From Forecast to Action: Enabling Predictive O&M Through Weather-Driven PV Performance Analytics

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EU PVPMC, Ayia Napa, 30.10.2025

What does Univers Analytics do?

Transforms raw PV data into performance intelligence — the foundation for predictive analytics and O&M proactive actions.



Expectations

Losses

O&M driven improvement opportunity

Forecast

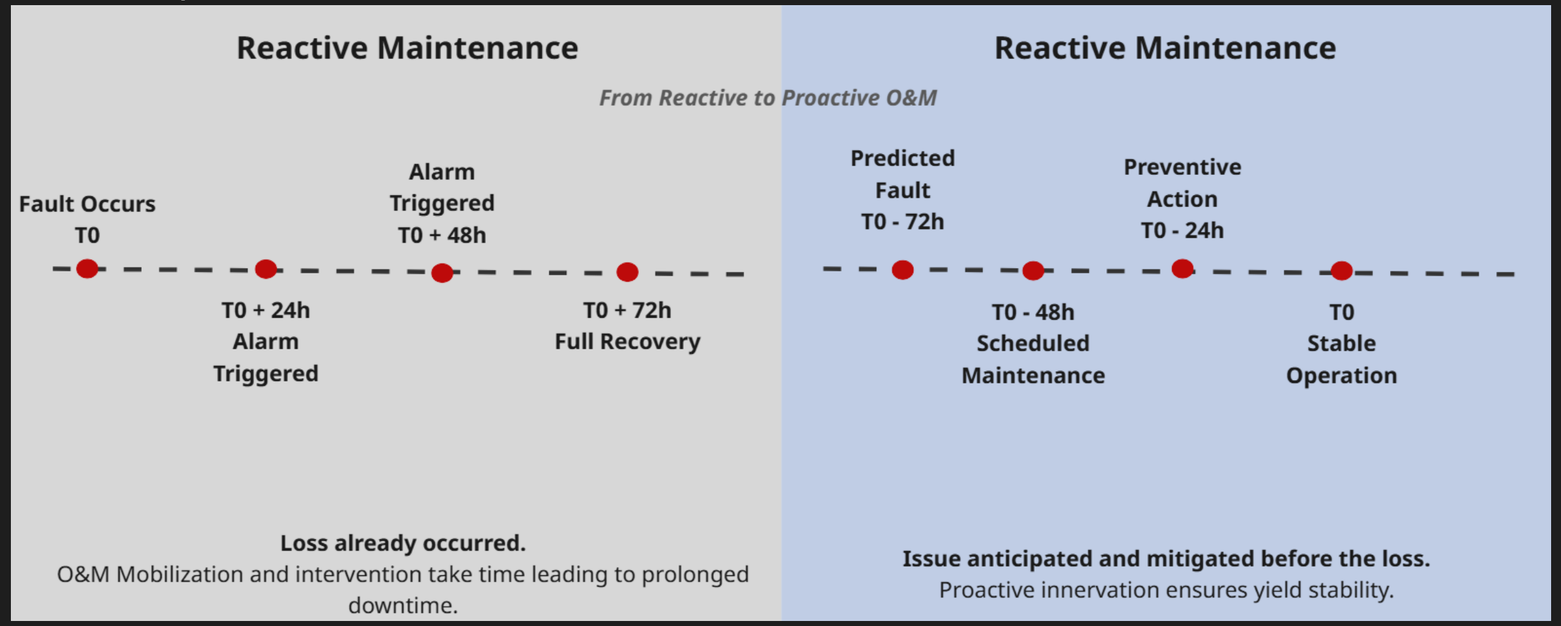
Detect

Act

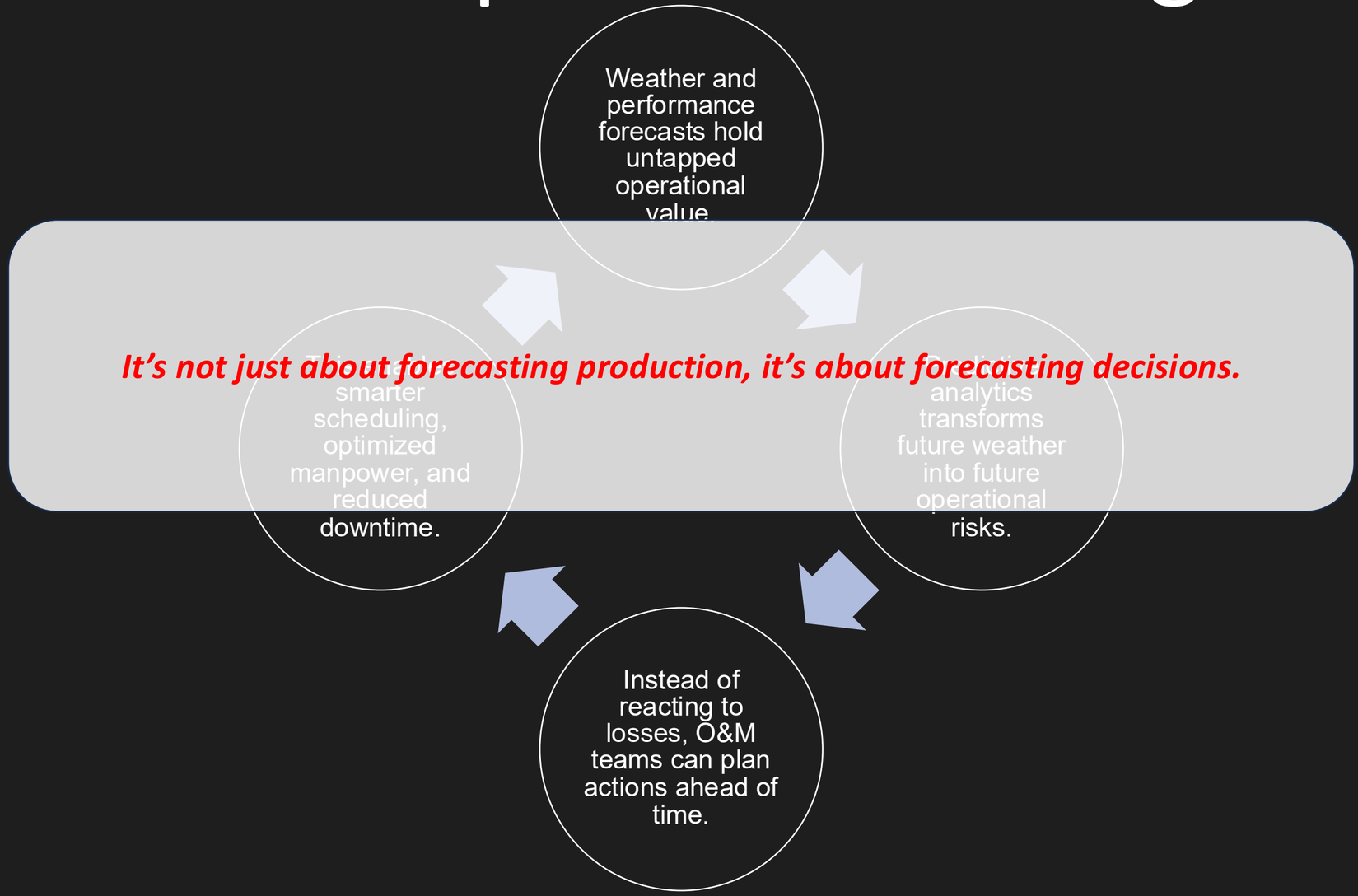
Introduction

Predictive O&M

- As solar portfolios grow, the volume and complexity of operational data increase exponentially.
- O&M teams struggle to maintain efficiency across hundreds of geographically dispersed sites with varying environmental conditions.
- **Reactive maintenance** identifies issues after energy losses have occurred → delayed interventions and inefficiencies.
- **Predictive maintenance** shifts the paradigm by anticipating potential issues through real-time analytics and weather-based forecasting.
- Predictive O&M bridges the gap between **forecast data, performance analytics**, and **maintenance actions**, transforming weather insights into direct operational value.



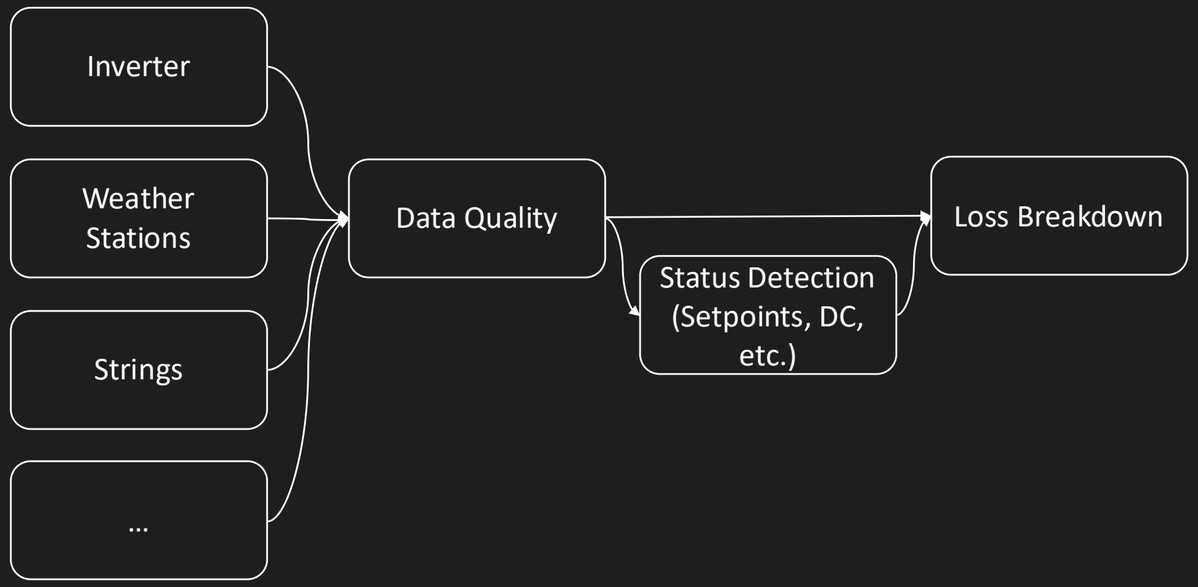
From Forecast to Operational Foresight



Forecasted Loss Breakdown: The Missing Link

Historical Loss Breakdown

Raw Inputs

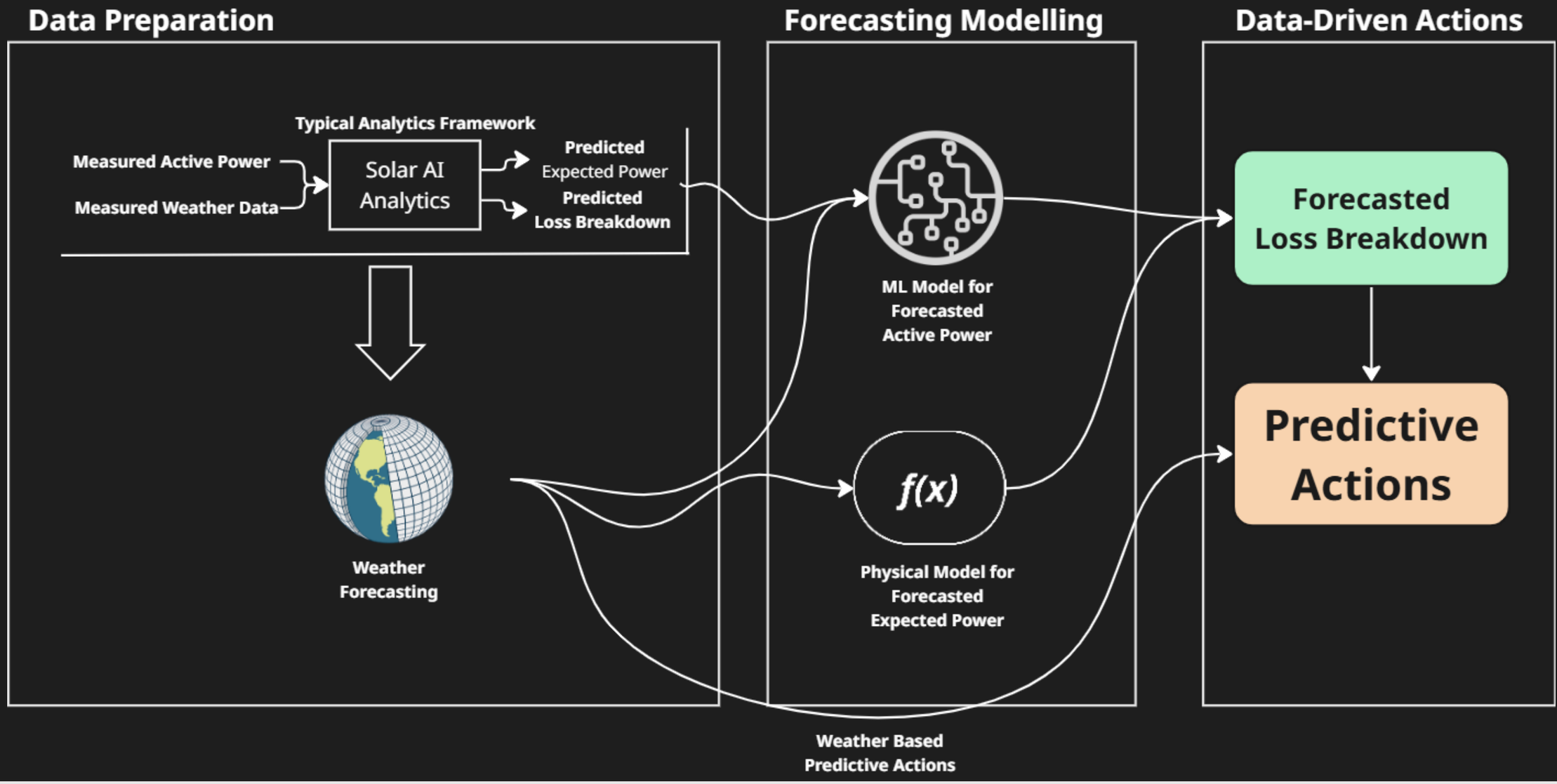




Predictive Loss Breakdown

The Predictive Analytics Framework

The Framework – High Level Architecture



Forecasted Loss Breakdown: The Missing Link

Historical Loss Breakdown

Raw Inputs

- Inverter
- Weather Stations
- Strings
- ...

Data Quality

Status Detection (Setpoints, DC, etc.)

Loss Breakdown



Predictive Loss Breakdown

Historical Set of Loss Breakdown



ML Model

Forecasted Loss Breakdown

Forecasting where losses will happen is the first step toward preventing them.

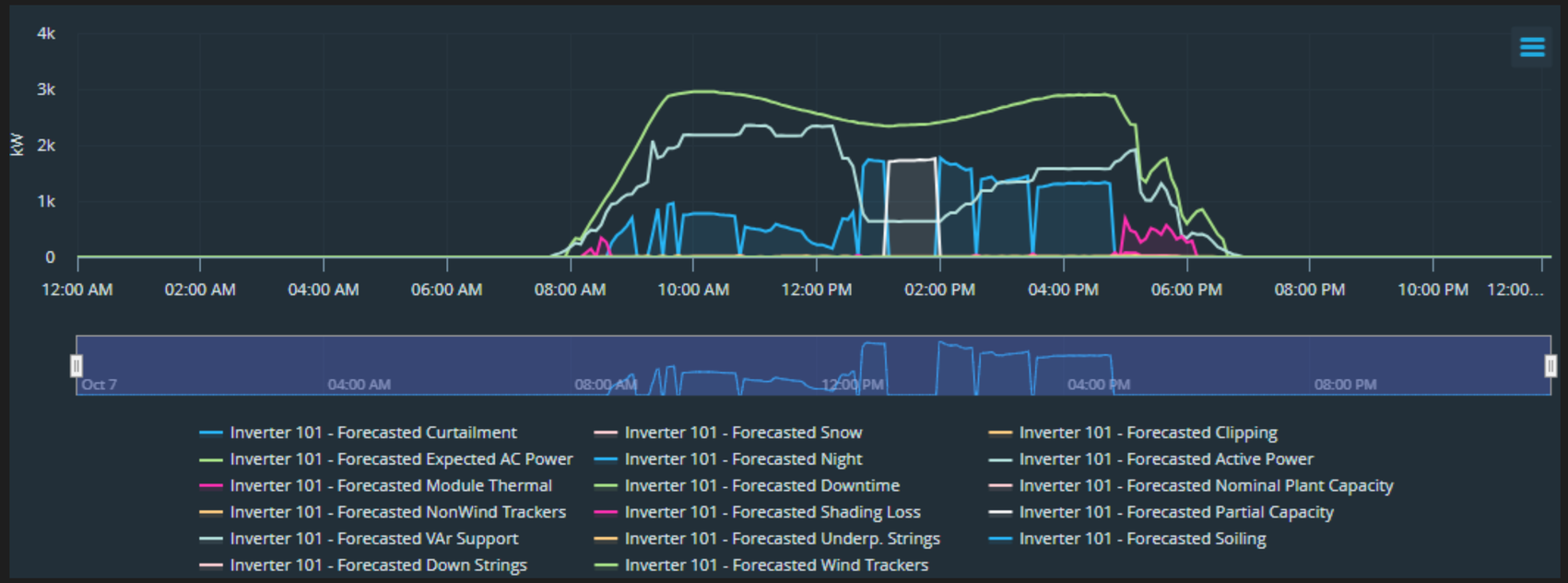
The Framework – Predictive Actions Mechanism

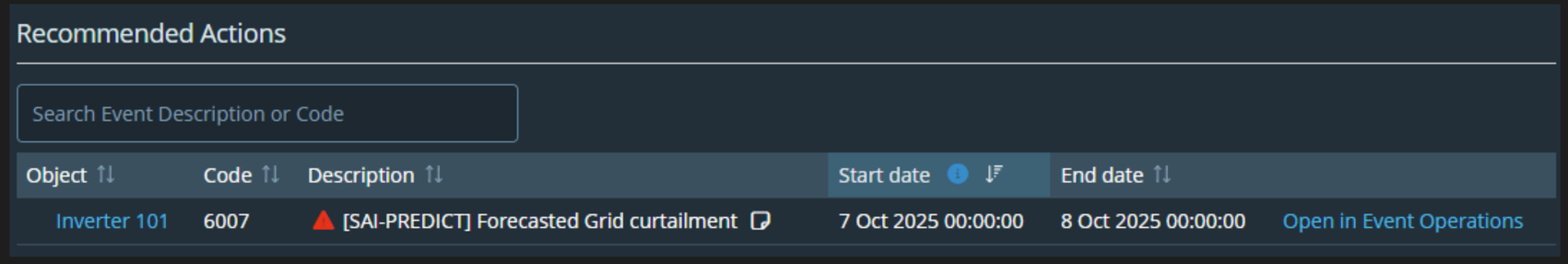
Forecasted Parameter	Detected / Predicted Condition	Recommended Predictive Action	Expected Operational Outcome
Soiling Loss	Rising loss % under prolonged dry spell	Schedule or delay washing based on rainfall forecast	Maintain PR stability / reduce unnecessary wash cost
Curtailment	Forecasted curtailment >50%	Plan maintenance during curtailment hours	Perform maintenance with zero yield impact
Temperature Derating	Forecasted temperature >40 °C	Inspect inverter cooling and filters	Prevent inverter trips / reduce derating
Clipping	Forecasted clipping >30%	Defer non-critical maintenance	Maximize yield during high-production periods
Downtime Risk	Predicted downtime >20%	Inspect communication / control systems	Avoid fault escalation / data loss
Rainfall	Forecasted rain >5 mm	Defer washing; monitor post-rain recovery	Save O&M cost / validate natural cleaning
Wind Speed	Forecasted wind >23.75 m/s	Verify tracker stow / mechanical readiness	Prevent structural or tracker damage

Steps – Power Forecasts

Step 3: Forecasted Loss Breakdown

The allocation of forecasted loss breakdown percentages to each category is currently derived from the actual loss breakdown observed on the preceding day.





Step 1: Active Power Forecasting

Step 2: Expected Power Forecasting

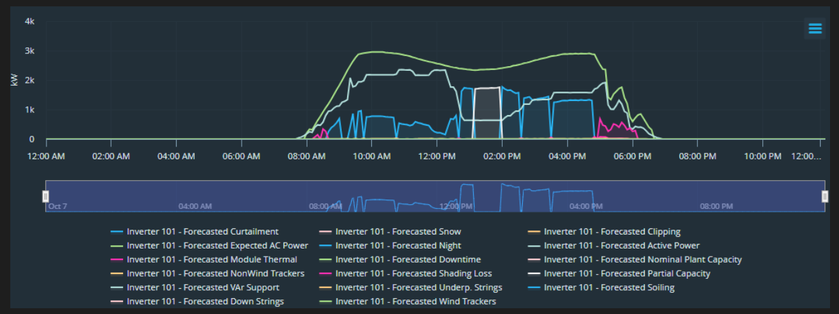
Step 4: Actions

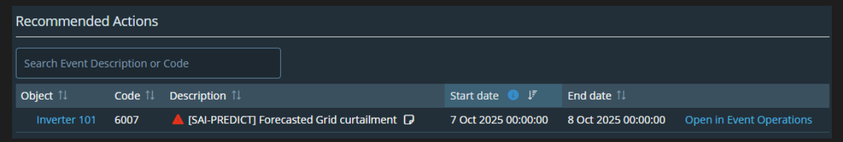
Currently, targeted predictive actions are initiated to inform technical teams of anticipated production levels, facilitating optimal maintenance scheduling.

Use Cases

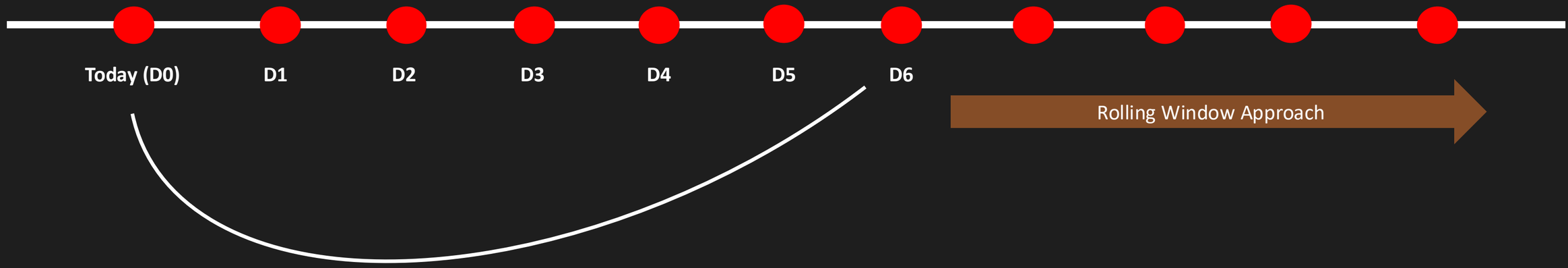
Use Case: Forecasted Curtailment

- Day 0: The forecast indicates grid curtailment is anticipated between 10:00 and 14:00 the following day because of transmission congestion.
- Breakdown of Predictive Loss:
  - Curtailment: 65%
  - Soiling: 15%
  - Temperature Derating: 10%
  - Other Factors: 10%
  - System Response: Predictive measures implemented



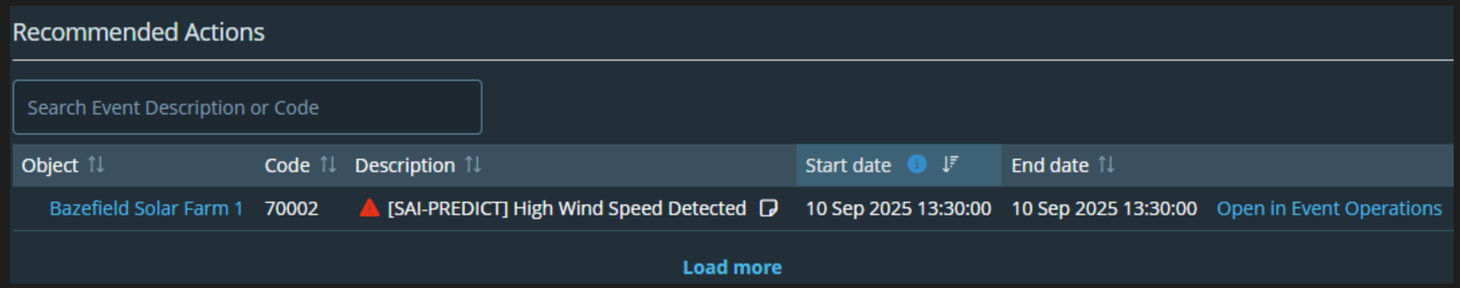


Schedule non-critical maintenance during curtailment window to minimize production impact.

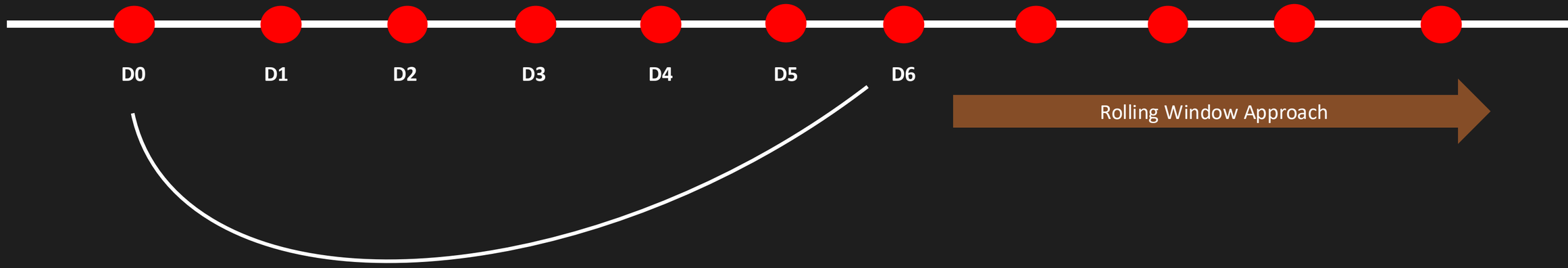


Use Case: Forecasted High Wind Speed

- Day 0: Weather Forecasts show High Wind Speed:
  - WS > 23.75 m/s
  - Activated only for tracker sites



Ensure the Tracker Stow Mode Will Operate



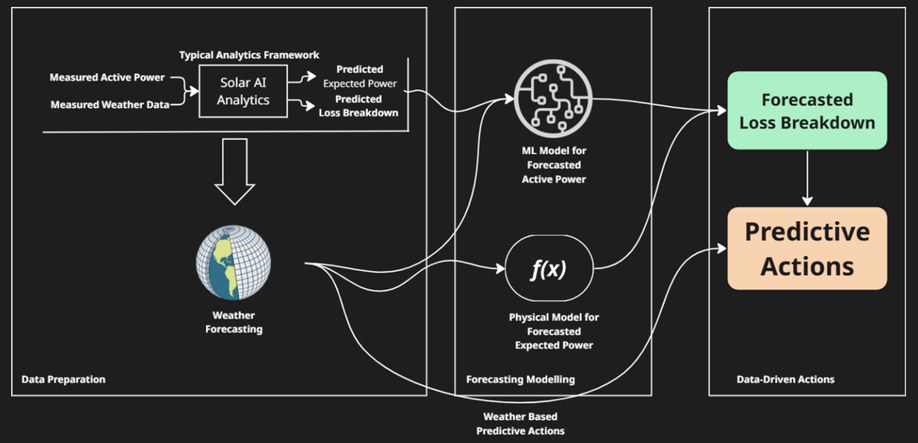
Conclusions

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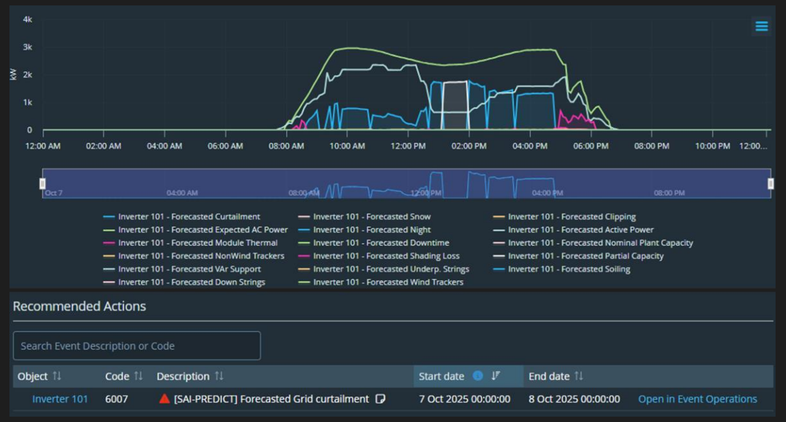
- The Framework converts weather forecasts into quantified, **category-specific loss risks**, giving **O&M teams early visibility and clear priorities.**

- By linking predicted losses to **targeted actions**, it enables **proactive maintenance**, **optimized scheduling**, and **reduced yield impact.**

- **Predictive O&M goes beyond forecasting losses**, it's about **acting before they occur** to protect performance and reliability.

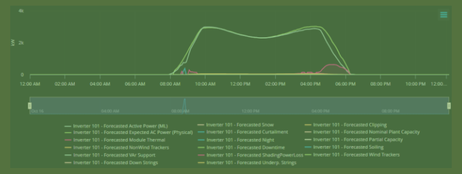
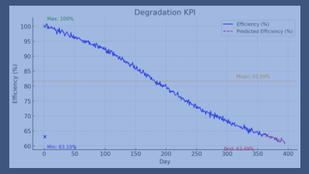
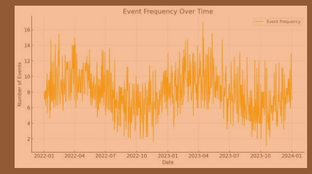


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Future Developments

Predictive Analytics Timeline

Weather Forecast-based	KPI Projections	Seasonal Patterns
Short-term (1 to 16 days ahead)	**Mid-term** (weeks to months)	**Long-term** (months to year(s))
• A simplified physics-based power model is implemented to generate power forecasts using weather prediction data. • Weather-forecast–driven predictive actions are applied to monitor key environmental factors such as temperature, rainfall, and wind speed, enabling early detection of potential performance risks.	• Continues monitoring of the trends of some KPIs to trigger Predictive Action. • KPIs to monitor degradation, DC health, soiling, inverter efficiency, etc.	• Classification of historical events and actions to identify frequency, seasonality and periodicity check. • Helps to proactively trigger actions during high-risk periods
		
Current Developments	Work in Progress	Future Developments

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Thank you for your attention!



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