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Probabilistic Forecasting in PV System Operation: An Overview

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Agenda

- **Uses Cases Based on Sector**
  - Energy Market Participation
  - Grid and Portfolio Management
  - Asset Operation and Optimization
  - Enhanced Strategies and New Services
- **Potential Business Cases for Probabilistic Forecasts – Client Based**

Energy Market Participation

IPPs / Utilities / Energy Traders

- **Bidding Strategies - Optimal Quantile Bidding**
  - ‘Optimal Quantile’ - higher average revenues and lower penalties than bidding the mean or median
- **Revenue Optimization under Uncertainty**
  - ‘Confidence Intervals’ – Avoids under or overbidding
  - More clearer picture on curtailment/imbalance - Asset for energy arbitrage
  - Accurate reserve requirement calculations – Asset for Ancillary markets
- **Risk Management**
  - Help manage the risk of rare but costly extreme events (substantial forecast errors)
  - Can be incorporated into constrained or risk-averse bidding strategies (expected value vs DSM penalties)

Grid and Portfolio Management

TSOs / DSOs / Aggregators

- **Balancing Reserve Sizing & Congestion Management**
  - Exact probabilities of excess/shortfalls - Reduced error margins
  - Directly translates to required size and activation strategy - cost and reliability improvements

- **Portfolio Diversification**
  - Quantify correlation between sites – Imbalance handling at portfolio level

Asset Operation and Optimization

Plant Operators / Hybrid System Operators

- **Battery and Hybrid System Dispatch**
  - Enables Model Predictive Control (MPC), thus transparency on profit - health trade-offs – Optimized Battery Cycling
- **Storage Optimization**
  - Better decisions on charging & discharging
- **Curtailment Management**
  - Limits the risk of oversupply to grid (Might be of interest based on regulations)
- **O&M Scheduling**
  - Scheduled maintenance at high probability low production period – Reduced generation loss & improved grid stability

Enhanced Strategies and New Services

All Stakeholders

- **Insurance Products**
  - Quantified uncertainty allows design of “forecast accuracy guarantees” or imbalance insurance
- **Contract Structuring**
  - Risk premiums from forecasts for PPAs or flexibility services – A pathway for newer energy contracts
- **Trading in Multiple Market Layers**
  - Competitive participation in spot markets and intra-day markets – Increased Arbitrage

Part 1/2

Clients	Category	Usability	Output	Complexity & Status Quo
Urbasolar(FR)	IPP	Revenue Maximization	% increase in revenue	High + Strong
Neoen (FR)	IPP			
Vena Energy (IDN)	IPP			
Enefit Green(EST)	IPP			
Adris Grupa(CRO)	IPP			
BlueLeaf Energy(AsiaPacific)	IPP			
Engie Chile	IPP			
Finerge (POR)	IPP / Trader			
Grid Beyond(UK)	Aggregator / Trader		% increase in revenue	IPP + portfolio level
Sunnic(GERMANY)	Aggregator / Trader			

Part 2/2

Clients	Category	Usability	Output	Complexity & Status Quo
PowerFlow Trade (LAT)	Aggregator / Trader			
Adani (IND)	Utility	Same as IPP	Same as IPP	Moderate
TATA Power (IND)	Utility			
Engie India	Utility			
Enel (SPAIN)	Utility			
Masdar (Multi)	Utility			
Corsica Sole (FR)	Hybrid Sys	Battery Health	% reduction in LCOS	Moderate to high, Avg
SiemensEnergy (FR)	Hybrid Sys			
Spie-Kibali (AFR)	Hybrid Sys			
Electricite de Tahiti (FR)	Standalone	Improved operational planning	% reduction in LCOE	Highly complex and not studied

Stakeholders based Use Cases

Summary	Key Use cases	Advantages
Renewable IPPs, Utilities	Market Bidding, Portfolio Management	Reduced Penalties, Increased Revenue, Risk Management
Aggregators, DSOs, TSOs	Reserve Management, System Operation	Reduced Reserves, Improved Reliability
Hybrid Asset Operators	Dispatch Optimization, Asset Care (Trade-off)	Longer Asset Life, Lower OPEX, Increased Profit Margin
Energy Traders	Risk-Aware Bidding, New Service Design	New Contract Types, Product Innovation
General	Regulatory Compliance and Reporting	Documented Risk Management, Transparency

THANK YOU