The Hidden Losses and Impacts Behind Grid Constraints

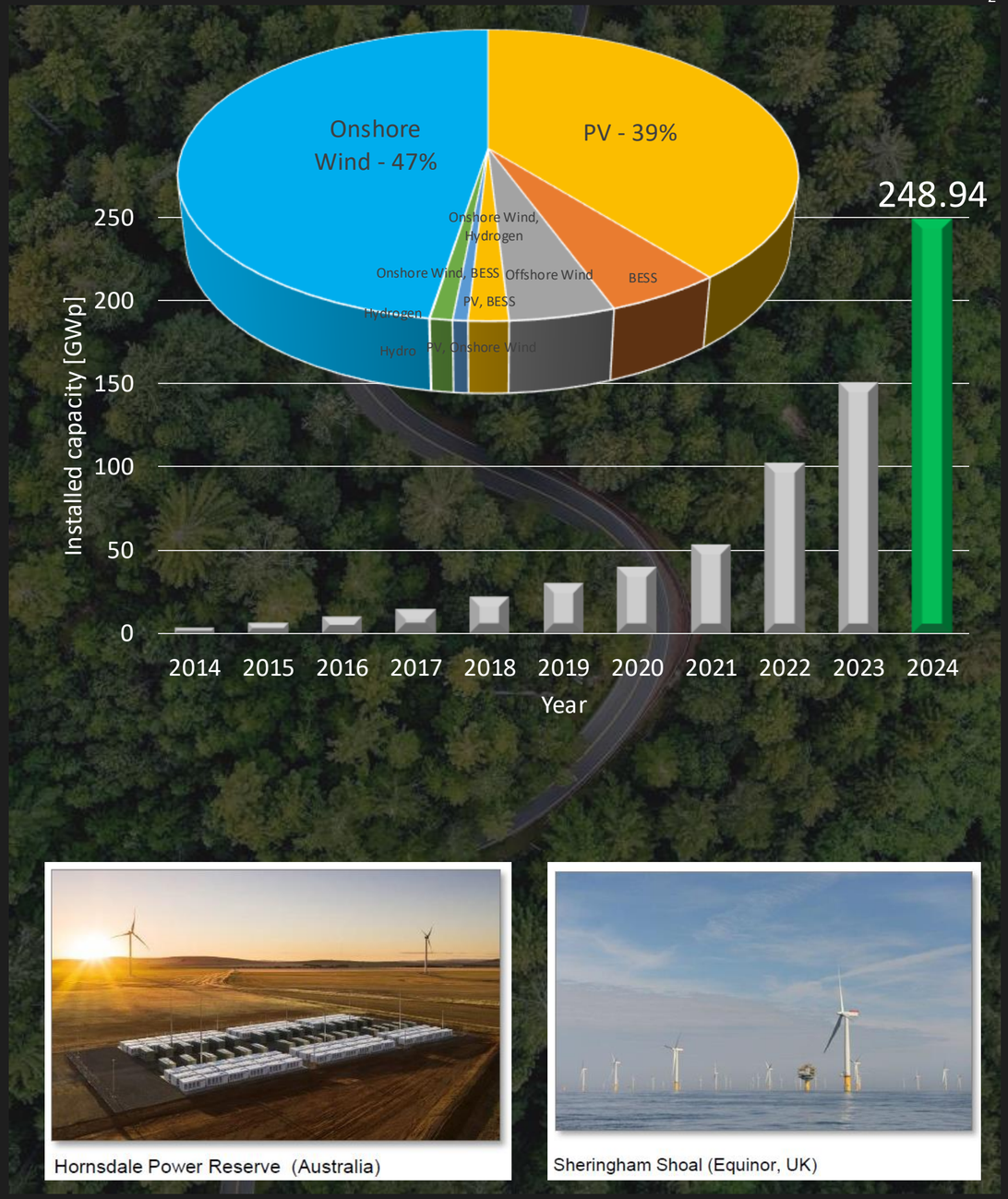
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Senior Solar Performance Engineer

EU PVPMC, Ayia Napa, 30.10.2025

Univers AS (former Bazefield)

- Global software company within renewables. Roots back to 1991 as an industrial IT company
- OEM independent offering within renewable since 2010
- Market leading Bazefield® Operations Management System. Based on the same foundation that has shown its scalability, performance, reliability and robustness for many clients over many years in different industries
- Offer off-the-shelf support for solar, wind, battery storage, hydro, biomass and other renewable technology sources
- Univers AS operates fully independent regarding governance, data confidentiality, cybersecurity etc.




Kingfield Solar Portfolio (Excelsior Energy, Minnesota , US)


Fallago Rig (Natural Power, UK)

Hornsdale Power Reserve (Australia)

Sheringham Shoal (Equinor, UK)

Bazefield including Solar AI Analytics



Monitoring and control

- Portfolio
- Sites
- Assets
- Control
- Production
- Reports
- Alarms
- Trending



Analysing

- Availability
- Performance
- Alarms and stops
- Power curves
- Weather



Operations Management

- Work Management
- Events and tasks
- Planning
- Forecast



Partners/Expert

- Data exchange APIs
- Developers APIs
- Openness
- Data mining and intelligence



Solar AI Analytics

- Loss categorization & quantification
- Recommended actions
- Performance Optimization
- Predictive maintenance

Integrated data management

What does Univers Solar Analytics do?

Transform raw data coming from PV plants into human readable key information about:

- Economic viability
- Sustainability aspects
- Technical viability
- System performance
- Compare different PV projects
- **Detection of potential problems**
- **Actionable/data-driven insights**



Loss Breakdown and Grid Categories

Introduction

- Current Analytics approach can disentangle more than 15 different loss categories
  - From Status Detection to Loss Breakdown, including DC and AC loss buckets.

1) What will be the operators/asset manager strategy when site's export is constrained by the grid limitations?

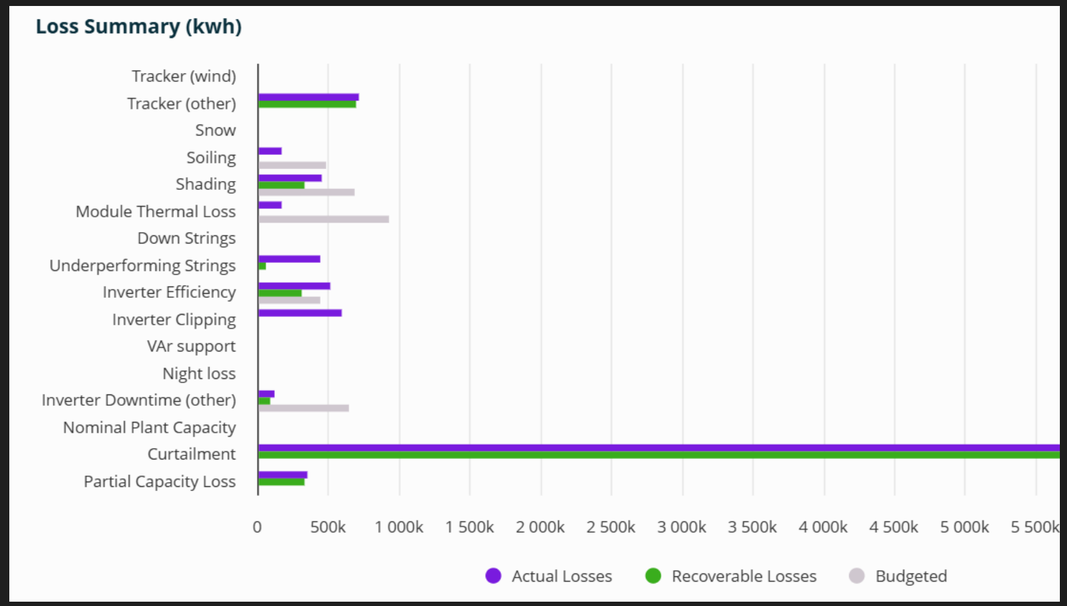
2) How to spot real issues when the grid caps your output?

Status Detection

Operation status at any timestamp

Loss Breakdown

Energy Loss per specific time range



Initialize

Night status

Down status

Clipping status

Reactive Power status

Max KVA status

Nom plant status

Curtailment status

Thermal derating status

Partial capacity status

Snow status

Shading status

Tracker status

...

Sequential Algorithm

*Irradiance-dependent

**Partially dependent on irradiance

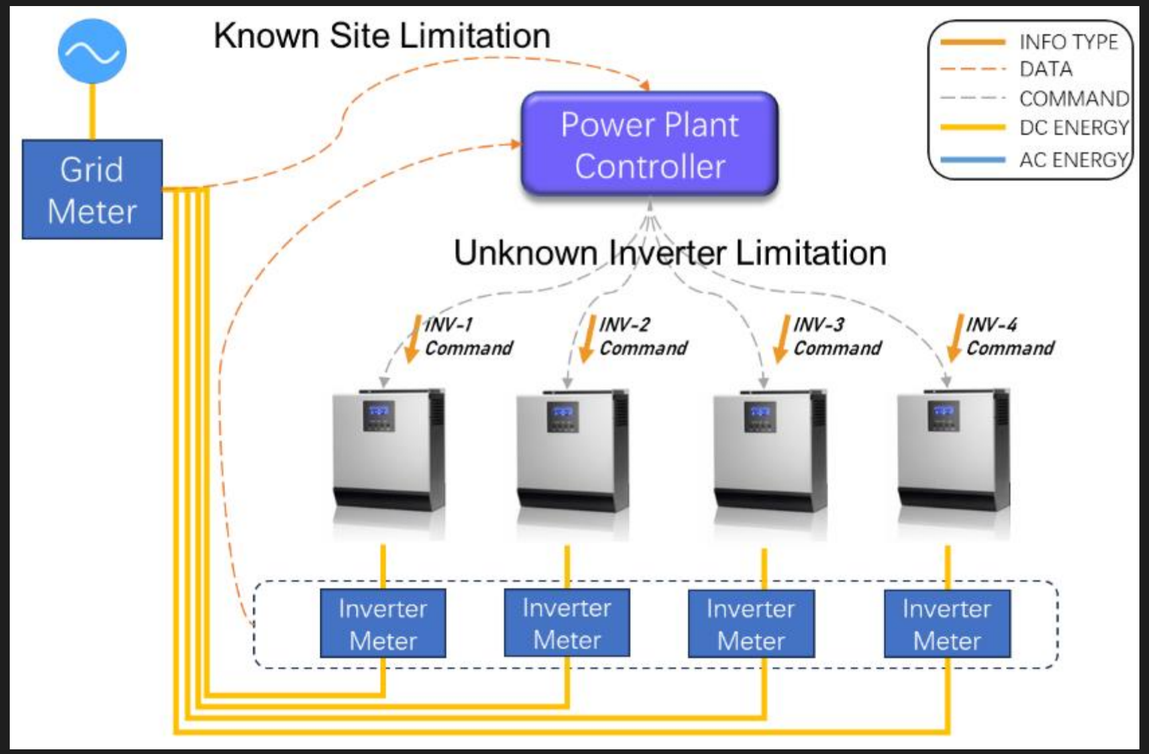
Grid Constraints

Nominal Plant Capacity and Curtailment

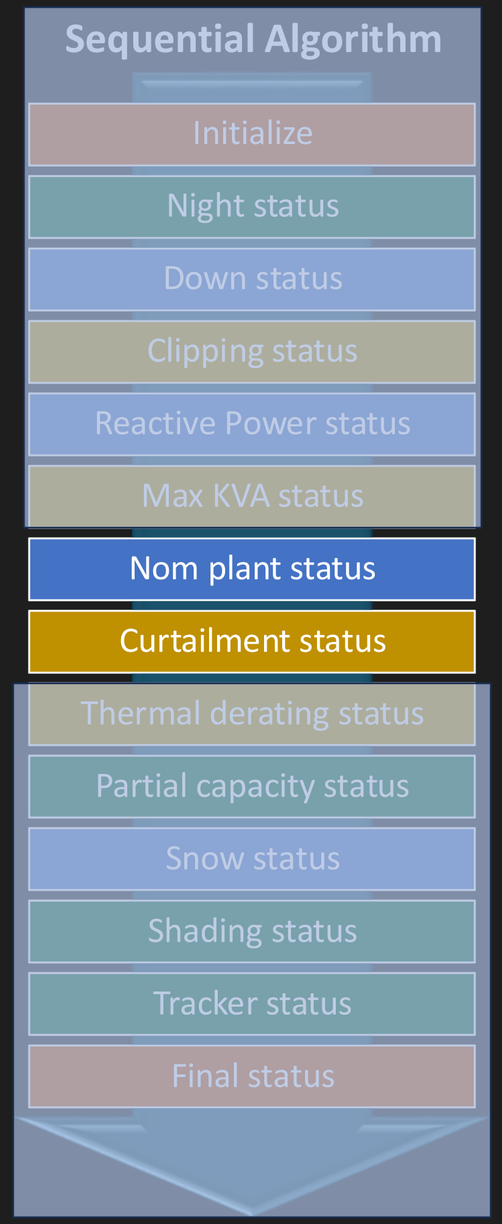
- Grid will dictate the export limitation, and the PPC will command the inverters

1) How to consider this problem at inverter-level when the setpoints are typically unknown?

2) Do we actually care on DC-side Performance if the AC-side is limited?



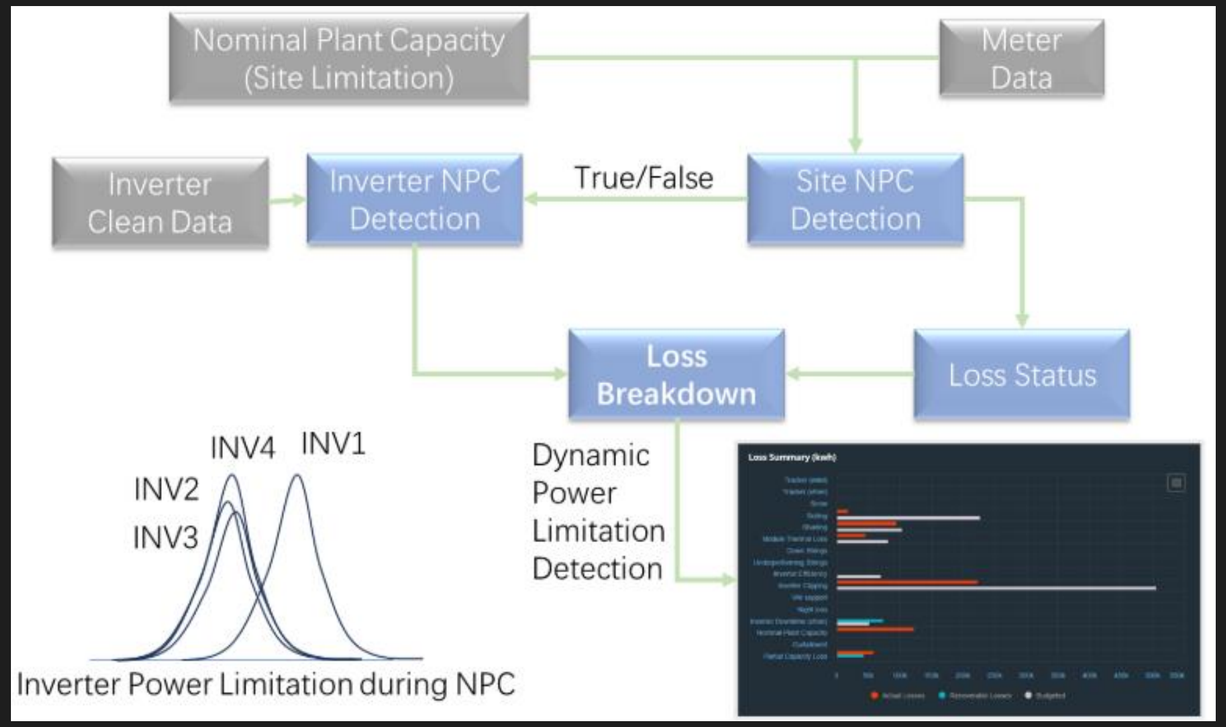
Typical data and electrical flow in a solar farm



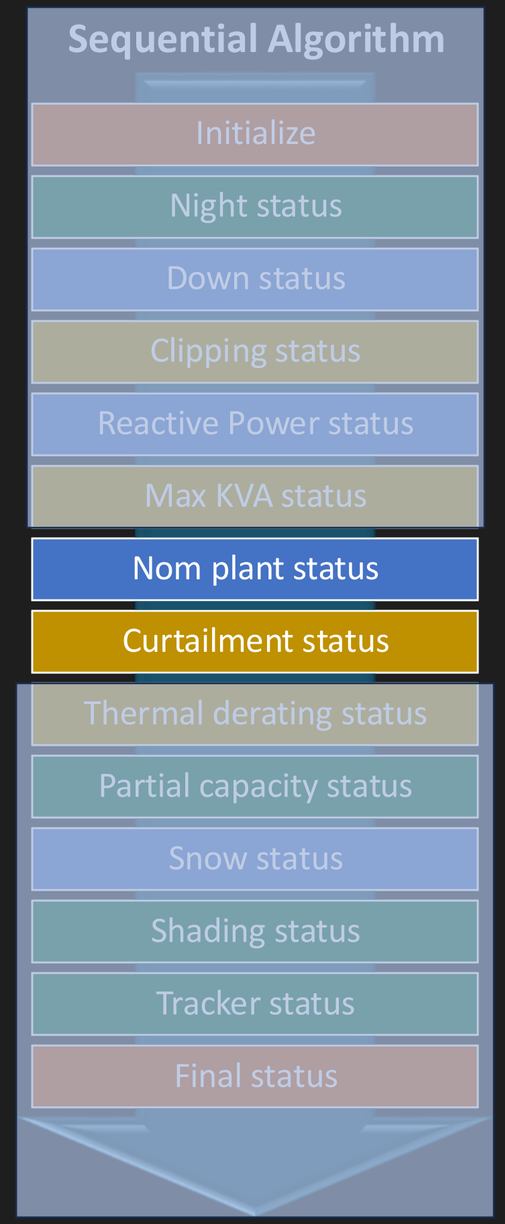
Nominal Plant Capacity

Also known as Site Clipping

- NPC is a fixed limit on how much power the plant can send to the grid.
- In oversized plants, this limit often forces inverters to reduce output.
- In-house algorithm to infer PPC signals under Nominal Plant Capacity.



Algorithm structure to detect NPC factors and losses.



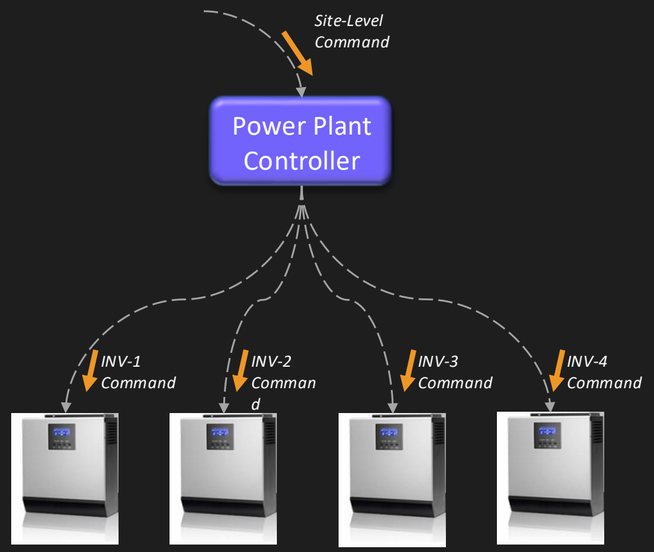
Curtailment

It can be flat or dynamic...

- Curtailment is when the grid temporarily forces the plant to reduce power due to changing grid conditions.
- It can affect the whole site or only some inverters, and can easily be confused with real equipment problems.
- In-house algorithm that considers many different input signals from multiple devices.

Possible data Inputs

- Site-Level
  - Active Power Setpoint
  - Ratio from Nominal
  - Boolean (yes/no)
  - *Curtailment Type*
- Inverter-Level
  - Active Power Setpoint
  - Ratio from Nominal
  - Inverter State



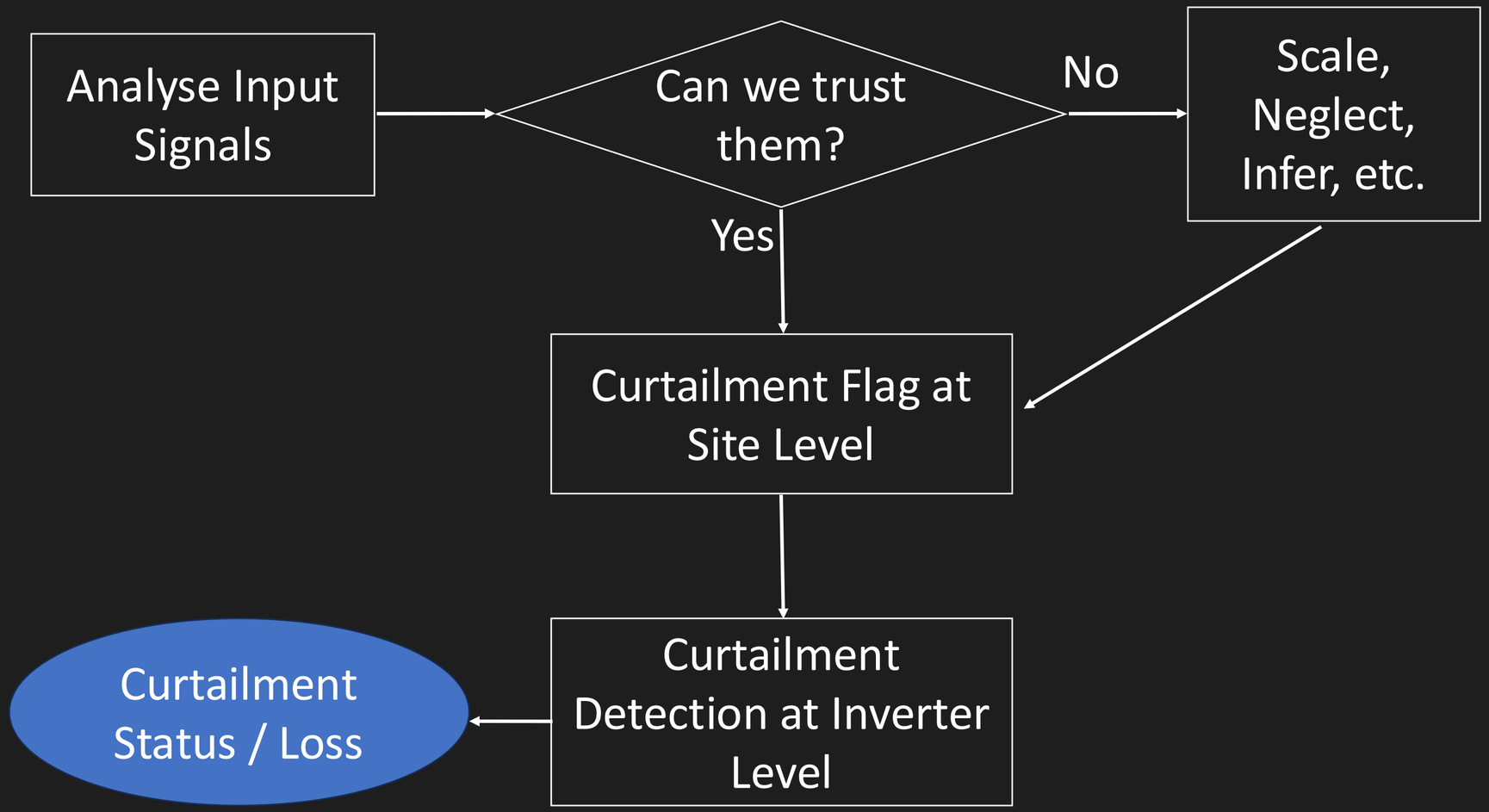
- ❑ If ONE input given, then it is used
- ❑ If MORE THAN ONE inputs are given, then we can prioritize

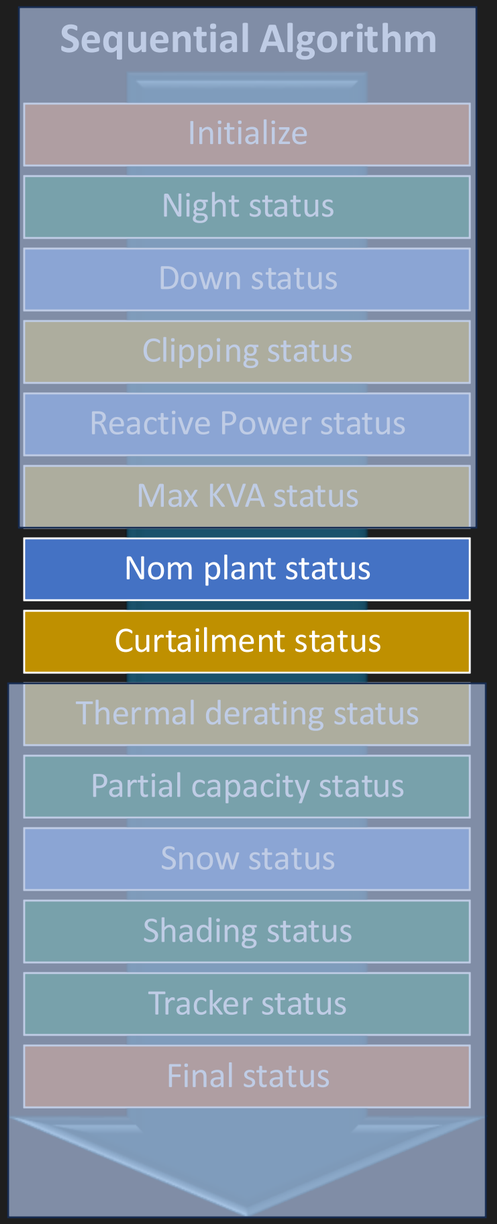
Sequential Algorithm

- Initialize
- Night status
- Down status
- Clipping status
- Reactive Power status
- Max KVA status
- Nom plant status
- Curtailment status
- Thermal derating status
- Partial capacity status
- Snow status
- Shading status
- Tracker status
- Final status

Curtailment

It can be flat or dynamic...



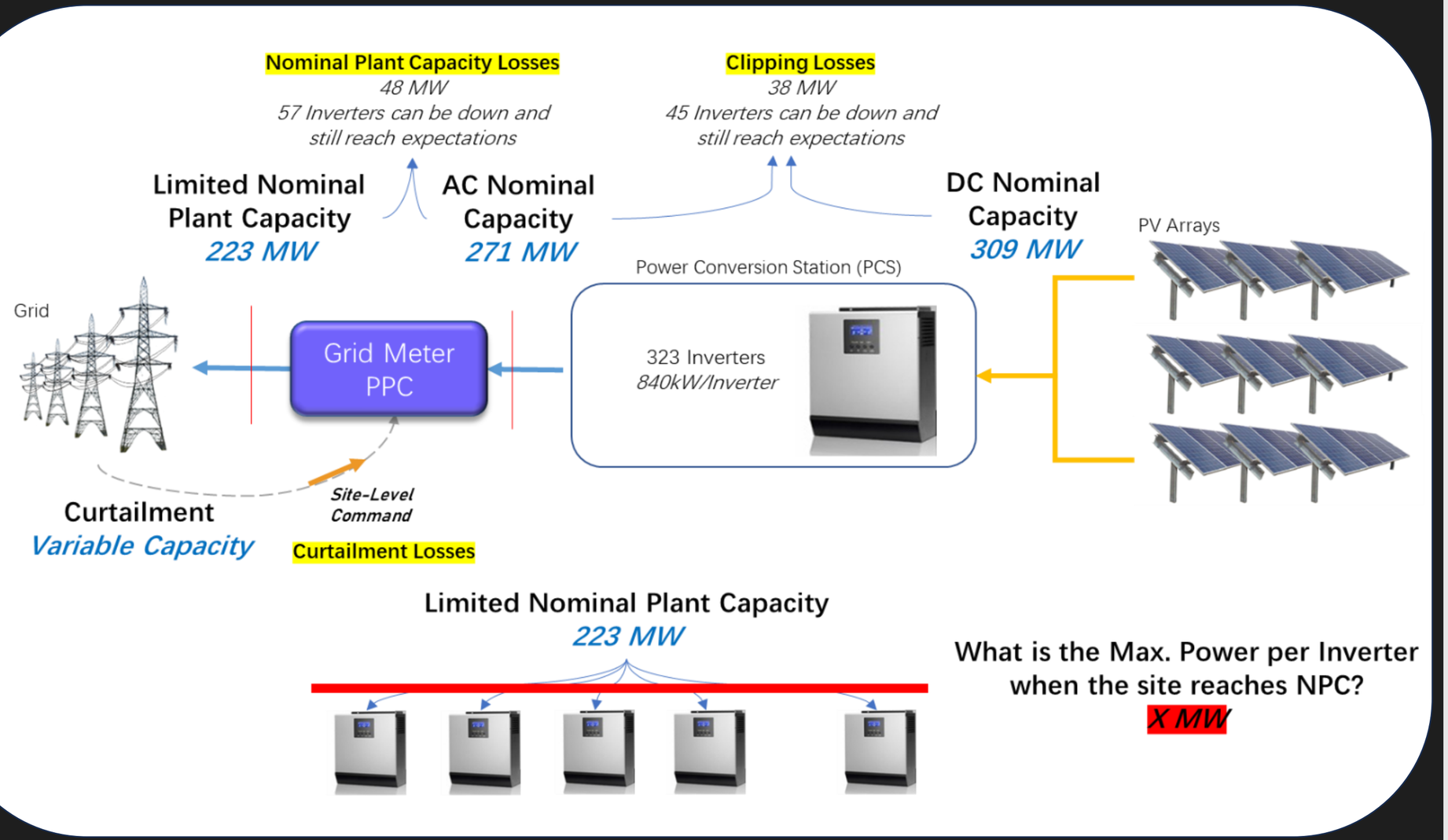


Practical Cases

#1 Oversized with Grid Limitations

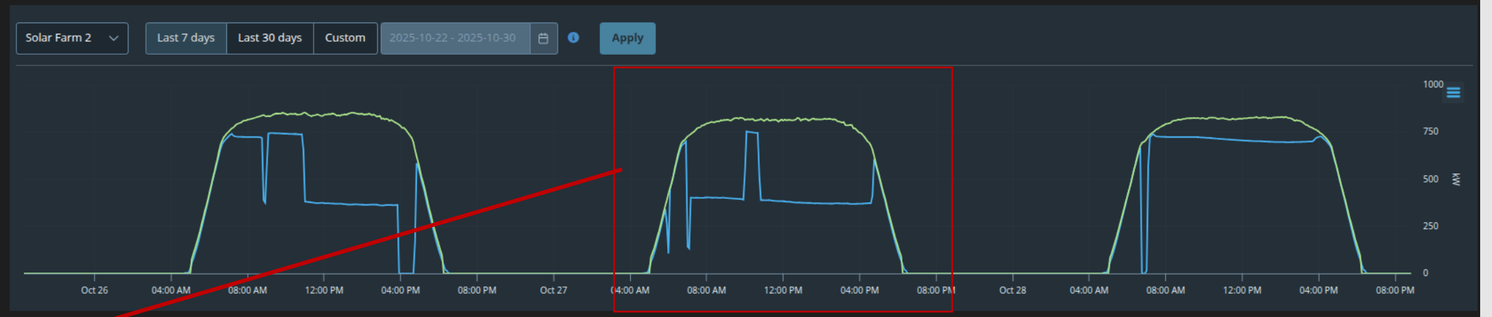
1) Site is oversized at DC
2) Grid suffering voltage limitations so export is constrained

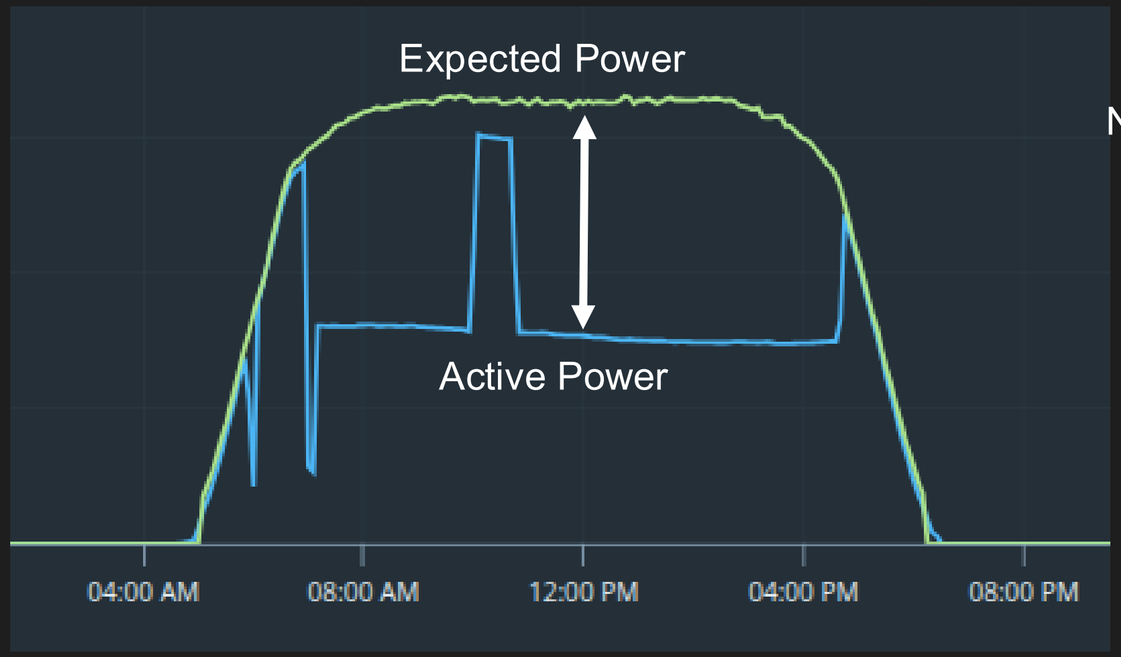
- At full sun, 57 out of 323 inverters can down and still export the allowed capacity.
- Is the PPC limiting power balanced across the fleet?

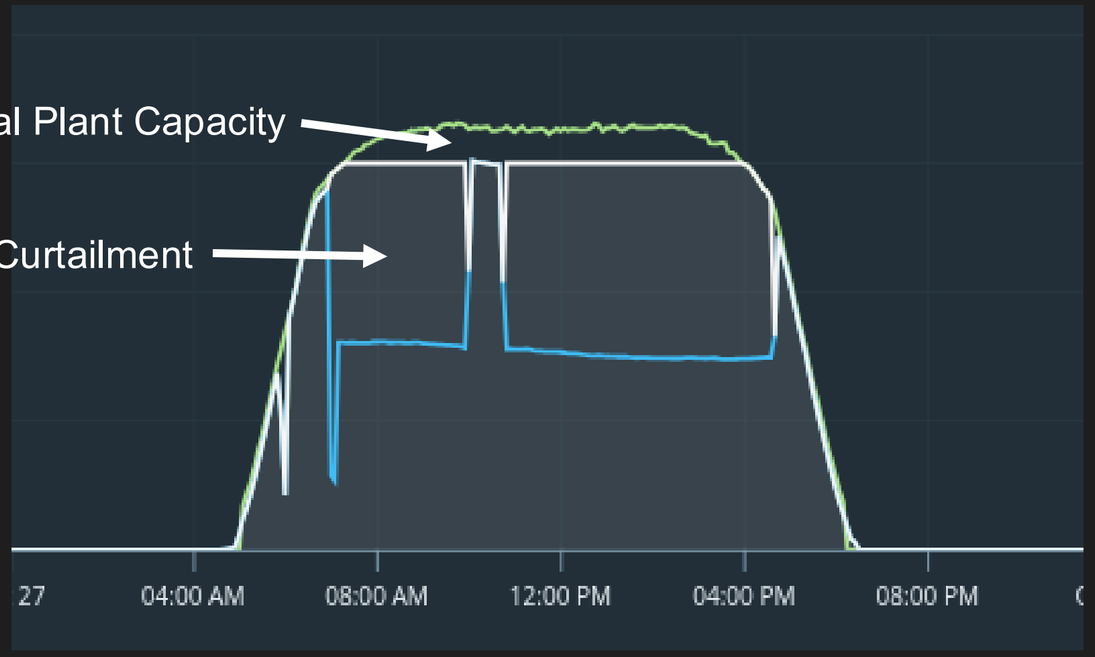


#2 Gap Analysis and Loss Breakdown

1) Curtailment loss calculations must include NPC methods to avoid loss overestimations
2) Due to strong curtailment, all DC loss bucketing is neglected
3) No actions can avoid grid export limitations

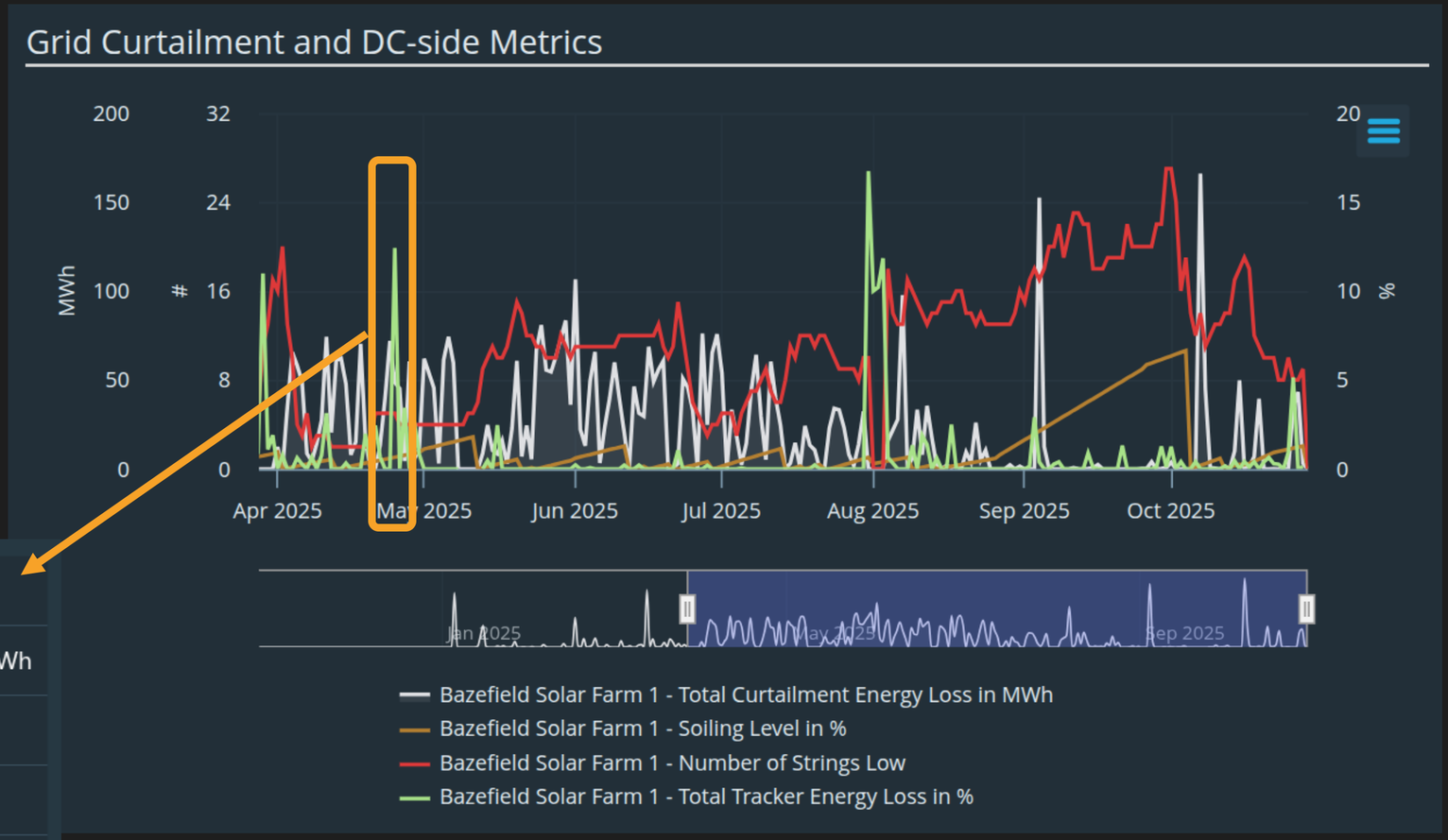






#3 DC-side Visibility despite Grid Constraints

1. Still DC-side performance metrics can be inferred during curtailment events.
2. In the example, Curtailment is very frequent, but analytics can still reveal:
   - Soiling Level in %
   - Amount of underperforming strings
   - Tracker Energy losses
   - …



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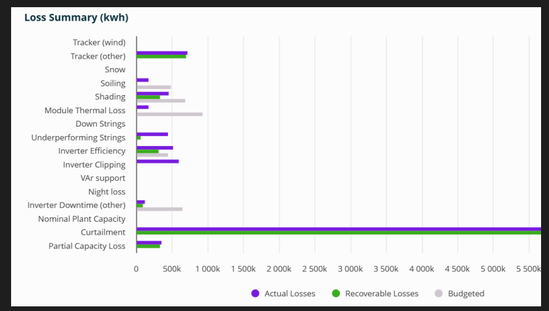
Bazefield Solar Farm 1 - Total Curtailment Energy Loss in MWh	48.63 MWh
Bazefield Solar Farm 1 - Soiling Level in %	0.66 %
Bazefield Solar Farm 1 - Number of Strings Low	5 #
Bazefield Solar Farm 1 - Total Tracker Energy Loss in %	12.41 %

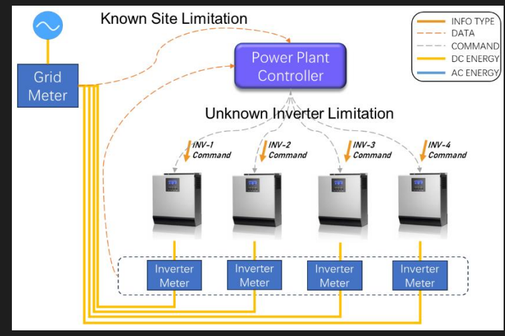
Conclusions

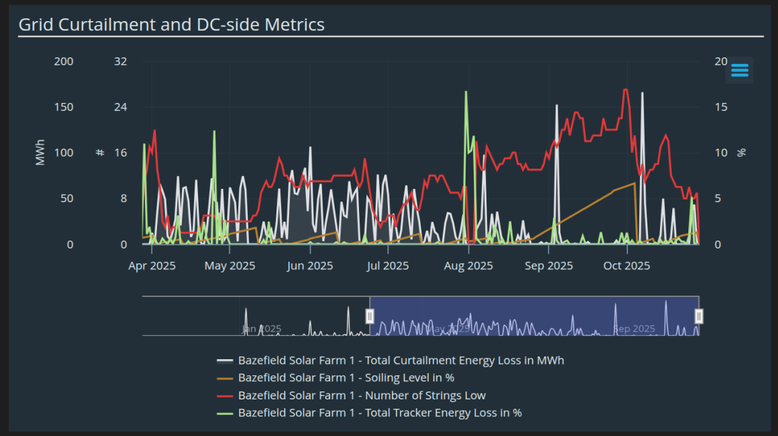
Conclusions

- Comprehensive Status Detection and Loss breakdown can help to reveal hidden losses.
- Dedicated algorithms for Curtailment and Nominal Plant Capacity (Grid Constraints) are crucial to ensure proper full-scope PV Analytics.
- Grid Constraints reduce today's power export and can have a huge negative impact on the long-term DC-side reliability

-> Act on-time to keep your project profitable.







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Thank you for your attention!



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