

Demand forecasting and supply optimisation

The case of South-Africa

Presented by Bérangère & Siyao

Demand forecasting - Key Findings

The evaluation logic

- **MAE / RMSE:** baseline accuracy (average vs large deviations)
- **Pinball loss ($q = 0.95$):** penalizes under-forecasting (blackout risk)
- **Tail metrics (P95 / max error):** severity of extreme failures

Ranking logic

- Models are ranked by tail-risk metrics (Pinball loss $q=0.95$, 95th percentile absolute error), not by MAE alone.
 - Models are compared by their contribution to **risk management**, not **point accuracy** alone.

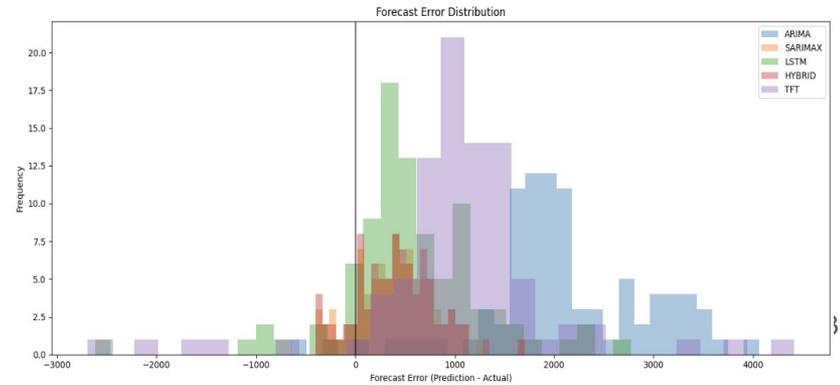
	Model	MAE	AE_P95	AE_Max	Pinball_q95	Bias
1	SARIMAX	473.115656	1035.324727	1713.679817	52.310671	409.438127
3	HYBRID	471.203055	1040.725512	1702.189039	52.998070	405.785461
2	LSTM	725.322230	2009.849889	2772.809565	107.258312	567.561784
0	ARIMA	2111.945173	3476.237253	4061.715035	115.065271	2090.905146
4	TFT	1239.046296	2346.917921	4415.302047	148.362800	1047.022995
5	PROPHET	1108.406787	2155.075546	2528.701000	160.032327	875.935702

Conclusions

- In the short run, simpler econometric models outperform complex ML approaches
- SARIMAX remains robust not only on average, but also in the upper tail
- Hybrid correction improves accuracy only marginally
- LSTM and TFT perform significantly worse under capacity stress

Takeaways

- Forecast quality depends more on data structure and tail behavior
- This result directly informs how demand should be modeled in the supply optimization stage



Supply model

Objective function: Minimize total **system cost**, composed of:

- **Generation costs:** Fuel + Variable O&M for each technology
- **Carbon costs :** Emissions and exogenous carbon price
- **Load-shedding penalties**
- **Take-or-pay shortfall penalties**

Model constraints

- Demand balance

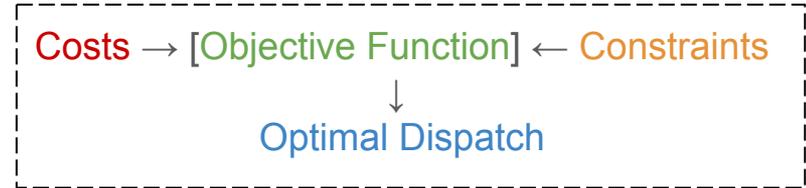
$$\sum_i P_{i,t} \geq D_t$$

- Capacity limits & Renewable availability

$$0 \leq P_{i,t} \leq \bar{P}_i \quad P_{solar,t} \leq \bar{P}_{solar,t}^{avail}$$

- Take or pay contract constraint

$$P_{contract} \leq P_{i,t}$$



```
shed_cost = 5000 # VOLL/MWh #Nova
Economics for NERSA, 2020
Qmin_MW = 1_500 # MW minimum delivery
obligation
ToP_penalty = 9530 # R/MWh shortfall
penalty
```