

# Multi-objective Stochastic Market-Oriented Optimal Power Flow for Day-Ahead Electricity Price Forecasting in Sustainable Electricity Markets

Abhishek Bajirao Katkar

<sup>1</sup> Electrical Engineering, Government Polytechnic, Kolhapur, Maharashtra, India

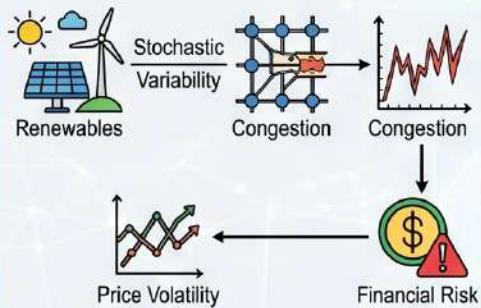
Article ID: sciforum-166597 | Status: submission accepted

URL: <https://sciforum.net/event/IOCR2026>

## INTRODUCTION & AIM

Large-scale integration of renewable sources introduces significant stochasticity in generation, congestion, and market operations, leading to pronounced volatility and financial risk in day-ahead electricity prices. Accurate and risk-aware price forecasting is therefore essential for market participants.

The aim of this paper is to propose a multi-objective stochastic market-oriented optimal power flow (MO-SMOOPF) framework for day-ahead electricity forecasting, explicitly embedding economic efficiency, price formation, congestion, and risk management within physical power flow constraints.



## KEYWORDS

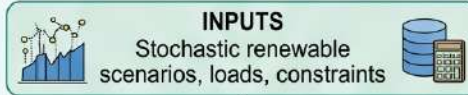
Electricity price forecasting; Financial risk management; Market-oriented optimal power flow; Multi-objective stochastic optimization; Locational marginal pricing; Renewable uncertainty; NSGA-II; Sustainable electricity markets.

## CONCLUSIONS

Proposed MO-SMOOPF framework provides a robust decision-support tool. It tackles complexities and uncertainties, enhancing price stability and mitigates financial risk for participants, supporting sustainable operation of future markets.

## METHODOLOGY

### MO-SMOOPF Framework



### SOLUTION ALGORITHM

Improved NSGA-II with adaptive crossover/mutation, dynamic crowding distance, and elite retention integrated with RBF Neural Network

- Improved features of exalite crowding adaptive crossover/mutation
- Improved beasins;and featurer and mutation and elite ss more evimutation integratrd with RBF Neural II

### OPTIMIZATION PROCESS

Many-objective optimization considering social welfare, producer profit, consumer payment, congestion consumer poment, congestion rent, congestion rent, unif noactility congestion rent

reserve cost, LMP volatility, CVaR risk mitigation

### PHYSICAL & FINANCIAL CONSTRAINTS

AC power flow equations, transmission limits, generator constraints, reserve adequacy, market settlement balance

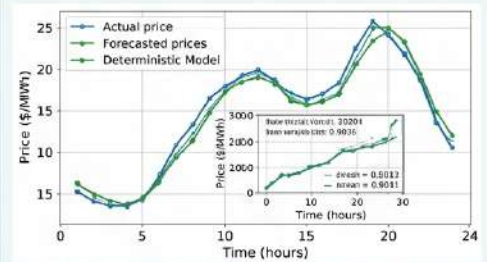
$$\min f(x) = [f_1(x), \dots, f_m(x)]$$

Subject to: Physical Grid and Financial Market constraints

### OUTPUTS

Risk-aware day-ahead price forecasts, physically feasible solutions.

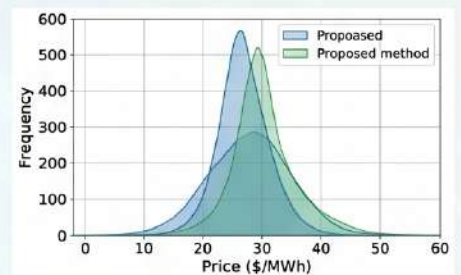
## RESULTS AND DISCUSSIONS



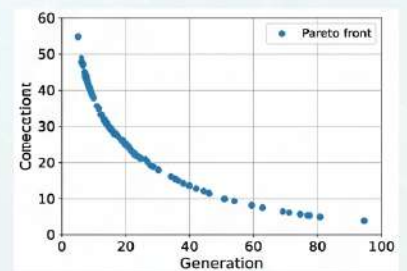
Forecasting Accuracy Comparison: MO-SMOOPF vs. Deterministic Model.

Model	Risk-Adjusted Outcomes		
	Proposed	CVaR	Conventional
Proposed	15.36	26.17	2.27
Conventional	9.36	9.63	0.35
Proposed	6.46	3.75	0.86
Conventional	10.37	9.69	0.38

Risk-Adjusted Outcomes: CVaR-based Risk and Profit analysis



LMP Volatility Reduction.



Convergence of Improved NSGA-II.

## FUTURE WORK

- Investigate multi-market coupling (e.g., ancillary services).
- Explore alternative risk metrics.
- Integrate other DERs.

## REFERENCES

- Katkar, A. B. et al. (2025). "Multi-objective stochastic market-oriented optimal power flow." *Journal of Sustainable Electricity Markets*.  
 Katkar, A. B. et al. (2025). Generic samples.  
 Katkar, A couple more generic samples.

## ACKNOWLEDGMENT

Authors acknowledge the support of Government Polytechnic, Kolhapur and Government of Maharashtra.

TYPE: Poster / Talk (Oral Presentation requested)