refinery optimally set its Gasoline and Middle Distillate cuts to maximize the revenue generated, in which the prices of both products depend on Crude Prices, inventory levels, and demand seasonality coupled with market dynamic development.**

Model Construction:

Sets/ Indices:

- i € S, and S = [G,MD]; G=Gasoline, MD=Middle Distillates (Diesel & Jet Fuel)

Parameters:

- **Production:**

$Gasoline\ Production\ Rate: S_G = S\ .X$, $Middle\ Destillate\ Production\ Rate: S_{MD} = (1-S)\ .X$

Where:

- X ≥ 0: Crude Throughput or Processing Capacity (Kbbl/day)
- S: Gasoline Cut Share

Variables:

- **Quantity Demanded:**

$$Q_G = \alpha_0 + \alpha_1 INV_G + \alpha_2 P_G + \alpha_3 EV + \alpha_4 W$$

$$Q_{MD} = \beta_0 + \beta_1 INV_{MD} + \beta_2 P_{MD} + \beta_3 (A\&A) + \beta_4 W$$

Where:

- $Q_G\ and\ Q_{MD}\ are\ Gasoline\ and\ Middle\ Distillate\ quantity\ demanded\ respectively$
- $\alpha_0,\ \alpha_1, \alpha_2, \alpha_3, and\ \alpha_4$ are Gasoline demand coefficients

- $\beta_0, \beta_1, \beta_2, \beta_3, and\ \beta_4\ are\ Middle\ Destillate\ demand\ coefficients$
- $INV_G\ and\ INV_{MD}$ are Gasoline and Middle Distillate inventories, respectively.
- $P_G\ and\ P_{MD}$ are Gasoline and Middle Distillate prices, respectively.
- $EV\ is\ Electric\ vehicle\ adoption$
- $(A\&A)\ is\ agricalture\ seasonality\ and\ aviation\ secotr\ expantion$
- W is Crude Price

➢ **Price (Inverse Demand):**

$$P_G = \frac{\alpha_0 + \alpha_1\, INV_G + \alpha_3\, EV + \alpha_4\, W}{\alpha_2}$$

$$P_{MD} = \frac{\beta_0 + \beta_1\, INV_G + \beta_3\, (A\&A) + \beta_4\, W}{\beta_2}$$

➢ **Production Cost (C):**

$$K = S_G + S_{MD}\,,\ C = C_0 + K\,W$$

Where:

C_0 is the processing cost, including administrative, power consumption, electricity generated, and labor (fixed cost)

$W\ is\ Crude\ Oil\ Price\ (in\ which\ K\ W\ is\ variable\ cost)$

Objective Function:

$$\boldsymbol{\pi}_{\ max} = P_G\,.S_G + P_{MD}\,.\,S_{MD} - C_0 - K\,W$$

Constraints:

$$\text{X} \geq \text{K},\ K = S_G + S_{MD}\,,\ 0.3 \geq \text{S} \geq 0.7$$

Thorough refinery's Crude Distillation Unit (first unit in the refinery) optimization keeps the allocated cuts the most optimum, minimizing the giveaway, and eliminating the contaminations to produce on-specification product with higher recovery rate of Gasoline and Middle Distillate products. Crude Distillation Unit CDU Optimization (ABB Inc. Measurement & Analytics) can be used as a reference while developing the model and final report, ABB-CDU-Unit-A4-US.indd.

Data Availability:

1- EIA Weekly Petroleum Status Report: Weekly Petroleum Status Report - U.S. Energy Information Administration (EIA)
2- EIA Short-Term Energy Outlook: Short-Term Energy Outlook - U.S. Energy Information Administration (EIA)
3- USDA Crop Progress Report: USDA Economics, Statistics and Market Information System
4- FAA/BTS Aviation Data: Airlines, Airports, and Aviation | Bureau of Transportation Statistics
5- U.S. share of electric and hybrid vehicle sales: U.S. share of electric and hybrid vehicle sales reached a record in the third quarter - U.S. Energy Information Administration (EIA)