# Market-based Fuel Pricing

## *Government-led initiatives and possible revision*


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# 1. Context & Objectives

## 1.1 Context & Objectives

- The government of Bangladesh has adopted a market-based pricing system for fuel oils particularly diesel, petroleum oil, octane, kerosene and jet fuel in **March 2024**.
    - This decision has been taken to **reduce the fiscal and financial burden of the government under the IMF loan condition**
- The adoption of periodic formula-based pricing by BPC carries a particular significance as it needs to attain a number of goals
    - First, the goal is to **reduce the fiscal burden by ending the subsidy provided to the fossil fuel**-based energy system
    - Second, the transition from an administered pricing system to an automated pricing system will have to be in such a way that the **consumers especially vulnerable households are not affected by the upward revision of the tariffs**
    - Third, the pricing mechanism needs to ensure **moving toward the energy transition pathway**
- In this backdrop, it is important to monitor the transition process from an administered pricing system to a market-based pricing system, **review and assess the adapted model** by the government
    - And put **forward suggestions for necessary revisions** of the pricing formula taking into consideration the border economic, social and environmental goals

## 1.1 Context & Objectives

- Against this backdrop, the Centre for Policy Dialogue (CPD) in partnership with the Australian High Commission in Dhaka has undertaken the study on ***Market-based Fuel Pricing: Government-led initiatives and possible revision***.

- The specific objectives of this study are-
  a) To **review policies related with the energy sector** particularly those with energy pricing
  b) To give an **overview of the subsidy regime setting** out the market structures for the different fuels
  c) To review the **international practices of market-based** energy pricing mechanisms and **find out the suitable options** that Bangladesh may take into consideration while designing its pricing mechanism
  d) To **analyse the current administered pricing mechanism** to identify the **possible differences** with the market-based pricing mechanism in view of understanding the required changes for ensuring energy security and energy transition in the country
  e) To **propose an appropriate price-setting model** for the fuel oil prices in Bangladesh from the energy security and energy transition point of view.

## 1.2 Methodology

- The study utilises the **Neural Network Model to forecast the fuel oil price upto 2025 based on the secondary data**
  - Data for the model have been extracted from global data bank and websites such as World Bank DataBank; World Development Indicators, Our World in Data, Statistical Review of World Energy by Energy Institute (EI)
  - Domestic pricing data and historical trends have been collected from Bangladesh Petroleum Corporation (BPC)

- Qualitative data for the analysis have been collected through Key Informant Interviews (KIIs) with the related government officials, national and international energy experts and academicians
  - A total of **7 KIIs** have been conducted for the study (table 1)
- On 3 October 2024, an Expert Group Meeting (EGM) was organised to share the findings of the study and seek validation from the related regulatory bodies, energy experts and academicians
  - A group of **10 regulatory officials, experts and academicians** have provided their review and feedback on the methodology and analysis of the CPD's proposed pricing

**Table 1: List of organisation of KII Respondent**

| **Organisation of KII Respondent** | **No. of KIIs** |
|---|---|
| Bangladesh Energy Regulatory Commission (BERC) | 2 |
| Power Cell | 1 |
| Bangladeshi Energy Experts, CSOs and Academia | 2 |
| Power and Energy Sector Specialist from Private Sector (IFC and MarketForces) | 2 |

## 1.2 Methodology

# List of KII Respondents

**Bangladesh Energy Regulatory Commission (BERC)**

1. *Mr. Kamruzzaman* Deputy Director
2. *Mr. Md. Firoz Zaman,* Deputy Director

**Power Division**

1. *Mohammad Hossain, Former Director General, Power Cell*

**Bangladeshi Energy Experts, CSOs and Academia**

4. *Dr M. Tamim,* Professor and Dean of Chemical and Materials Engineering Faculty, BUET
5. *Dr. Sakib Bin Amin,* Associate Professor, Economics, North South University

**Power and Energy Sector Specialist from Private Sector (IFC)**

6. *Mr Stephane Barbeau,* Energy Consultant, International Finance Corporation (IFC)
7. *Mr Dave Jones,* Global Insights Programme Director, Ember energy think tank

## 1.2 Methodology

# List of EGM Participants

1. *Mr Jalal Ahmed, Chairman,* Bangladesh Energy Regulatory Commission (BERC)
2. *Professor Dr M Shamsul Alam,* Energy Advisor, Consumers Association of Bangladesh (CAB)
3. *Professor Dr Ijaz Hossain,* Formerly with Department of Chemical Engineering, Bangladesh University of Engineering and Technology (BUET)
4. *Mr Md Maqbul-E-Elahi*, Primary Energy Expert
5. *Mr Humayun Rashid*, Former Senior Vice President, DCCI and Managing Director Energypac Power Generation Ltd
6. *Dr S. M. Nasif Shams,* Associate Professor & Director, Institute of Energy Science Library Campus, University of Dhaka
7. *Dr Sakib Bin Amin,* Associate Professor, Department of Economics, North South University
8. *Dr Farseem Mannan Mohammedy,* Founding Director, Institute of Energy and Sustainable Development IESD, BUET and Professor, Department of Electrical and Electronic Engineering (BUET)
9. *Mr Muntasir Murshed,* Research Fellow, Bangladesh Institute of Development Studies (BIDS)

# 2. Analysis of International Practices of Market-based Energy Pricing Mechanisms

## 2. Analysis of International Practices of Market-based Energy Pricing Mechanisms

Table 6: An overview of different categories of models employed across various power and energy market

| **Market Name** | Model Names | | | | | |
|---|---|---|---|---|---|---|
| | Neural Network (NN) | Dynamic Regression (DR) | Transfer Function | ARIMA | GARCH | Jump Diffusion |
| Ontario electricity market | Yes and Fuzzy Logic | | | | | |
| Spanish electricity market | | Yes | Yes | Yes | Yes | |
| Norwegian electricity market | | | Yes | Yes | Yes | |
| California electricity market | | Yes | Yes | | | |
| Victorian energy wholesale market | Yes | | | | | Yes |
| England and Wales pool of energy market | Yes | | | | | |

Source: Authors' illustration from literature review

## 2. Analysis of International Practices of Market-based Energy Pricing Mechanisms

**Neural Network as an Ideal for Identifying Market-based Mechanism:**

- The limitations of the widely-used traditional models are outlined below:

- *Jump Diffusion/Mean Reversion Models:*
  - They involve **complex parameter estimation**, and the assumptions may not hold in markets undergoing structural changes.
  - These models often assume that price movements will **revert to a historical mean**, which may not accurately reflect the new market conditions shaped by external interventions or sudden economic policies.
  - Reference: Skantze, Ilic, & Chapman (2000)

- *Time-series Model:*
  - They assume data stationarity and linearity, and are **sensitive to market shocks**, which may not always hold true in volatile energy markets.
  - Although the class of GARCH models are effective at modeling volatility clustering such as energy prices, they typically assume a **normal distribution of errors**, which can be unrealistic in the energy market context, and can be overly sensitive to changes in data, necessitating frequent updates in model parameters.
  - Reference: Nogales et al. (2022), Contreras & Santos (2006),

## 2. Analysis of International Practices of Market-based Energy Pricing Mechanisms

**Neural Network as an Ideal for Identifying Market-based Mechanism:**

- *Transfer Function Models:*
  - These models require precise specification of the **input-output relationships** and the **correct identification of lags and leads**, which can be challenging due to continuous updates of the market situation.
  - Transfer function models also assume **a linear relationship** among variables, which may not hold in all market scenarios, especially in non-linear and complex markets like energy, where interactions can be more volatile and less predictable.
  - **References:** Nogales et al. (2022), Contreras & Santos (2006)

- *Analytic Network Process:*
  - It **lacks empirical validation** and might be less reliable in practical scenarios due to the theoretical nature of its constructs.
  - ANP heavily relies on the judgments of experts to determine the weights of various elements, which can introduce **subjectivity** into the analysis. This subjectivity might affect the reproducibility and objectivity of the results.
  - **References**: Iskin, Daim, Kayakutlu, & Altuntas (2012)

## 2. Analysis of International Practices of Market-based Energy Pricing Mechanisms

**Neural Network as an Ideal for Identifying Market-based Mechanism:**

- *Neural Network:*
  - **Adaptability and Learning:** Neural networks continually improve as they process more data, making them highly adaptable to changes in market dynamics.
  - **Handling Non-linear Dynamics:** Capable of understanding complex and hidden relationships within the data which traditional models might miss.
  - **Predictive Power:** Superior in environments where market conditions are unpredictable, and data is abundant.
  - They excel in environments where the relationships between variables are complex and hidden, making them highly effective in capturing market-based mechanisms where numerous influencing factors interact dynamically.
  - **Case Studies:**
    - *Application in the California Market:* Shows how neural networks have been used to forecast prices amidst high volatility.
    - *Comparison with Other Models:* Neural networks often outperform traditional models like ARIMA in terms of accuracy and responsiveness to market changes.
  - Their "black box" nature often does not provide transparency in how decisions are derived, which can be problematic in settings that require clear audit trails and explainability. However, in our case, these issues are irrelevant since we are setting only the effective import price by using the model.



Reference: Gao et al. (2000), Malliaris & Malliaris (2008), Wang & Ramsay (1998), Anders & Rodriguez (2004)

# 3. Review of Policies: Focusing on Fuel Pricing

## 3.1 Energy related policies and perspectives on energy pricing from the energy transition point of view

**Table 2: Reflection of energy pricing in various policy documents**

| Policies/plans | Pricing issues mentioned in policy/plan documents | | |
|---|---|---|---|
| | Goals/objectives | Instruments | Institutions |
| IEPMP | • Only talks about **energy demand forecast** keeping the global energy price in mind | Not mentioned | MoPEMR |
| MCPP | Absent | | |
| Perspective Plan | Absent | | |
| National Energy Policy | • To ensure reliable supply of energy to the people at **reasonable and affordable price**<br>• Enabling competitive environment for giving the **best deal** to the consumer **in price and quality** | Not mentioned | BERC |
| RE Policy | Absent | | |
| 8th FYP | • **Justified and proper pricing of the energy** and fuel to rationalise the national subsidy burden<br>• **BERC to conduct and regulate** the regular price adjustment to avoid energy subsidy | Not mentioned | BERC |

## 3.1 Energy related policies and perspectives on energy pricing from the energy transition point of view

| Policies/ plans | Pricing issues mentioned in policy/plan documents | | |
|---|---|---|---|
| | Goals/objectives | Instruments | Institutions |
| BERC Act 2003 | • The **price of power generation** in wholesale, bulk and retail, and the supply of energy at the level of end-user, shall be **determined in accordance with the policy and methodology made by the Commission** in consultation with the Government.<br>• At the time of making the policy, the Commission shall take into consideration some specific matters.<br>• **Commission by regulation shall make methodology** for determination of tariff<br>• Tariff determined by the Commission shall not **be revised more than once** in a fiscal year, unless there is change in the prices of energy including any other changes. | • Guidelines of the commission<br>• Discussion with the ministry | BERC |
| BERC Act 2023 | • The **tariff revision is rationalised** based on few factors such as for subsidy rationalization, for consumers' betterment, demand of agriculture, industry, business and household, for uninterrupted power supply, expansion of transmission and distribution system, storage<br>• Under the new mechanism, the public organisations **doesn't need to disclose** their financial state to justify the price adjustment<br>• There is **no room for accountability from government's side** to explain the reasons for multiple and frequent price hike in details | Not mentioned | MoPEMR |
| BPC Act | Absent | | |

# 4. Analysis of Subsidy in the Power and Energy Sector and Its Implications on Competitive Fuel Pricing

## 4.1 Subsidy in the Power and Energy Sector

- **Subsidising power and energy** to ensure access to energy and power at an affordable price to mass-people is a widely applied instrument in developing countries.

- Most of the **net energy-importing countries** have undertaken various subsidisation measures at the local market to address the global high price of energy in recent years.

- **Large energy subsidies** make Bangladesh‘s fiscal position highly vulnerable to changes in global energy prices.

- The amount of subsidised credit in the power and energy sector has been **increasing at an exponential rate**
  - From Tk. 4,000 crore in FY2017 to Tk. 23,000 crore in FY2023
  - This is apprehended to rise to Tk. 32,000 crore in FY2024 and increased to further Tk. 40,000 in FY2025.

- Taking such a huge amount of subsidised credit made it one of the highest recipients of subsidised credit from the government
  - It alone accounted for 37.9 per cent of the total subsidy.

## 4.2 Financial Account of BPC

- Bangladesh Petroleum Corporation **(BPC) does not** receive subsidy from the MoPEMR anymore. BPC **used to receive** a hefty amount of subsidy from the national budget of Bangladesh till FY2014-15.
  - Even when BPC incurred loss during the **Covid-19 pandemic** due to the global fuel oil price, no subsidy or loan was provided.
- BPC has been **adjusting its loss through incremental price adjustments** and making profits for last few years (Table 3)
- Under the administered pricing regime, a wide range of difference between import cost and tariff of fuel oil can be observed
  - Table 4 represents that the fuel oils diesel, kerosene, petrol and furnace oil **are being sold at a wide margin**
- The retail tariff of all types of petroleum products have been set at a higher level compared to the import cost or oil refining cost of BPC - it is yielding **profit in all type of oil**

**Table 3: Financial account of the BPC (2023)**

| Issues | Amount (in crore taka) |
|---|---|
| Revenue | 79187.5 |
| Expenditure | 183.6 |
| Profit/Loss | **4586.1** |
| Subsidy | 0 |

**Table 4: Discrepancy between fuel oil import price and tariff**

| Product Name | Local Selling Price (Tk/litre) | Import cost per liter (Tk/litre) | Selling tariff | Margin Between cost and price |
|---|---|---|---|---|
| HSD (Diesel) | 105.50 | 50.00 | 95 | 10.50 |
| SKO (Kerosene) | 105.50 | 50.00 | 97.40 | 8.10 |
| MS (Petrol) | 121.00 | 60.68 | 109.677 | 11.32 |
| FO (Furnace Oil) | 86.00 | 42.29 | 85.29 | 0.71 |

Source: Authors' calculation based on BPC data

## 4.2 Financial Account of BPC

- There is a trend of **incremental profit obtained by BPC** throughout the years
- This is mainly because of increasing the tariff by **minimum of Tk25 per liter to as high as Tk44** per liter to adjust loss
- Given  to the price increment BPC was in profit in the following year 2023
    - Even if BPC did not receive subsidy, the upward tariff revision under the administrative pricing regime made it **profitable for BPC to import and sell fuel oil by passing the burden onto the consumers shoulders**

**Table 5: Trend of Tariff Adjustment**

| Years | Incremental tariff (Tk/litre) | | | Incremental revenue or loss (Crore Tk.) | Amount of subsidy required (Crore Tk.) |
|---|---|---|---|---|---|
| | Diesel | Petrol | Octane | | |
| **2020** | 0 | 0 | 0 | 5065.3 | **0** |
| **2021** | 15 | 0 | 0 | 6493.7 | **0** |
| **2022** | 34 | 44 | 25 | -2705.64 | **0** |
| **2023** | -5 | -5 | -5 | 4586.09 | **0** |

Source: Authors' calculation based on BPC data

## 4.3 Financial Account of PetroBangla and RPGCL

- The main reason for the provided subsidy to PetroBangla is **mainly for LNG import by RPGCL.**
  - The high cost incurred due to the LNG purchase from spot market **Tk 6000 crore** has been provided to PetroBangla (Table 6).
- To reduce the subsidy burden, the **government has increased the gas price** at the retail level in different sectors from February 2023
- Exactly after 1 year of gas tariff for private and captive power producers were increased in February 2024
- Such **non-proportional and discriminatory tariff adjustment indicates the unfair and unjust distribution of subsidy across different consumer class.**

Table 6: Financial situation of PetroBangla and RPGCL

| | Tk in Crore | | | |
|---|---|---|---|---|
| | **Revenue** | **Expenditure** | **Profit/ Loss** | **Subsidy** |
| PetroBangla (2022) | 21,771 | 47,095 | -16,299 | 6000 |
| RPGCL (2023) | 57.66 | 11.46 | 26.60 | 0 |

Source: Annual reports of PetroBangla and RPGCL

Table 7: Trend of sectoral gas tariff adjustment

| **Sectors** | **Previous Tarif (Tk/ cubic meter)** | **New Tariff (Tk/ cubic meter)** | **% Change** |
|---|---|---|---|
| Power (Public, IPP, Rental) | 5.02 | 14.75 | 194 |
| Captive Power | 16 | 30.75 | 92 |
| Large Industry | 11.98 | 30 | 150 |
| Medium Industry | 11.78 | 30 | 155 |
| Small, cottage and other Industry | 10.78 | 30 | 178 |
| Commercial (Hotel & Restaurant) | 26.64 | 30.5 | 14 |

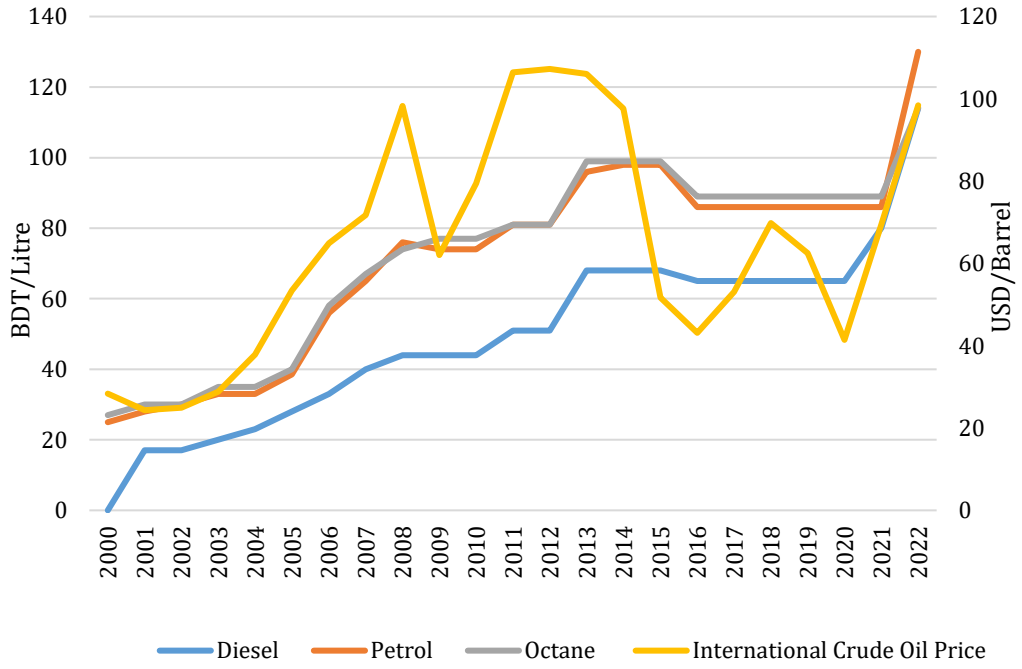
Source: BERC

# 5. Transition from Administered to Market Based Pricing System

# 5. Transition from Administered to Market Based Pricing System

## 5.1 Historical Fuel-oil Price Trend under Administered Pricing System

Figure 1 : Historical Price Trend of Domestic Fuel Oil and International Crude Oil Price




Source: Authors' calculation based on BPC and Trading Economics

- **Consistent Upward Domestic Trend:** Despite global fluctuations, domestic prices for diesel, petrol, and octane show a steady increase over the period, highlighting the influence of administrative pricing.

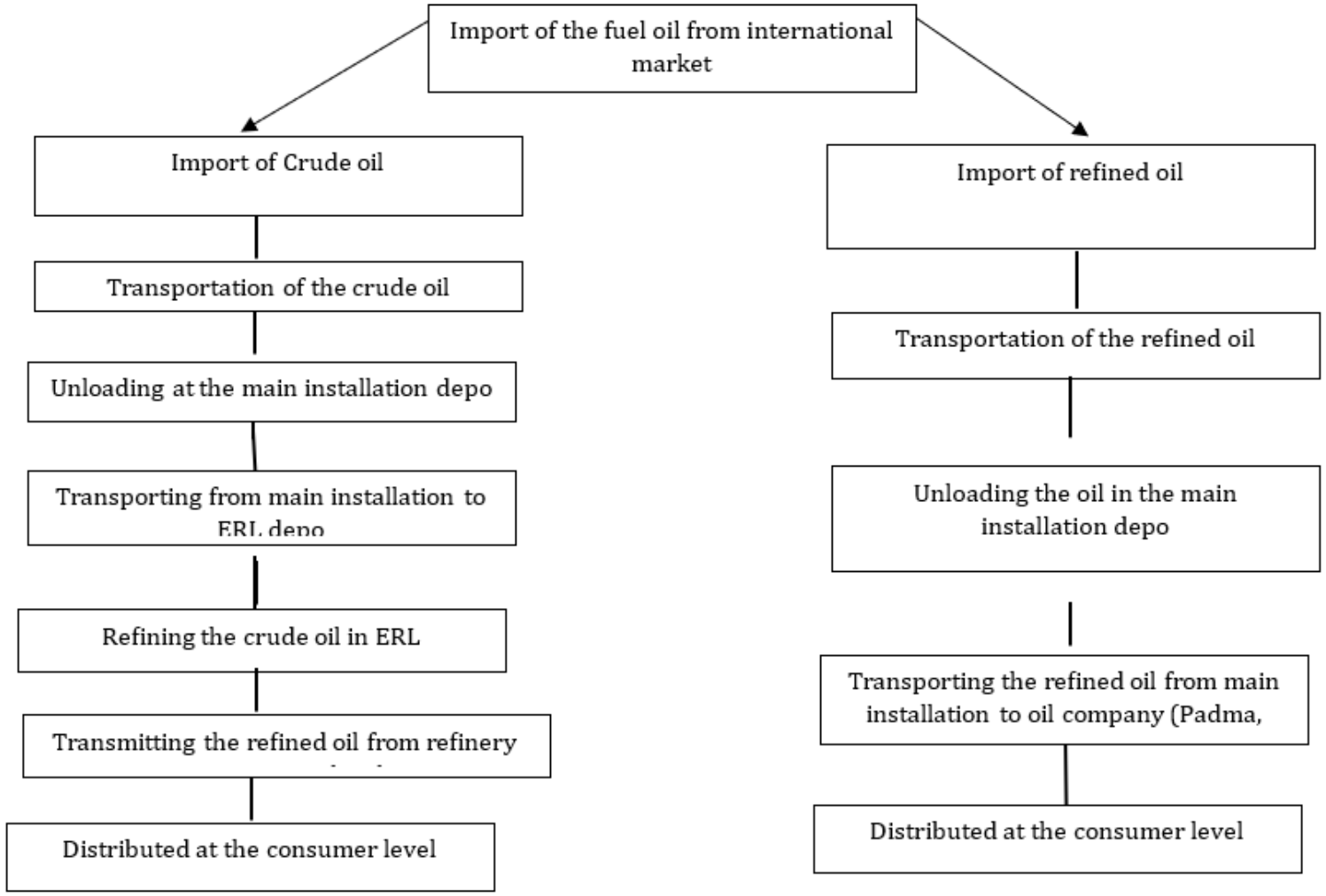
- **Disconnection from International Prices:** The figure demonstrates several instances where domestic fuel prices do not decrease in tandem with a drop in international crude oil prices, illustrating a lag in price adjustments due to the administrative pricing system.

- **Post-2018 Price Behavior:** After 2018, as international crude oil prices began to decline, domestic prices remained relatively high or decreased insignificantly, pointing to the administered system's inflexibility in reducing prices promptly.

# 5. Transition from Administered to Market Based Pricing System

## 5.1 Historical Fuel-oil Price Trend under Administered Pricing System

Figure 2: Supply Chain of Fuel Oil in Bangladesh




Source: Authors' Illustration

# 5. Transition from Administered to Market Based Pricing System

## 5.2 Automatic Fuel Oil Pricing System proposed by the BPC

- The MoPEMR has announced an automatic fuel pricing guidelines on 29 February 2024.

Table 9: BPC Formula

| SL. | Particulars | SL. | Particulars |
|---|---|---|---|
| A | 1. Crude oil FOB rate (Tk per Litre) | D | Financing charges (Tk per litre) |
| | 2. Premium freight, service charges (Tk per Litre) | | Administrative, maintenance & development expense (Tk per litre) |
| | **(A) Total Product Cost** | | **(D) Total financing, administrative, maintenance & development expense (Tk per litre)** |
| B | Duty (Tk per litre): 5% for crude oil | E | **BPC's margin on C2+D (Tk per litre)** |
| | AIT (Tk per litre): 2% of tariff value | F1 | Total cost: C2+D+E (Tk per litre) |
| | **(B) Total duty & taxes per litre in Tk** | F4 | VAT 15% on F1 |
| C | Handling Commission + Jetty Throughout Charge (Tk per Litre) | G1 | **Ex-refinery price after VAT (F1+F4)** |
| | River Dues (Tk per litre) + 15% VAT | G | 4. Company margin, development fund and freight pool (Tk per litre): Tk 0.8 + Tk 0.25 + Tk 1.20 |
| | Survey Fee (Tk per Litre) - Standard Assumption: | | 5. Dealer's commission and transport (Tk per litre) |
| | Ocean Loss (Tk per Litre) 0.5% on FOB for crude oil | | 6. Traders' 2% VAT on G1+4+5 (Tk per litre) |
| | L/C Commission + VAT (Tk per litre) | | **(G) Total selling and distribution expenses (4+5+6)** |
| | Crude oil Processing Cost - Avg. Cost of ERL processing (Tk. per litre) | H | **(H) Selling Price (Tk per litre): G1+G** |
| | Crude oil process lost | | |
| | **(c) Total Operational Expense (Tk per litre)** | | |
| C1 | Average cost (A+B+C) incurred for fuel oil (Tk per litre) | | |
| C2 | **Cost (Tk per litre) considering balancing factor for HSD: C1*1.14** | | |

Source: MoPEMR

## 5. Transition from Administered to Market Based Pricing System

### 5.3 Observations regarding Automated Pricing System (Based on KIIs)

***1. Unethical Practice of BPC's Margin Including Product Cost:***

- The BPC includes margins on raw materials such as oil, gas, and water, which is contrary to international best practices that advocate only including margins on financing and investment. Internationally, margins should be calculated using the *Weighted Average Cost of Capital (WACC)* method and excluding product costs, VAT, and duty.

***2. Anomalies in Determining Conversion Rates:***

- The adopted pricing mechanism applies a financing charge of 9% per liter, which is considered excessively high without adequate justification.
- The basis for determining other rates such as L/C Commission, transit loss, and crude oil processing loss is not transparent and needs thorough review.

***3. Upward Adjustment of Exchange Rate:*** Exchange rate determination and adjustment is unclear.

***4. Unclear Factors in the Pricing Formula:***

- The components and justification for balancing factors in High-Speed Diesel (HSD) pricing are not explicitly defined.

***5. Multilayered Duty, AIT & Differential VAT Burden on Consumers:***

- Multi-layered taxes and duties, determined by National Board of Revenue (NBR) rates, significantly increase the final consumer price.

***6.* Lack of Price Adjustment Mechanisms:**

- Unlike other countries with automated systems, the newly adopted pricing mechanism does not reflect adjustments in tax and duty during international price surges, impacting domestic market prices.

# 5. Transition from Administered to Market Based Pricing System

## 5.4 BERC Price Formula

Table 9: BERC Formula

| SL. | Particulars | SL. | Particulars |
|---|---|---|---|
| A | 1. Crude oil FOB rate (Tk per Litre) | (i) | **(C)+(D) Pre-tax Ex-Refinery Price (Tk per Litre)** |
| | 2. Premium freight, service charges (Tk per Litre) | (ii) | VAT (15%) |
| | **(A) Total Produce Cost**** | **(iii)** | **(i)+(ii) Post-tax Ex-Refinery Price (Tk per Litre)** |
| B | Handling Commission (Tk per Litre) | (iv) | VAT at the Business level |
| | Port Dues (Tk per Litre) | (v) | Fuel Oil Development Fund (Tk per Litre) |
| | Survey Fee (Tk per Litre) | (vi) | Internal Transportation Cost (Tk per Litre) |
| | Insurance (Tk per Litre) | (vii) | Storage and Marketing Expense |
| | Bank Charge and Commission (Tk per Litre) | (viii) | Total Local Transportation Expense (Tk per Litre) |
| | **(B) Total Import Related Other Direct Expense** | | Other Expense, Technical Loss and Return |
| C | **(A)+(B) Total Landed Cost (Tk per Litre)** | | **(viii) Total Distribution/Dealers' Expense (Tk per Litre)** |
| **D** | **Total Storage and Supply Expense (Tk per litre)***** | E | **(iii)+(iv)+(v)+(vi)+(vii)+(viii)** **Selling Price (Tk per Litre)** |

** Ocean Loss and Pipeline Distribution Expense are included in this segment, which are subject to incidence. In our case, we assume BDT 0 for both.

*** Includes operational expense of BPC, expense associated with processing and refinery, technical loss

# 5. Transition from Administered to Market Based Pricing System

## 5.5 Overview of BERC's Automated Fuel Oil Pricing Formula

**Authority Reinstatement:** Following recent governmental changes, the Bangladesh Energy Regulatory Commission (BERC) has regained the authority to set retail fuel oil prices in Bangladesh (UNB, 2024).

**BERC Formula Overview (BERC, 2023):**

- **No Specific Margin for Government Bodies:** The BERC formula does not include a profit margin for any government entities, such as the Bangladesh Petroleum Corporation (BPC).
- **Fuel Oil Development Fund:** BERC has dedicated BDT 0.1 per liter to a fund aimed at supporting offshore exploration and infrastructure enhancements.
- **Consistency in Taxation:** The BERC formula retains similar tax, VAT, and other duty components as the BPC formula related to refinery, transmission, and distribution operations.
- **Key Differences:**
    - **VAT Structure:** Unlike the BPC, which imposes a multilayer VAT and tax system, the BERC formula simplifies this by applying a 15% VAT on the ex-refinery price and an additional 2% VAT on traders. No AIT in this case.
    - **Missing breakdowns of Various Broad Components:** The BERC formula lacks transparent breakdown of various broad components and assumed a lump-sum expense. This might be subjected to public hearing.
    - **Additional Charges in BPC Formula:** The BPC formula applies a 5% duty on imported fuel, along with various additional VATs and funds for maintenance, administrative costs, and development, which are absent in the BERC formula.

# 5. Transition from Administered to Market Based Pricing System

## 5.6 Major Differences between the BERC and BPC Formula

Table 11: Major Differences between the BERC and BPC Formula

| Issues | BPC Formula | BERC Formula |
|---|---|---|
| 1. Pipeline transportation expense and ocean loss | The BPC formula set a fixed rate for these expenses | The BERC formula set the expense of these two components subject to incidence |
| 2. Administrative, maintenance and development expense of BPC | The BPC formula has set out an expense of BDT 1.065 per litre in addition to a BPC margin of 3% to 5% from the fuel oil price. [3% margin = 2.947; 5% margin = 4.912 per litre] | The BERC formula has set out less than BDT 1.18 per litre for BPC. [BPC expense is included in the total storage and supply expense, equals BDT 1.18] |
| 3. Tax, duty and VAT structure | Multilayer structure: AIT, a 5% duty on imported fuel, along with various additional VATs for maintenance, administrative costs, and development expense, at traders' point, VAT on ex-refinery price | Simplified: VAT on ex-refinery price, VAT on traders' point |
| 4. Component with higher per litre operational expense | Internal transportation cost; financing charges (9% 3 months on crude oil); administrative, maintenance and development expense; allowable transit loss; | Total distribution and dealers' expense varies depending on the type of fuel oil; no allowable transit loss |

# 6. Proposal for Market-based Pricing of Energy for Bangladesh

# 6. CPD's Proposed Market-based Pricing of Energy for Bangladesh

## 6.1 Conceptual Framework of Market-based Price System

- **Objective:** To predict and determine effective price of fuel oil at the import point by integrating international and domestic variables into a neural network model.
- **Historical Context:** Previous pricing models focused mainly on **weighted average of fuel oil import cost**, refining, and distribution costs. These models have not adequately accounted for domestic demand, socio-economic conditions, or environmental factors, leading to prices that may not align with local realities (Raza, 2023; Islam, Ghosh, & Wang, 2023).
- **Neural Network Approach:**
  - Data Integration: Uses **historical competitive price data from global markets** as the baseline to forecast domestic prices.
  - Domestic Integration: Adds **local variables such as economic growth, inflation, and currency exchange** rates to the model to fine-tune the price forecasts to be more context-sensitive, country-specific and accurate.
  - An **effective price at the import point** will be calculated which is more suitable to the domestic socio-economic condition, reflecting the purchasing power condition of the demand side or consumers.
- **Challenges with Current Model:**
  - **Oversight in Pricing:** The final consumer price needs to reflect more than just international costs - domestic economic conditions must also be factored into the pricing model to ensure fairness and economic stability.
  - **Impact of Local Conditions:** Changes in the Bangladeshi Taka's value, inflation, and domestic demand significantly affect the cost structure once the fuel oil reaches local markets, influencing the final prices consumers pay.

# 6. CPD's Proposed Market-based Pricing of Energy for Bangladesh

## 6.1 Conceptual Framework of Market-based Price System

- Historically, the overall socio-economic condition and purchasing power of Bangladesh has been improving over time. The Neural Network model **captures these transitions to improved condition** into account and determine a price that is consistent with the historical trend of improvement and **do not allow for a worse-off situation**.
- **Complexities of Real Markets:** True market pricing must account for both supply and demand complexities that impact economic reality and social welfare.
- **Pricing Model Strategy:**
  - **Use of Average Price:** The model uses the average international price of fuel oil from four major sources to:
    - ✓ Reflect average cost scenarios, essential for planning and risk management.
    - ✓ Serve as a benchmark for assessing competitiveness against international markets.
  - **Forecasting Considerations:** Ensures forecasts considering the most probable scenarios by aligning import prices with international peaks to maintain supply security.
- **Adjusting for Socio-economic Changes:** Continuously adjusts for local socio-economic changes like exchange rate fluctuations and inflation to keep fuel prices relevant and fair for the consumers.
- **Adjusting for Macroeconomic Lags:** The model considers macroeconomic lags from historical long term non-linear time-trend and adjusts the effects accordingly.

# 6. CPD's Proposed Market-based Pricing of Energy for Bangladesh

## 6.1 Conceptual Framework of Market-based Price System

- *International Factors:*
  - **Crude Oil Production:** Global production levels impact supply dynamics and international prices
  - **World Inflation Rate:** Influences the costs associated with oil production and shipping globally
- *Domestic Economic Conditions:*
  - **Exchange Rates:** Fluctuations between the Bangladeshi Taka and the US Dollar critically impact the cost of imports
  - **Inflation and Interest Rates:** Domestic inflation affects transportation and distribution costs, while real interest rates influence financing costs for importers.
  - **Economic Growth Indicators:** Includes GDP growth rate, population growth, per capita national income, and the Gini index
- *Additional Domestic Factors:*
  - **Fuel Oil Consumption, Oil Rents and Refinery Capacity:** Trends in domestic consumption and the ability to refine oil locally affect demand dynamics and processing costs.
  - **CO2 Emission Growth Rate:** Environmental impacts and potential regulatory responses to CO2 emissions from fuel oil use can also affect fuel oil demand and pricing.
- *Dynamic Recalibration:* The model incorporates mechanisms to adjust predictions based on non-linear macroeconomic lags from emerging data points (e.g., anticipated prices for 2023), enhancing forecast accuracy and relevance.

# 6. Proposal for Market-based Pricing of Energy for Bangladesh

## 6.2 Model Description

- **Model Development:**
  - *Data Collection:* Historical oil prices and economic indicators were collected and prepared as inputs to the model, ensuring robustness against outliers through standardization.
- **Model Architecture - Layer Configuration:**
  - *First Dense Layer:* 64 neurons with Rectified Linear Unit (ReLU) activation function to handle nonlinearity and prevent vanishing gradients.
  - *Additional Dense Layers:* Progressive layers with varied neuron counts (32, 64, 128) during hyperparameter tuning to optimize learning.
  - *Dropout Layers:* Introduced with rates (0.0, 0.2, 0.5) to prevent overfitting by randomly deactivating neuron connections during training.
  - *Output Layer:* A single neuron with a linear activation function, suitable for regression tasks like price determination prediction.
- **Optimization and Tuning:** Adam optimizer used for adaptive learning rate adjustments to minimize the mean squared error (MSE).
- **Hyperparameter Tuning:** Manual grid search exploring combinations of neurons, dropout rates, learning rates, batch sizes, and epochs.
- **Cross-Validation:** Employed K-fold (3 splits) to validate model stability and performance across different data subsets.
- **Data Scaling:** Input data scaled using the Interquartile Range (IQR) method, removing the median and scaling based on the 25th and 75th percentiles.



Reference: Khalife, Cheng, & Basu (2024); Murray, Abrol, & Tanner (2022); Kingma & Ba, (2015).

# 6. Proposal for Market-based Pricing of Energy for Bangladesh

## 6.2 Findings from the Empirical Model

- MSE: 293.53
- R-square value: 0.75

Table 12: Determination of retail price of various types of fuel oil

| **Particulars** | **2023** | **2024** | **2025** |
|---|---|---|---|
| Effective (2023) Predicted Maximum Price at Import (Adjusted) – USD per BBL | $88.8 | $91.54 | $94.29 |
| Effective (2023) and Predicted Average Price at Import (Adjusted) – USD per BBL | $63.82 | $65.81 | $67.81 |
| Effective (2023) and Predicted Average Price at Import (Adjusted) – BDT per Litre | Tk 43.09 | Tk 47.60 | Tk49.04 |
| Retail Fuel Oil Price – BDT per Litre (Following formula BPC fixed portions formula – *BPC Margin: 5%):* **Diesel** | Tk 91.74 (Tk 109) | Tk 100.94 (Tk 105) | Tk 103.89 |
| Retail Fuel Oil Price – BDT per Litre (Following from BPC fixed portions formula – *BPC Margin: 5%):* **Octane** | Tk 117 (Tk 130) | Tk 122.1 (Tk 127) | Tk 125.7 |
| Retail Fuel Oil Price – BDT per Litre (Following BPC fixed portions formula – *BPC Margin: 5%):* **Petrol** | Tk 117 (Tk 127) | Tk 122.1 (Tk 131) | Tk 125.7 |

*Source: Authors' Calculation and BPC*

Note: BPC categorizes octane and petrol as luxury goods, applying an additional charge of BDT 10 per liter plus 15% VAT on these fuels. Parentheses indicate retail fuel oil price in 2023 and June, 2024.

# 6. Proposal for Market-based Pricing of Energy for Bangladesh

## 6.2 Findings from the Empirical Model

Table 11 : Determination of retail price of various types of fuel oil as per BERC model

| **Particulars** | **2023** | **2024** | **2025** |
|---|---|---|---|
| Effective (2023) Predicted Maximum Price at Import (Adjusted) – USD per BBL | $88.8 | $91.54 | $94.29 |
| Effective (2023) and Predicted Average Price at Import (Adjusted) – USD per BBL | $63.82 | $65.81 | $67.81 |
| Effective (2023) and Predicted Average Price at Import (Adjusted) – BDT per Litre | Tk 43.09 | Tk 47.60 | Tk49.04 |
| Retail Fuel Oil Price – BDT per Litre (Following formula BERC fixed portions formula): **Petrol** | Tk 65.14 (Tk 80.95) | Tk 71.10 | Tk 73.51 |

*Source: Authors' Calculation and BERC*

Note:

1. Unlike BPC, BERC does not categorize octane and petrol as luxury goods. Parentheses indicate retail fuel oil price in 2023 in accordance with the BERC formula.
2. Unlike BPC, BERC applies varying import prices to different types of fuel oil and so, individual data on other type of fuel oil is needed to calculate the price, which is beyond the scope of this study.
3. The freight of premium in the BERC also varies depending on the type of fuel oil and there is no fixed proportional calculation involved.
4. The proportional costs of BERC formula for the next two years are adjusted on an assumed inflation rate of 9%

# 6. CPD's Proposed Market-based Pricing of Energy for Bangladesh

## 6.3 Implications of CPD Estimated Energy Price

- **Potential for Price Reduction:**
  - **Analysis Insight:** Current retail prices set by BPC could potentially be reduced while maintaining adequate profit margins.
  - **Consumer Benefit:** Suggests room for lowering prices to alleviate financial burden on consumers, considering socio-economic factors, without even lowering BPC margin and fixed proportions.
- **Advantages of a Market-Driven Pricing Strategy**: Integrates a broad range of economic variables for adaptive pricing, ensuring prices are based on actual market conditions.
- **Macroeconomic Factors in Pricing:**
  - Currency Fluctuation Impact: Incorporates both the lag effect of currency fluctuations and their immediate impact on fuel prices.
  - Stabilization: Helps prevent abrupt price shocks, allowing for smoother price adjustments and reducing financial strain on consumers.
- **Challenges to Current Pricing Strategy:**
  - Luxury Classification Review: Challenges the rationale behind classifying certain fuels as luxury items, suggesting a re-evaluation could lead to more equitable pricing.
  - Realistic Market Prices: Demonstrates that a market-based system results in more realistic and typically lower prices, reflecting reduced purchasing power in a vulnerable economy.

# 7. Recommendation and Conclusion

## 7. Recommendations, Implications and Conclusions

- The study develops an **alternate price setting models** and test their possible applicability in the context of the energy market of Bangladesh; and **proposes an appropriate price** setting model for the fuel oil prices in Bangladesh from the energy security and energy transition point of view.
- Followings are the set of recommendations to be carried out by MoPEMR, BPC and BERC.

***Determination of Import FOB Price:*** Although the proportional cost of the **BERC is smaller** than those of the **BPC formula**, a concern regarding the pricing formula remains for both BERC and BPC formula at the import FOB price of fuel oil, which is taken at the face value and vulnerable to the shock of exchange rates.

- Our model proposes a different effective price at the import point, more shock absorbing and hence, suitable to the current socio-economic context.

***The current methodology of price determination must be reviewed based on the international best practices:*** The pricing methodology by the BERC and BPC has several variables, margins and indicators that are confusing and don't follow the international best practices.

- The methodology should follow the standard practices maintained by all the other pricing authorities.
- The fixed proportions of the pricing formula should be determined based on the income statement of the distribution companies while adjusting the yearly real inflation rate

## 7. Recommendations, Implications and Conclusions

***Methodology of Retail Price Needs to be Redetermined:*** Based on the findings of our study, which presents a market-based pricing model using an Artificial Neural Network (ANN), it is strongly recommended that the current methodology of price determination be redetermined.

- The adoption of the ANN-based model at the importing point, as outlined in our research, will not only simplify the pricing method but also ensure sensitivity to both fiscal constraints and consumer capabilities.
    - This change is essential for fostering a balanced and equitable pricing environment, aligning with international best practices and improving transparency and fairness in pricing strategies.

***Predictive Pricing and Consumer Planning:*** The implementation of the ANN-based model at the importing stage has significant advantages for future price predictability.

- By accurately forecasting fuel prices, consumers can better form expectations about future costs, facilitating **smoother consumption planning**. This **anticipatory pricing model** allows households and businesses to budget more effectively, ensuring they are less vulnerable to sudden price fluctuations.
    - Enhanced predictability not only contributes to improved energy security perceptions but also stabilizes market prices.

***The draft regulation prepared by BERC for the fuel oil price should be approved by the ministry immediately***: The draft mandate regarding the determination of fuel oil by BERC must be approved by the ministry. This approval will give BERC the power to determine the price of all the fuel oils.

## 7. Recommendations, Implications and Conclusions

***BERC should be the regulatory authority for determination of all the fuel oil price:*** As BERC has been established as a regulatory body of the power and energy sector, the full monitoring and implementation of the automated pricing model should be executed by BERC.

- BERC can organize public hearings on a regular basis to ensure the transparency of the process.

***Facilitating Transition to Sustainable Energy Sources:*** The predictive power of the ANN model also plays a crucial role in the strategic shift towards sustainable energy. By providing a clear forecast of fuel costs, the model enables consumers and policymakers to plan for transitions to alternative energy sources more effectively.

- This foresight supports long-term energy strategies, aligning financial and infrastructural investments with sustainable development goals.

# Thank You!