GROUP D2

Demand & Forecasting

Management Decision Science Project

Member names and task allocation

Task 1: Parvathy

Task 2: Parvathy

Task 3: Bhavya

Task 4: Rithwik

Task 5 / Case 1: Parichay

Task 5 / Case 2: _____



Forecasting and demand prediction

Forecasting uses past observations to estimate future outcomes.

Why management needs it

Managers commit budgets and resources before activity is known. A forecast makes the planning assumption visible.

Where it is used

Sales, staffing, inventory and utility demand planning. Our application is market activity on an electricity exchange.

Indian Energy Exchange (IEX)

IEX operates the trading platform and earns transaction fees.

Management problem

How should IEX plan when buyer interest and cleared activity change differently?

Decisions supported

Activity and budget assumptions, participant support, market development and investigation of weak clearing.

Financial and capacity decisions also need billable trades, fee rates and operational workload data.

What the dataset measures

Measure	Meaning	Unit
Purchase bid volume	Quantity buyers submit to purchase	MWh
Market Cleared Volume (MCV, unconstrained)	Quantity matched before transmission restrictions	MWh
Weighted Market Clearing Price (weighted MCP)	Published weighted average of market clearing prices	₹/MWh

1 million MWh = 1 billion kWh. Slides use million MWh for readability.

The Excel keeps purchase bids and MCV. Weighted MCP appears here as a definition only.

Decisions and available information

Manager’s decisions

Which simple forecast provides a useful baseline?

Which months or gaps deserve closer review?

Available information

2024 monthly history
2025 actuals for evaluation
Longer monthly and quarterly history
Published IEX market updates

Question: can a forecast made in December 2024 describe each month of 2025?

Uncertainty, constraints and variables

Uncertain information

Weather, supply offers, future bid prices and participants’ choice of market.

Constraints

Freeze forecasts at 31 December 2024. Keep 2025 actuals out of predictions.

Model variables

Monthly volume, three-month window, weights, forecast horizon and errors.

Business influences

Demand conditions, available supply, price compatibility and market rules.

Alternatives and decision scenarios

Model alternatives: equal weights (MA3) or more weight on recent months (WMA3).

Observed scenario	Proposed response for IEX
Bids and MCV rise	Review activity plans and participant support
Bids rise, MCV falls	Examine price matching and available sell offers
MCV falls below forecast	Review activity assumptions and persistent bias

Responses are our recommendations. Clearing remains governed by the auction rules.

Quantitative Application

- **Indian Energy Exchange (IEX) facilitates electricity trading between buyers and sellers.**

- **Purchase bids: quantity of electricity buyers want to purchase.**
- **Market Cleared Volume (MCV): quantity matched in the market, before transmission constraints.**

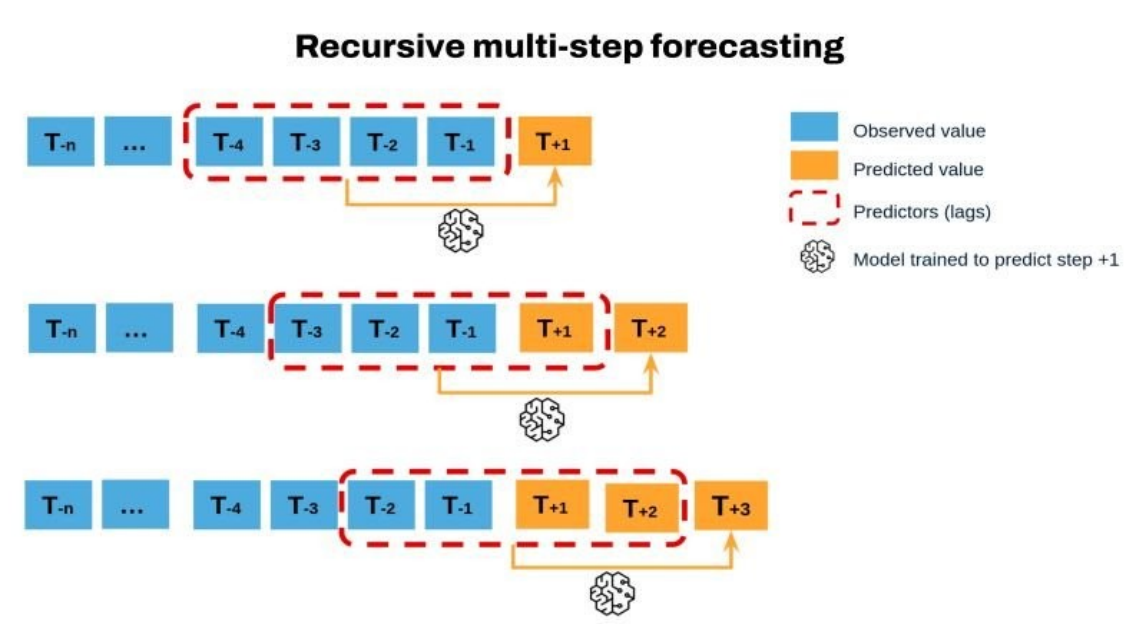
- **Data:**

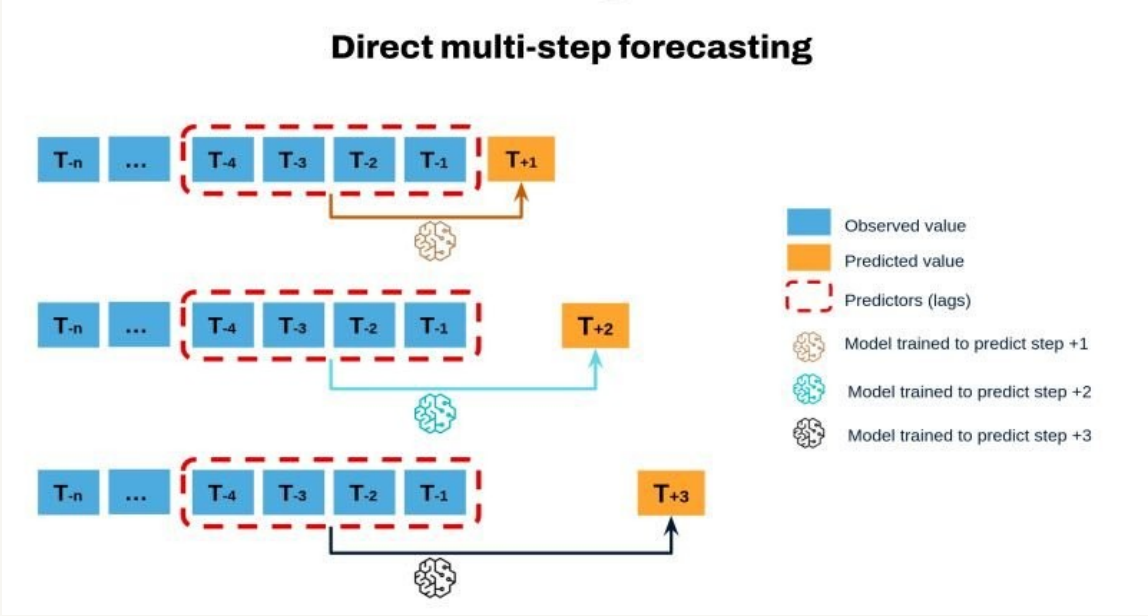
- Source: IEX Day-Ahead Market monthly data.
- Historical coverage: April 2022–September 2026.
- Forecast origin: December 2024.
- Forecast period: January–December 2025.

- **Assumptions:**

- Recent monthly values provide a useful baseline for the next month.
- Recursive Forecasting used. As future actual values are unavailable.

Recursive Forecasting





Later months use earlier forecasts because future actuals were unavailable.

Forecasting Models

Simple Moving Average

$$SMA = \frac{P_1 + P_2 + P_3 + \cdots + P_n}{n}$$

Each of the previous three months gets equal weight.

Weighted Moving Average

$$WMA = \frac{P_1 \times 1 + P_2 \times 2 + \cdot \ \cdot + P_n \times n}{1 + 2 + \cdots + n}$$

The most recent month gets the highest weight.

Purchase Bids- MA3

January 2025 purchase-bid forecast

Values shown in million MWh.

October 2024	November 2024	December 2024
6.605	8.312	10.306

(6.605 + 8.312 + 10.306) ÷ 3 = 8.408

February 2025 purchase-bid forecast

November 2024	December 2024	January 2025
8.312	10.306	8.408

(8.312 + 10.306 + 8.408) ÷ 3 = 9.009

February uses November, December and January's forecast.
By April, all three inputs are earlier forecasts.

QUANTITATIVE APPLICATION

Purchase Bids- WMA3

January 2025 purchase-bid forecast

Values shown in million MWh.

October 2024	November 2024	December 2024
6.605 × 1	8.312 × 2	10.306 × 3

Weighted total ÷ 6 = 9.025 million MWh

February 2025 purchase-bid forecast

November 2024	December 2024	January 2025
8.312 × 1	10.306 × 2	9.025 × 3

Weighted total ÷ 6 = 9.5 million MWh

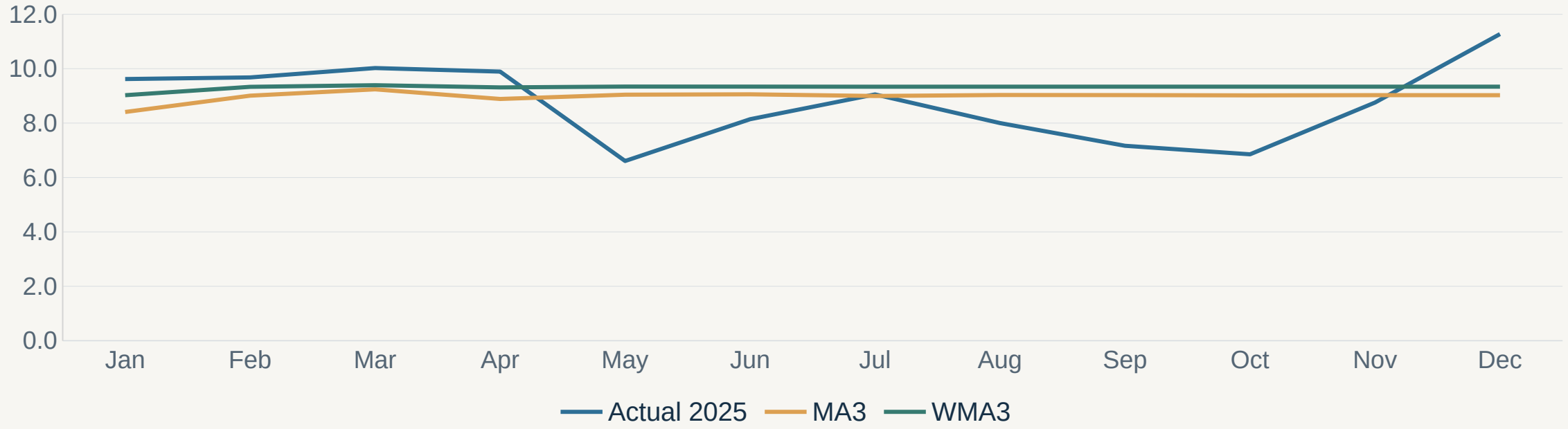
February uses November, December and January's forecast.
By April, all three inputs are earlier forecasts.

Full-year purchase-bid forecast

2025 month	Actual	MA3 forecast	WMA3 forecast	MA3 deviation	WMA3 deviation
Jan	9.619	8.408	9.025	1.211	0.594
Feb	9.678	9.009	9.333	0.670	0.345
Mar	10.022	9.241	9.392	0.781	0.630
Apr	9.893	8.886	9.311	1.007	0.582
May	6.606	9.045	9.342	-2.439	-2.736
Jun	8.143	9.057	9.340	-0.914	-1.197
Jul	9.053	8.996	9.336	0.057	-0.283
Aug	8.000	9.033	9.338	-1.032	-1.338
Sep	7.166	9.029	9.338	-1.862	-2.171
Oct	6.852	9.019	9.338	-2.167	-2.485
Nov	8.755	9.027	9.338	-0.272	-0.583
Dec	11.272	9.025	9.338	2.248	1.935
2025 total	**105.060**	**107.773**	**111.768**	**-2.713**	**-6.708**

Purchase Bids: 2025 Forecast vs. Actual

Monthly energy volume (million MWh)



MA3 MAPE 14.99%

WMA3 MAPE 15.69%

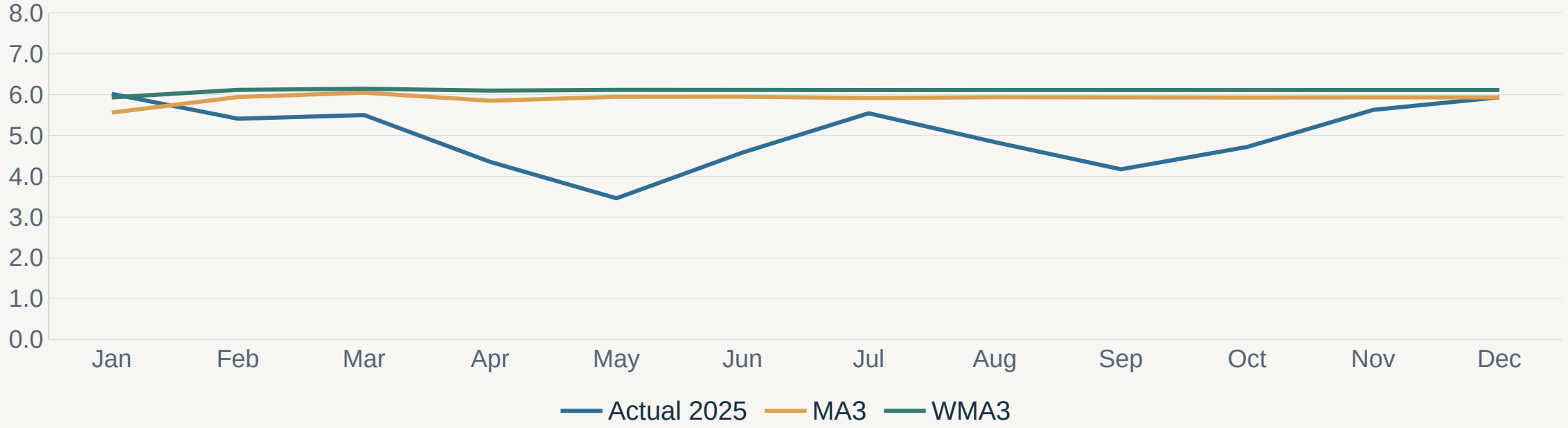
May produces the largest absolute miss. A close annual total can hide monthly errors.

Full-year MCV forecast

2025 month	Actual	MA3 forecast	WMA3 forecast	MA3 deviation	WMA3 deviation
Jan	6.017	5.560	5.931	0.457	0.087
Feb	5.409	5.940	6.116	-0.531	-0.707
Mar	5.499	6.048	6.142	-0.549	-0.643
Apr	4.352	5.849	6.098	-1.498	-1.746
May	3.461	5.946	6.116	-2.484	-2.654
Jun	4.581	5.948	6.114	-1.367	-1.533
Jul	5.543	5.914	6.112	-0.371	-0.569
Aug	4.836	5.936	6.113	-1.099	-1.277
Sep	4.172	5.932	6.113	-1.761	-1.941
Oct	4.719	5.927	6.113	-1.209	-1.394
Nov	5.626	5.932	6.113	-0.306	-0.487
Dec	5.933	5.931	6.113	0.002	-0.180
2025 total	**60.147**	**70.862**	**73.193**	**-10.715**	**-13.046**

MCV: 2025 Forecast vs. Actual

Monthly energy volume (million MWh)



MA3 MAPE 22.18%

WMA3 MAPE 25.08%

Both methods forecast too much annual MCV. Recursive averages flatten over time.

How forecast errors are measured

Error = actual − forecast. Negative error means the forecast was too high.

Measure	Simple calculation	What it tells us
MFE	Average signed error	Direction of bias
MAE	Average absolute error	Typical size of a miss
MSE / RMSE	Average squared error / its square root	Emphasis on large misses
MAPE	Average of (absolute error ÷ actual × 100)	Average monthly percentage miss

Every score uses 12 months. MAPE averages monthly percentages, not the annual error rate.

Accuracy and bias: both methods compared

Target / method	MFE	MAE	MSE	RMSE	MAPE
Bids / MA3	-0.226	1.222	2.057	1.434	14.99%
Bids / WMA3	-0.559	1.240	2.248	1.499	15.69%
MCV / MA3	-0.893	0.970	1.423	1.193	22.18%
MCV / WMA3	-1.087	1.102	1.775	1.332	25.08%

MA3 has lower absolute-error scores for both targets.

All MFE values are negative. Units: million MWh; MSE uses (million MWh)².

Purchase bids and MCV leave a volume gap

2025 total, million MWh	Purchase bids	MCV	Difference
MA3 forecast	107.773	70.862	36.910
Actual	105.060	60.147	44.913

Gap = submitted purchase quantity − unconstrained matched quantity.

Price limits and available sell offers determine which bids match. More buying interest can coexist with lower clearing.

Recurring monthly tendencies

High or low compared with that year’s monthly average, in all three years 2023–2025.

Measure	Consistently higher	Consistently lower
Purchase bids	January	May, September
MCV	January, November, December	May, August, September

Simple check: annual total ÷ 12. Compare each month with that number.

Other months have mixed results. “Higher” does not mean the highest month of the year.

Recurring quarterly tendencies

Calendar quarter	Months	Both bids and MCV
Q1	January–March	Above average in 3 of 3 years
Q2	April–June	Below average in 3 of 3 years
Q3	July–September	Below average in 3 of 3 years
Q4	October–December	Above average in 3 of 3 years

Simple check: annual total ÷ 4. Compare each quarter with that number.

1. July 2026 purchase-bid jump

July 2025	July 2026	Year-on-year change
9.053	12.899	+42.48%

(12.899 ÷ 9.053 − 1) × 100 ≈ 42.48%

Crisil links higher national demand to cooling use during an uneven monsoon. IEX links that demand growth to more buy bids.

Million MWh. IMD: rainfall 15% below normal for 1 June–29 July 2026.

2. February MCV growth accelerates

February	MCV, million MWh	Growth versus previous year
2024	4.742	Baseline
2025	5.409	+14.05%
2026	6.570	+21.48%

Growth accelerated by about 7.4 percentage points.

IEX reports more available supply and cheaper exchange power, offering buyers an alternative to costlier procurement.

3. July bids rise while MCV falls

Million MWh	July 2025	July 2026	Change
Purchase bids	9.053	12.899	+42.48%
MCV	5.543	5.064	−8.64%
Bids minus MCV	3.510	7.835	Gap widens

Higher clearing prices can leave more buy bids below the matching price.

This is a plausible mechanism. Monthly totals cannot establish the exact cause of the MCV decline.

4. June MCV reverses after 2024

June	MCV, million MWh	Year-on-year change
2023	4.124	Comparison baseline
2024	4.995	+21.12%
2025	4.581	−8.29%
2026	4.313	−5.84%

Strong growth was followed by two consecutive June declines.

The 2025 rate is −8.29%. This is a reversal across years, not a guaranteed June rule.

June’s reversal has different yearly conditions

Year	Documented conditions
2024	Heat drove high electricity demand. Government measures also increased available supply.
2025	Early monsoon reduced temperatures. IEX reported national consumption down 1.5%.
2026	Heat and late monsoon lifted national consumption 11.6%, yet snapshot MCV fell 5.84%.

June 2026 shows that national demand and DAM clearing can move differently.

The precise cause of June 2026’s MCV decline remains unproven.

5. October 2023 purchase-bid spike

Comparison month	Purchase bids, million MWh
October 2022	6.459
September 2023	7.862
October 2023	10.201

+29.76% month on month **+57.94% year on year**

IEX cites below-average rainfall and a low prior-year base. Stronger national demand led utilities to buy more through the exchange.

Monthly totals: October has 31 days; September has 30. Both Octobers have 31.

Recommendations for managers

Inventory & Buffer Planning

Forecast demand to estimate how much stock will be needed and when.
Set a safety buffer to reduce the risk of shortages

Pricing Decisions

Use expected demand to inform pricing. When demand is expected to weaken,
Check competitors and costs before changing prices.

Support and resources

Use seasonal tendencies to time reviews.
Check order counts before staffing or IT decisions.

Financial assumptions

Combine billable trading volume and fees before estimating revenue, costs or profit.

Recommendations for IEX management

Planning baseline

Use MA3 as the better historical baseline among the two tested methods.

Market monitoring

Track bids and MCV separately. Investigate widening gaps with price-level data.

Support and resources

Use seasonal tendencies to time reviews. Check order counts before staffing or IT decisions.

Financial assumptions

Combine billable trading volume and fees before estimating revenue, costs or profit.

Sensitivity to recent-month weights

Target	MA3 MAPE	WMA3 MAPE	Change
Purchase bids	14.99%	15.69%	+0.70 pp
MCV	22.18%	25.08%	+2.90 pp

Extra weight on late-2024 volumes made the 2025 forecast less accurate.

Hold the forecast date and actual months constant. Change only the weighting method.

Limits and a practical review process

Limits

One full test year

Recursive forecasts flatten

Monthly totals hide bid prices

Historical snapshots may be revised

Manager’s review

Compare forecast with actual monthly.

Track bias and absolute errors.

Investigate unusual movements before changing plans.

A future live forecast may update with new actuals. This 2025 test remains frozen at December 2024.

Case 1: IEX’s changing market mix

1. Business problem

May 2025 DAM trade fell while total exchange electricity trade grew. A single segment could mislead planning.

2. Why it mattered

IEX needs to know where activity occurs when planning participant support and business assumptions.

3. Alternatives

Compare a DAM-only outlook with separate product forecasts and a reconciled exchange total.

4. Constraints

Use consistent product definitions, available information and regulated auction rules.

Case 1: evidence, approach and lessons

5. Relevant information

May 2025: DAM 3,510 MU; RTM 4,770 MU. IEX reported cooler weather and more supply.

6. Proposed class approach

Forecast each product separately with moving averages. Compare errors and investigate exceptions.

7. Documented outcome

DAM fell 20%, RTM rose 42%, and total electricity trade rose 14% to 10,946 MU.

8. Managerial lesson

Check both the segment and the whole business before reacting to a decline.

Case 2: Duke Energy’s demand outlook

1. Business problem

Higher customer-demand forecasts required Duke to revisit its resource plan in 2024.

2. Why it mattered

Capacity decisions had to maintain reliable, affordable electricity service.

3. Alternatives

Different combinations and timing of generation, storage and demand-side resources.

4. Constraints

Reliability, cost, emissions requirements, development time and regulatory approval.

Case 2: forecasts influenced the plan

5. Relevant information

Updated customer demand, existing resources, future costs and system-modeling evidence.

6. Class connection

Use trend and seasonal patterns to discuss demand. Detailed utility planning needs further models.

7. Documented outcome

On 1 November 2024, the regulator accepted planning analysis and approved near-term actions.

8. Managerial lesson

Changed forecasts can require changed plans. Recheck assumptions and compare alternatives.

Source guide and calculation map

Evidence	Source / workbook location
Forecast inputs and actuals	IEX monthly snapshot; Source data, Purchases, MCV
Class formulas and errors	Class slides 15–24; Maths tab
Five movements and seasonality	IEX releases, Crisil and IMD; Trends tab
Company role and cases	IEX annual report; IEX release; Duke and NCUC

Exact links and evidence limits appear in slide notes and Excel.