



Jinko *Solar*

PID: an invisible danger for solar systems and how to prevent it

PV Magazine Quality Roundtable
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Total Quality Management

1.

Comprehensive QC/QA
across entire value chain

2.

Certified
QC/QA process,
methodology, acc.criteria,
devices and staff

3.

Advanced
inspection equipment &
data mgmt. system

4.

Accurate
QC protocols

5.

Consistent
control results

6.

Globally-distributed
control

IEC Test Sequence



Long-Term Performance: Accelerated Aging

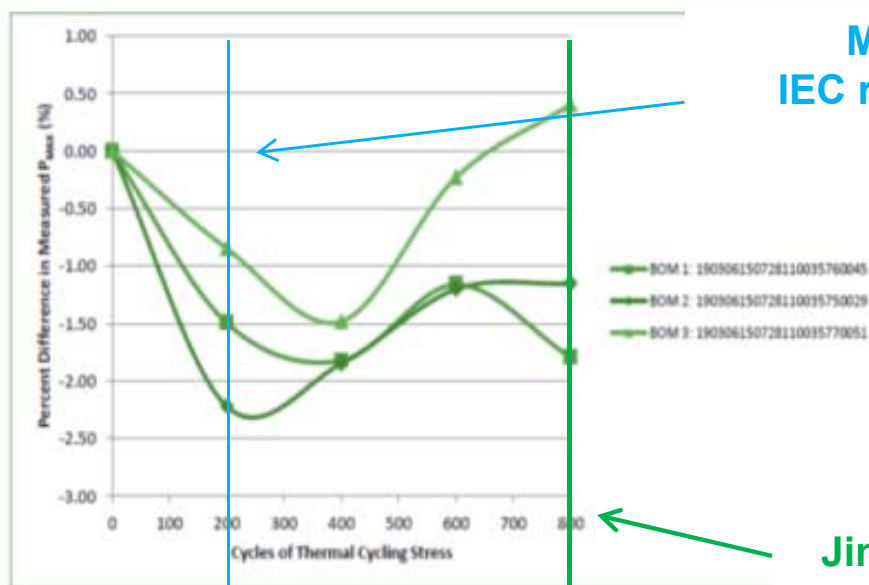


Figure 2-1 Percent Difference in Measured P_{max} due to Stress

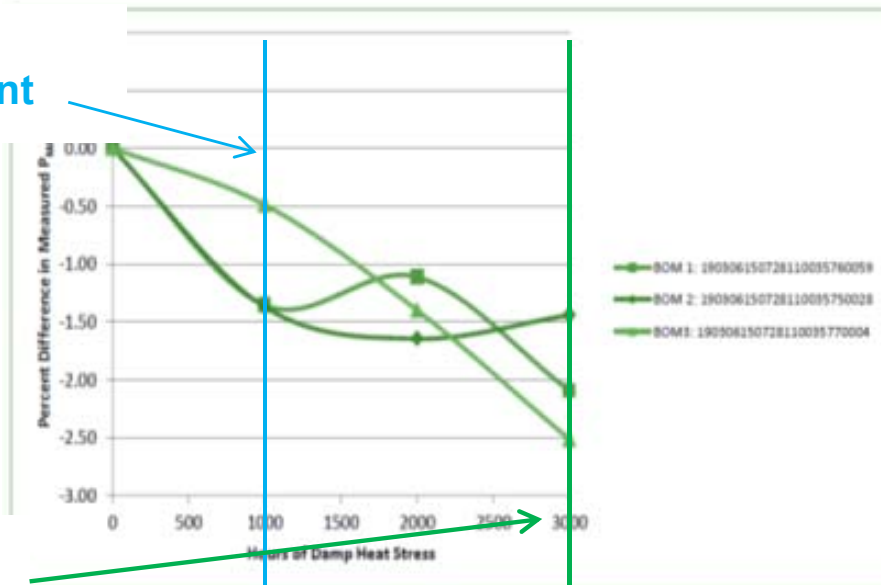
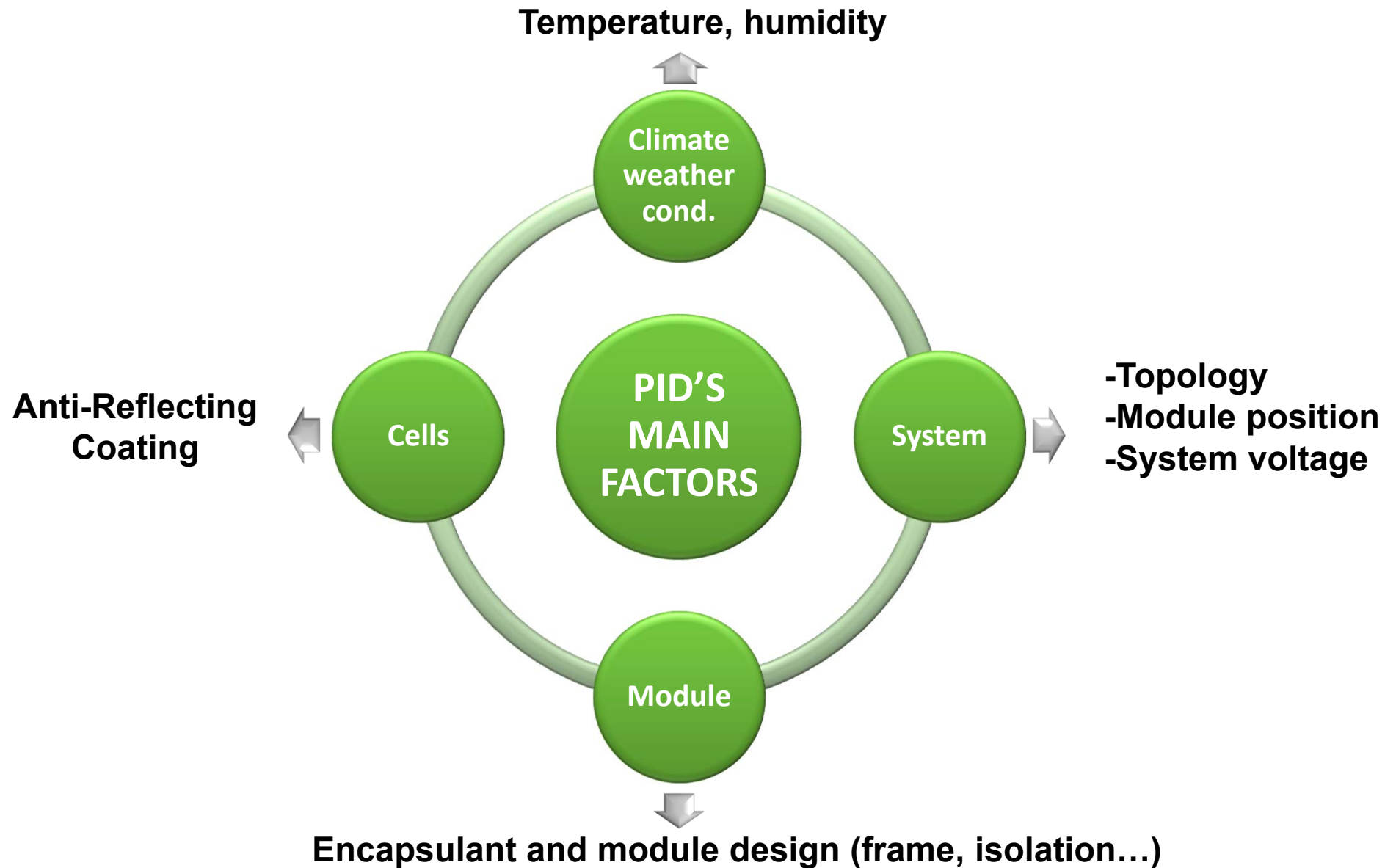


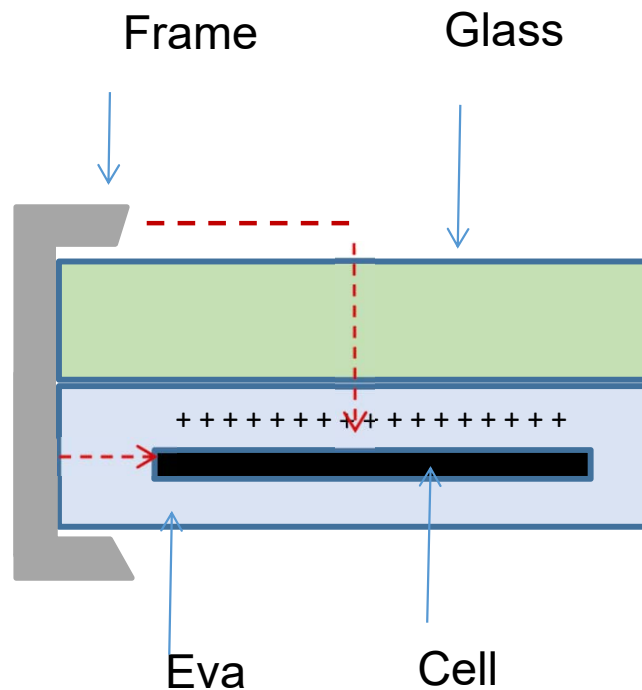
Figure 3-1 Percent Difference in Measured P_{max} due to Stress

Thermal Cycle 800
4x MORE SEVERE THAN STANDARD
El. Connections Stress Test
Results: -0.85% (average)

Damp Heat 3000
3x MORE SEVERE THAN STANDARD
Laminate Stress Test
Results: -2.01% (average)



Power degradation due to a potential of the module relative to ground



Leakage current through the encapsulant and glass



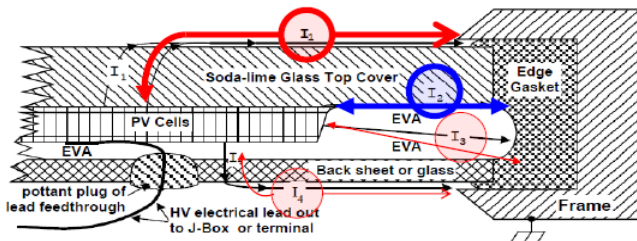
Accumulation of positive charge on cell surface



FF, V_{mpp} and I_{mpp} ↓↓

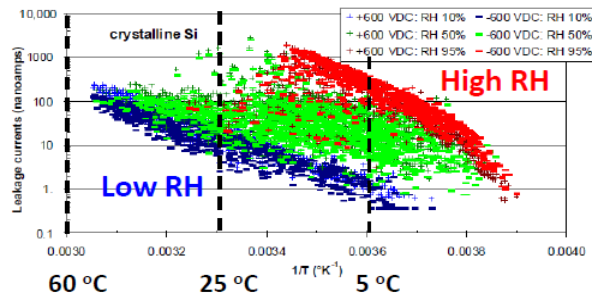
PID Environment Conditions

World map of Köppen-Geiger climate classification

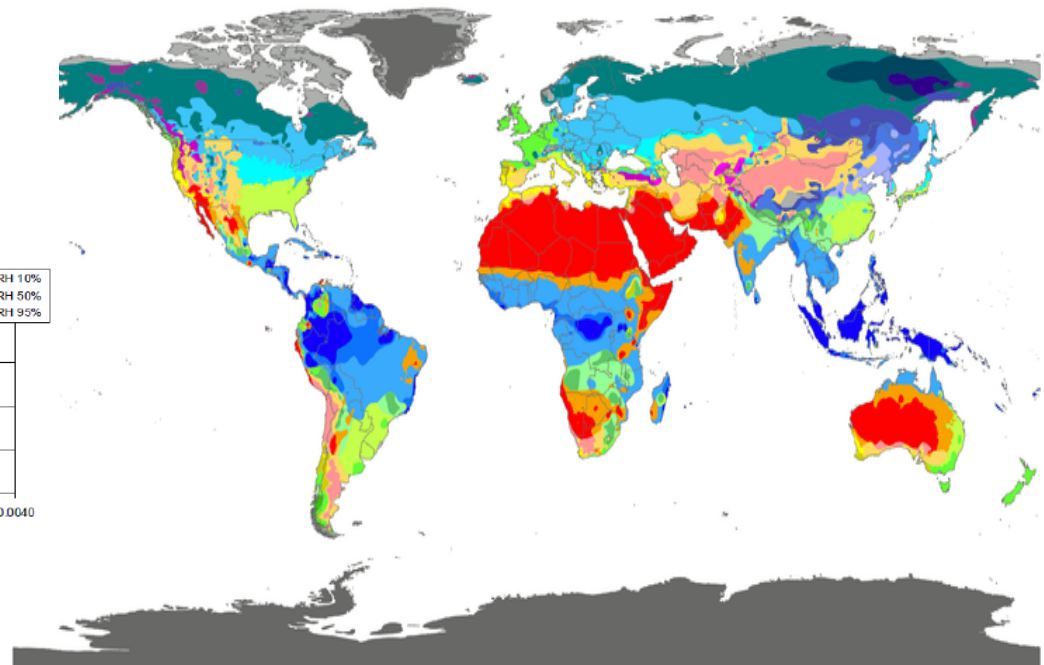


Predominant Leak Path

Low RH: Interface I₂
High RH: Glass I₁



J.A. del Cueto, T.J. McMahon, Prog. In Photovoltaics Res. & App. 10: 15–28 (2002).
J.A. del Cueto and S.R. Rummel, Proc. SPIE, 7773: 77730J-77730J-11 (2010)



Af	BWh	Csa	Cwa	Cfa	Dsa	Dwa	Dfa	ET
Am	BWk	Csb	Cwb	Cfb	Dsb	Dwb	Dfb	EF
Aw	BSh	Cwc	Cfc	Dsc	Dwc	Dfc		
BSk				Dsd	Dwd	Dfd		

DATA SOURCE : GHCN v2.0 station data
Temperature (N = 4,844) and
Precipitation (N = 12,396)

PERIOD OF RECORD : All available

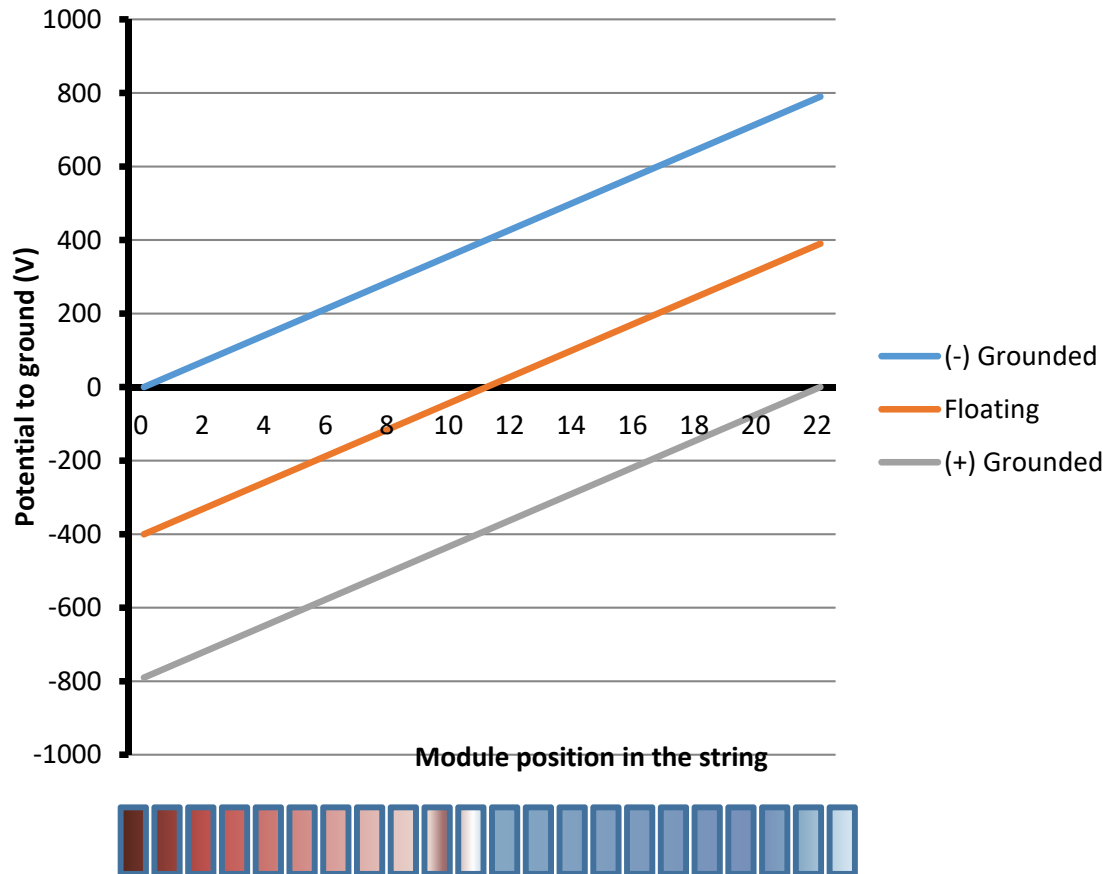
MIN LENGTH : ≥30 for each month.

RESOLUTION : 0.1 degree lat/long

Contact : Murray C. Peel (mpeel@unimelb.edu.au) for further information

PID System Topology

SYSTEM LEVEL



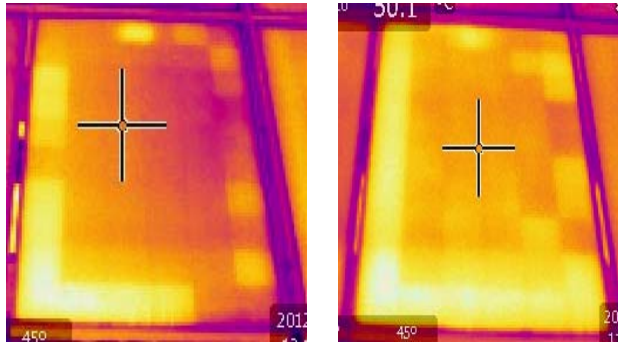
Inverter with transformer

- Negative pole functional grounding for p-doped cells
- Positive pole functional grounding for n-doped cells

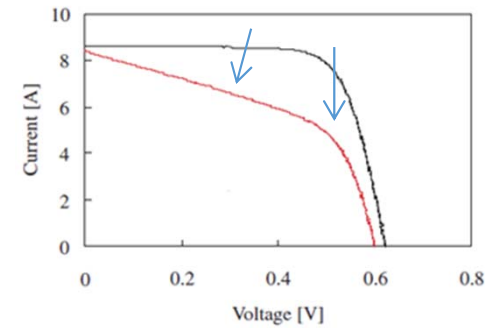
Transformer less inverter

- “Soft grounding” required
- Overnight recovery possible

PID Effect

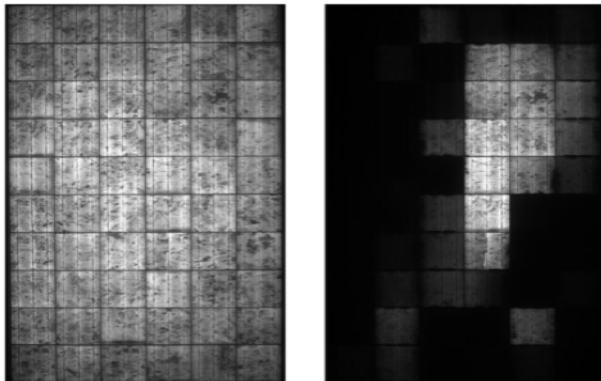


Thermal Picture with “L/U-shaped” Pattern

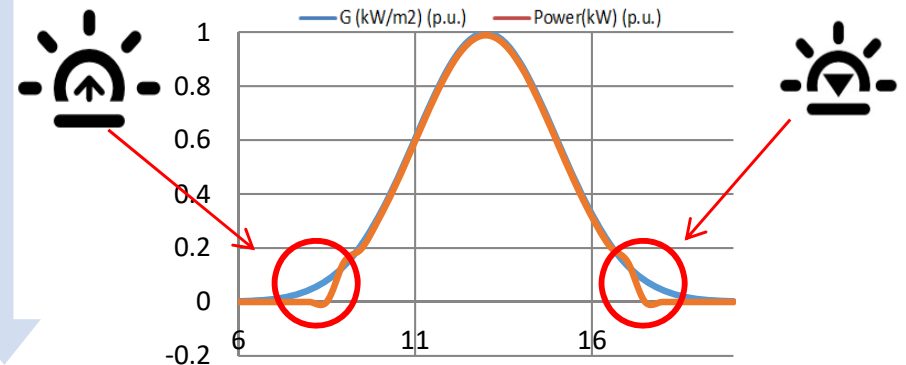


Effects on IV-Curve (Rsh, FF, Vmpp, Imppp, Voc)

EL before and after PID phenomenon



Inverter wake-up & drop-off (Voc)



(Floating System and PV modules installed in the most negative part of the string)

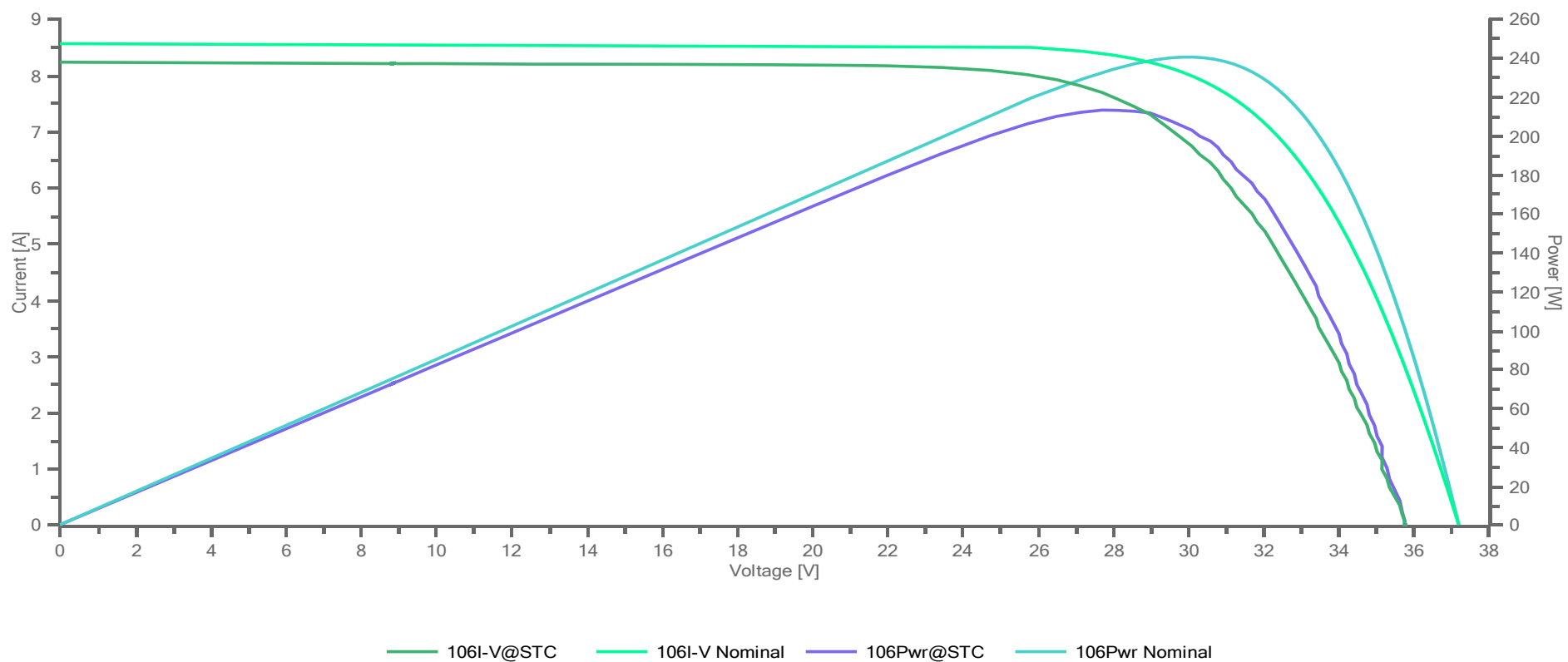
PID case study

- Installation peak power: 100kW
- Date of installation: 2012
- Location: Coastal environment
- Panel type: JKM-240P60 (not anti-PID certified)

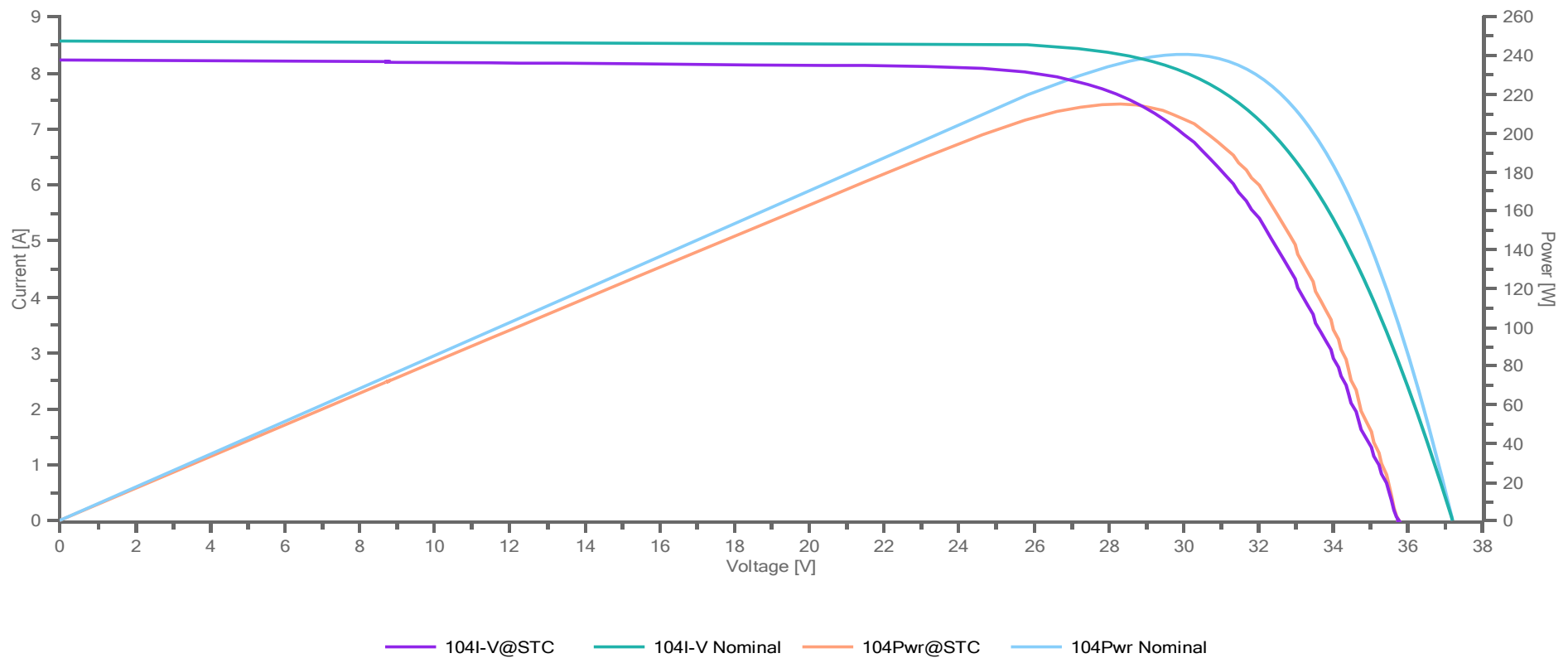


- Solution implemented: - PID recovery system operating overnight
- String polarity swap to speed up the recovery time
- Result: PV system PR recovered up to initial value after about 6 months

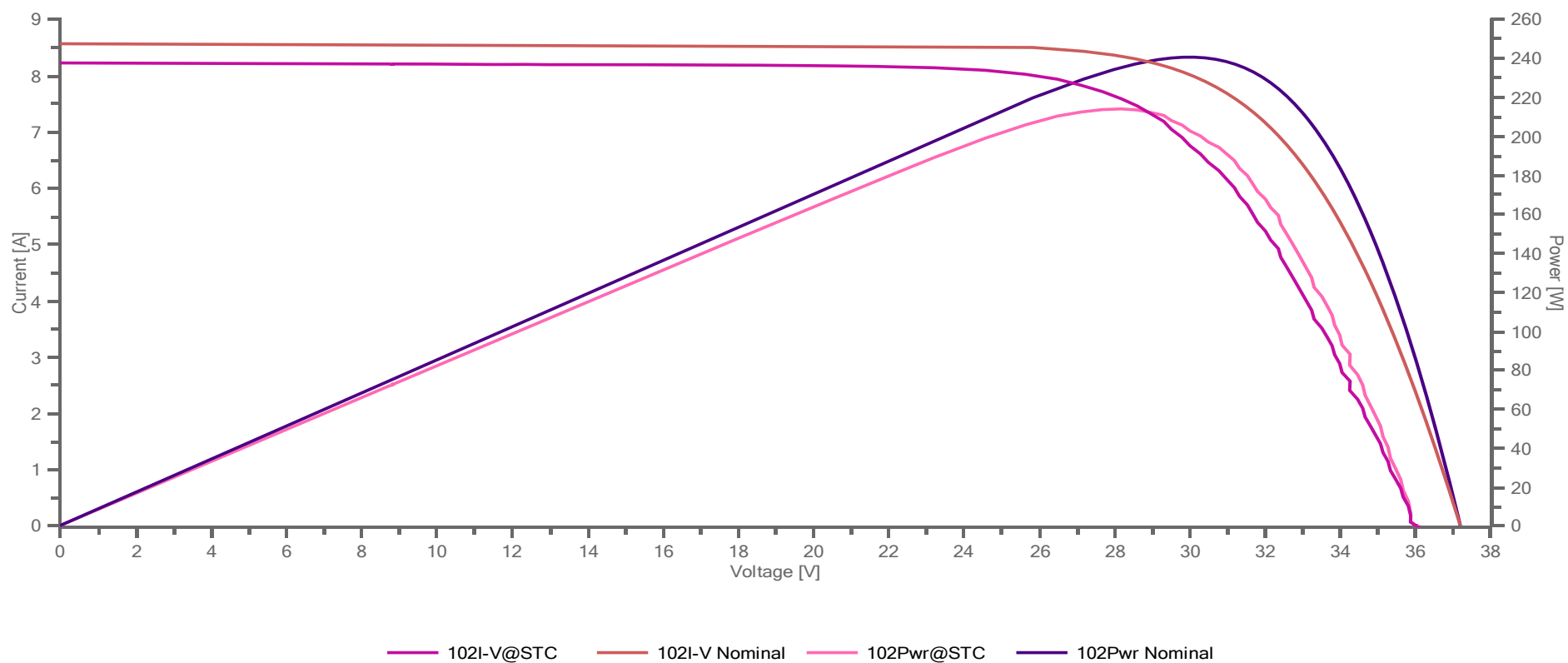
PID case study



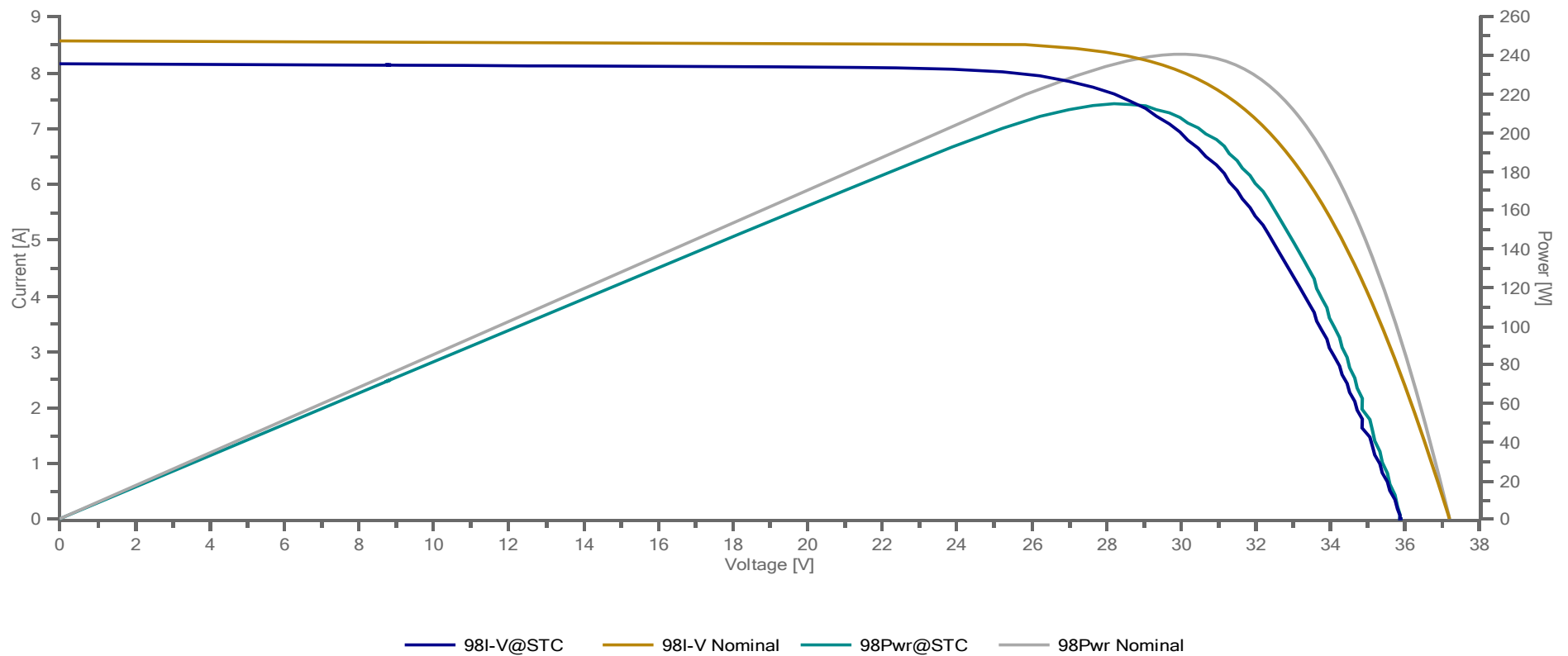
PID case study



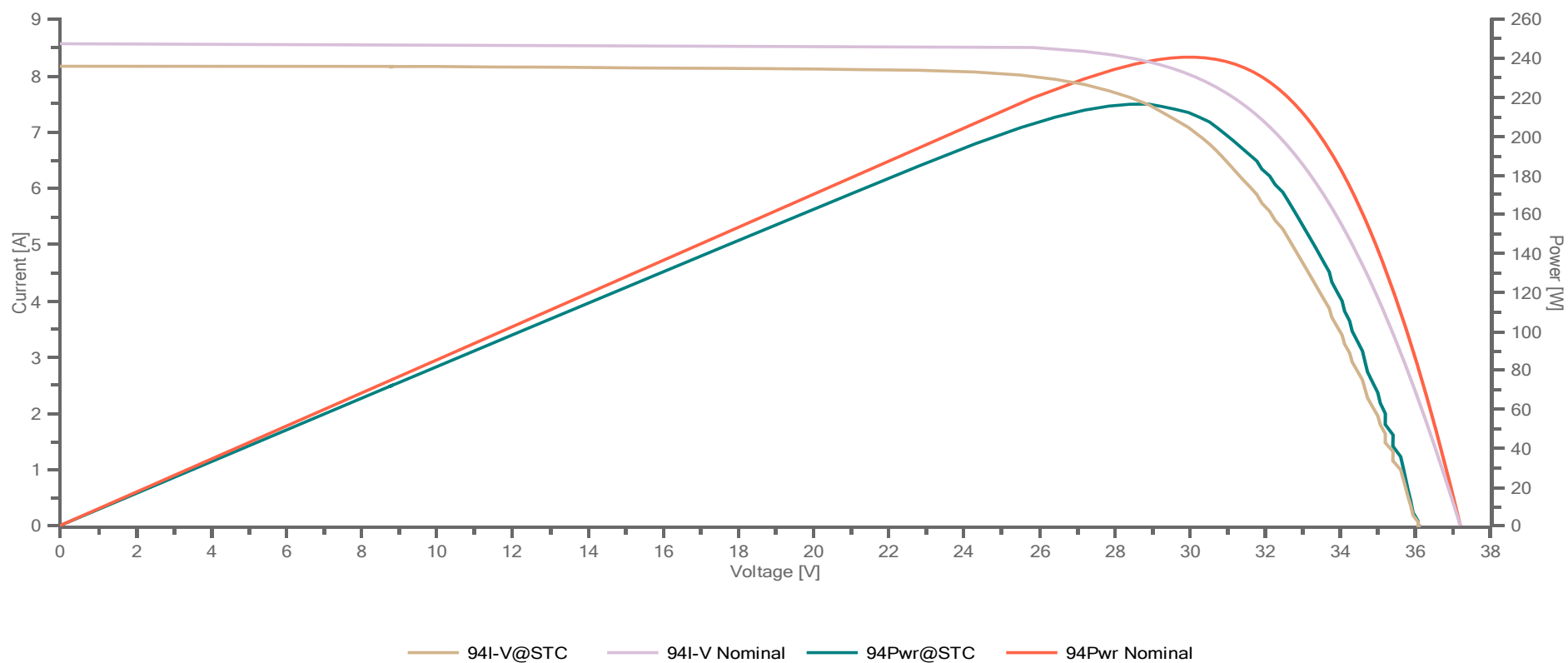
PID case study



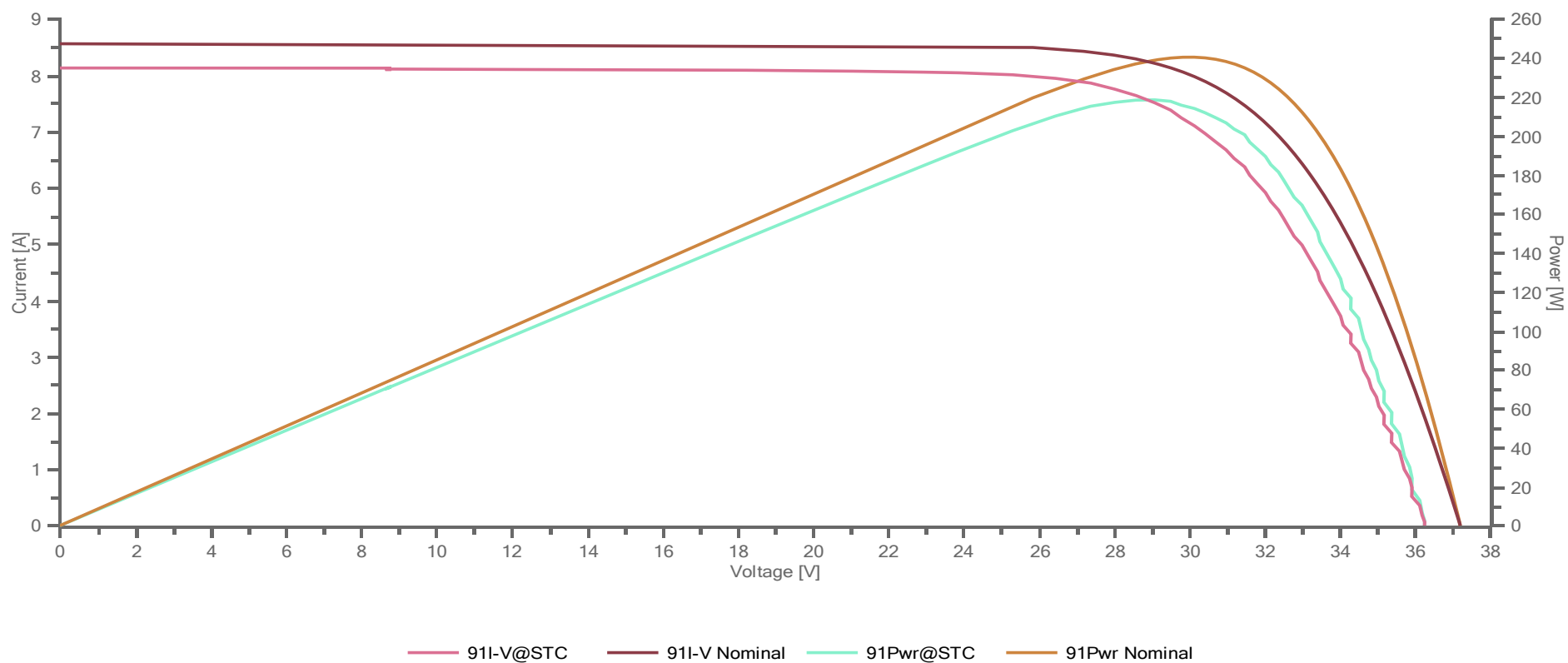
PID case study



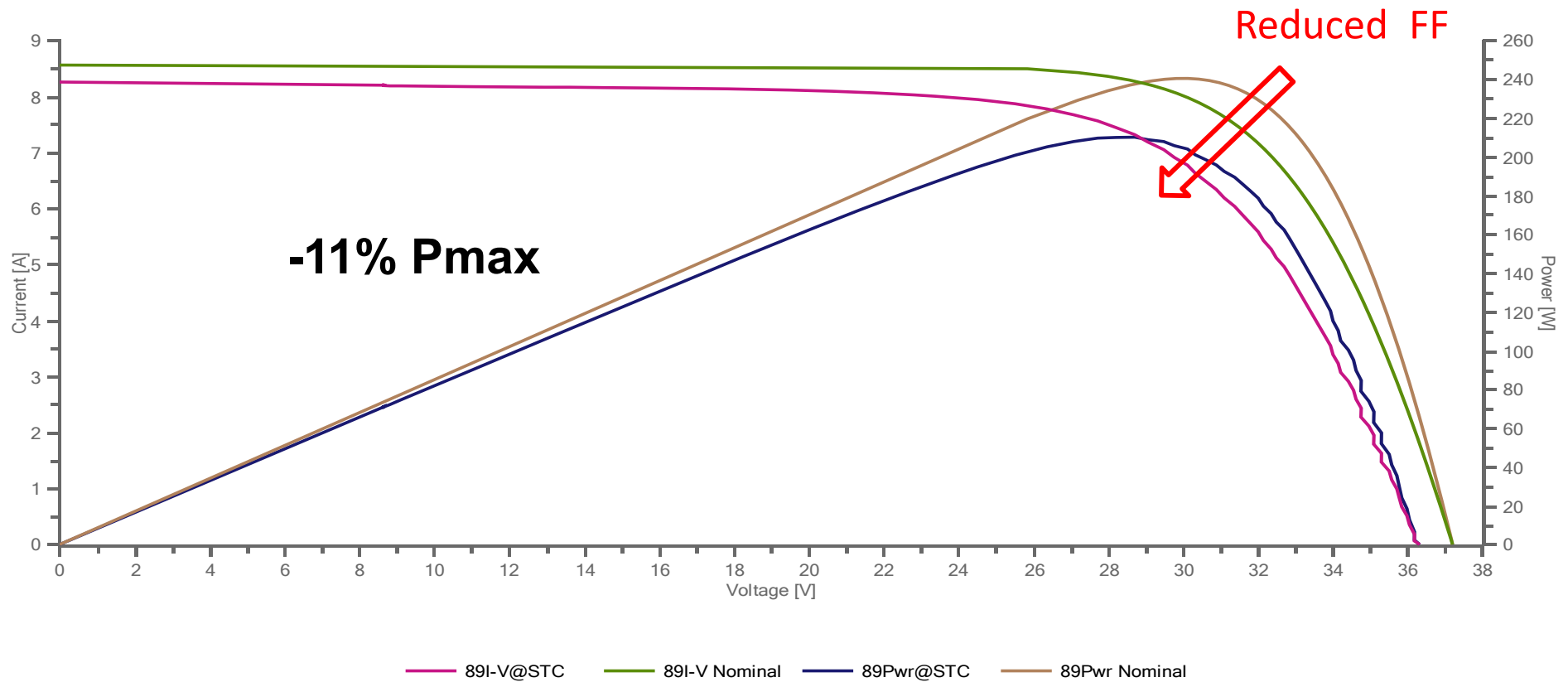
PID case study



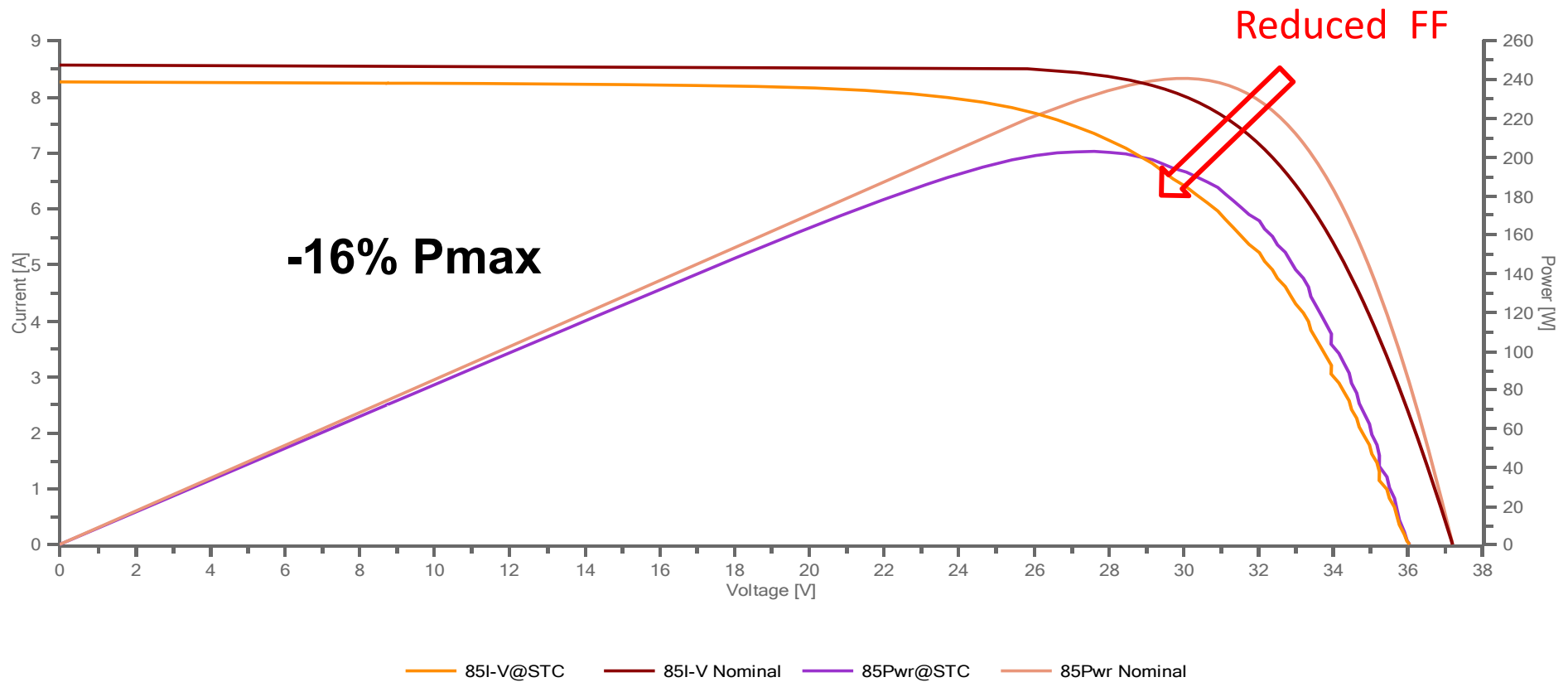
PID case study



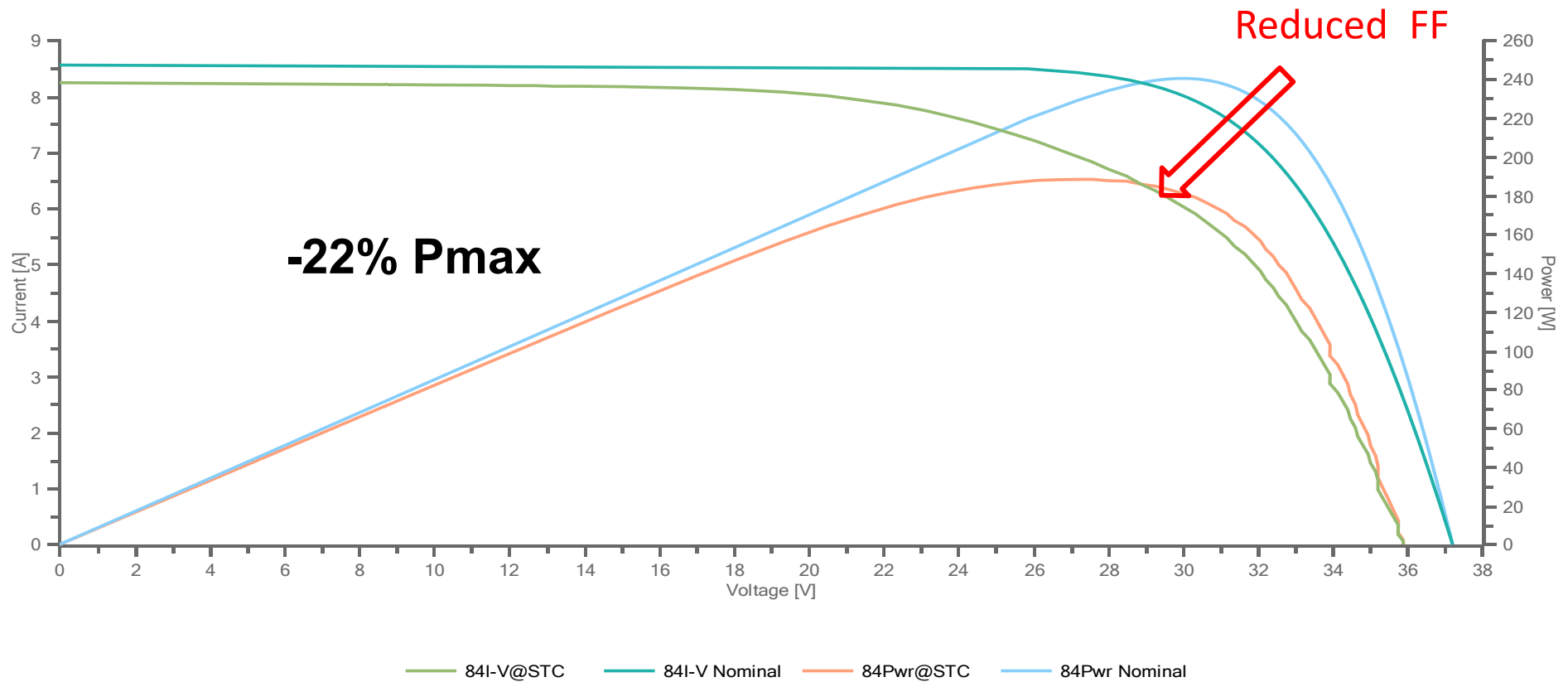
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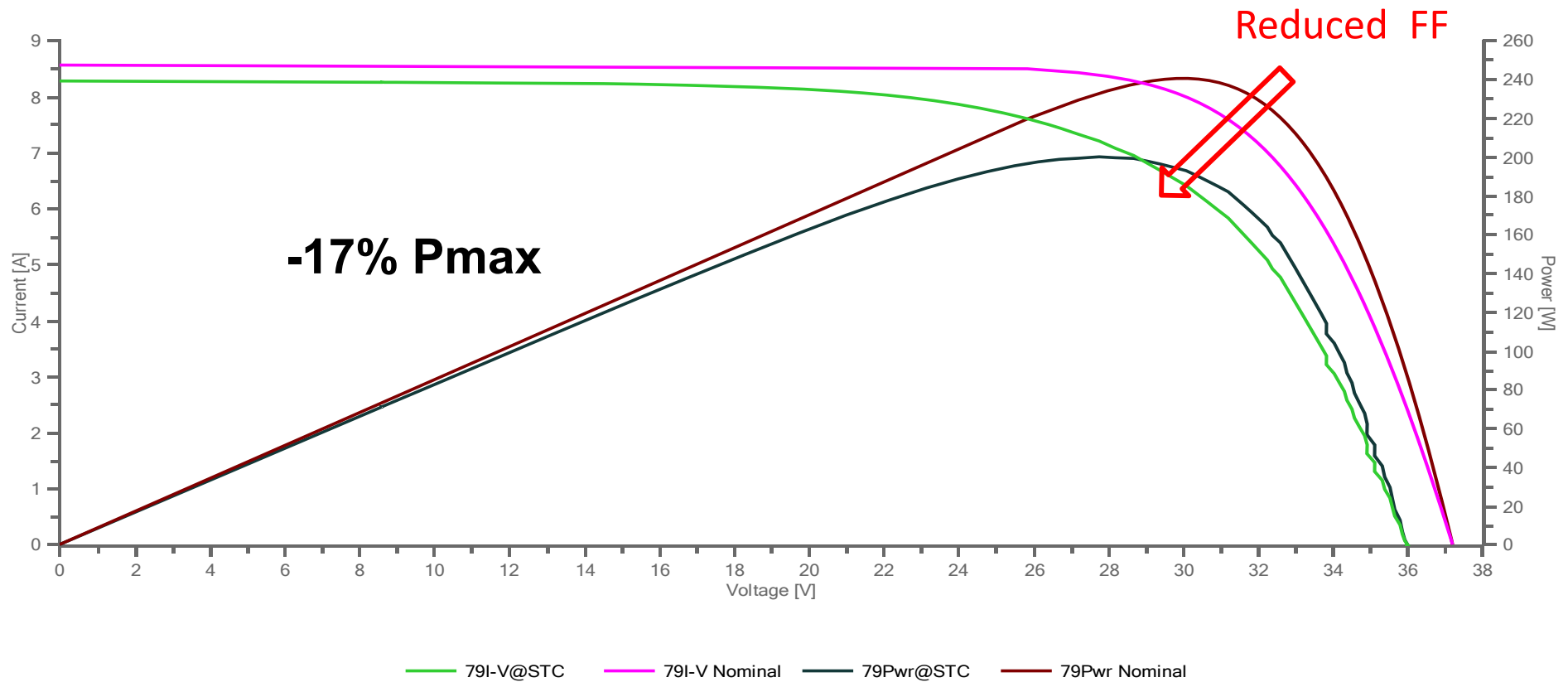
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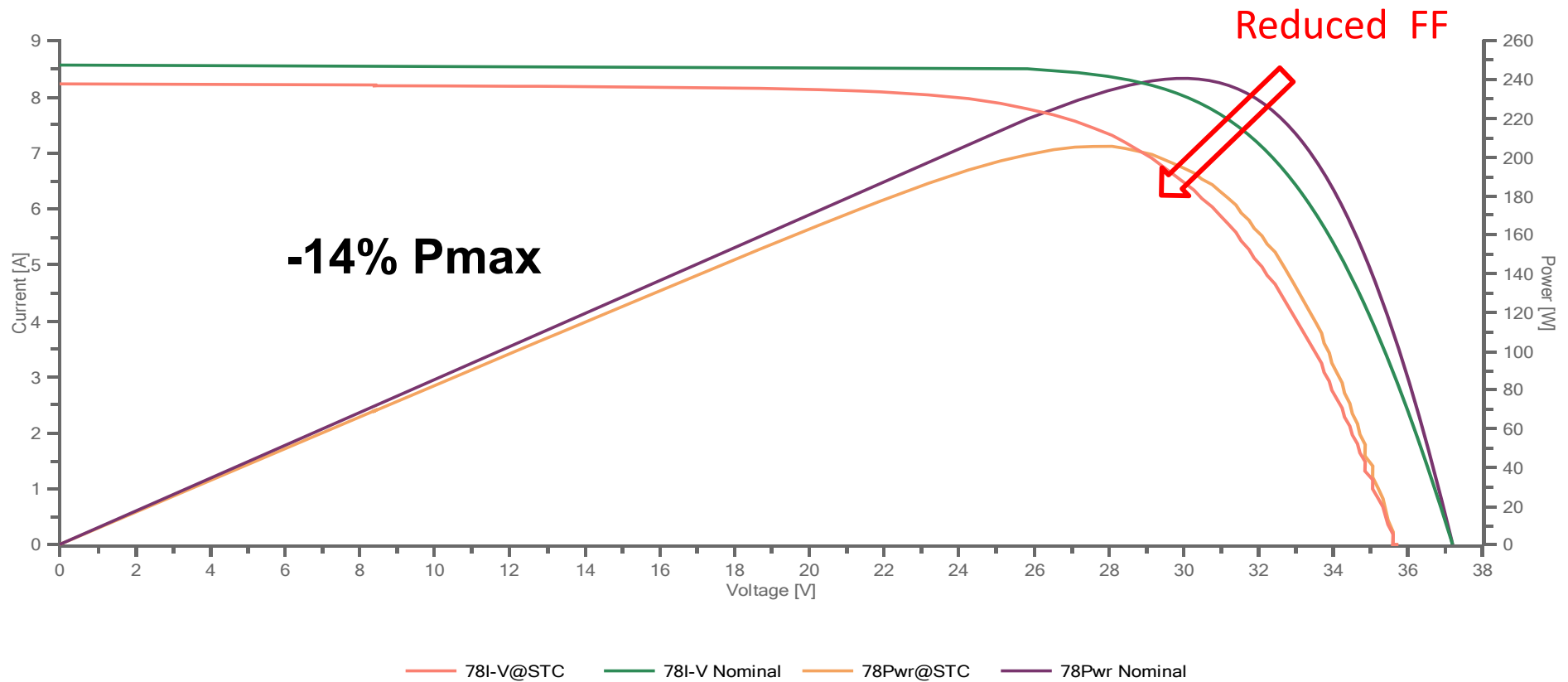
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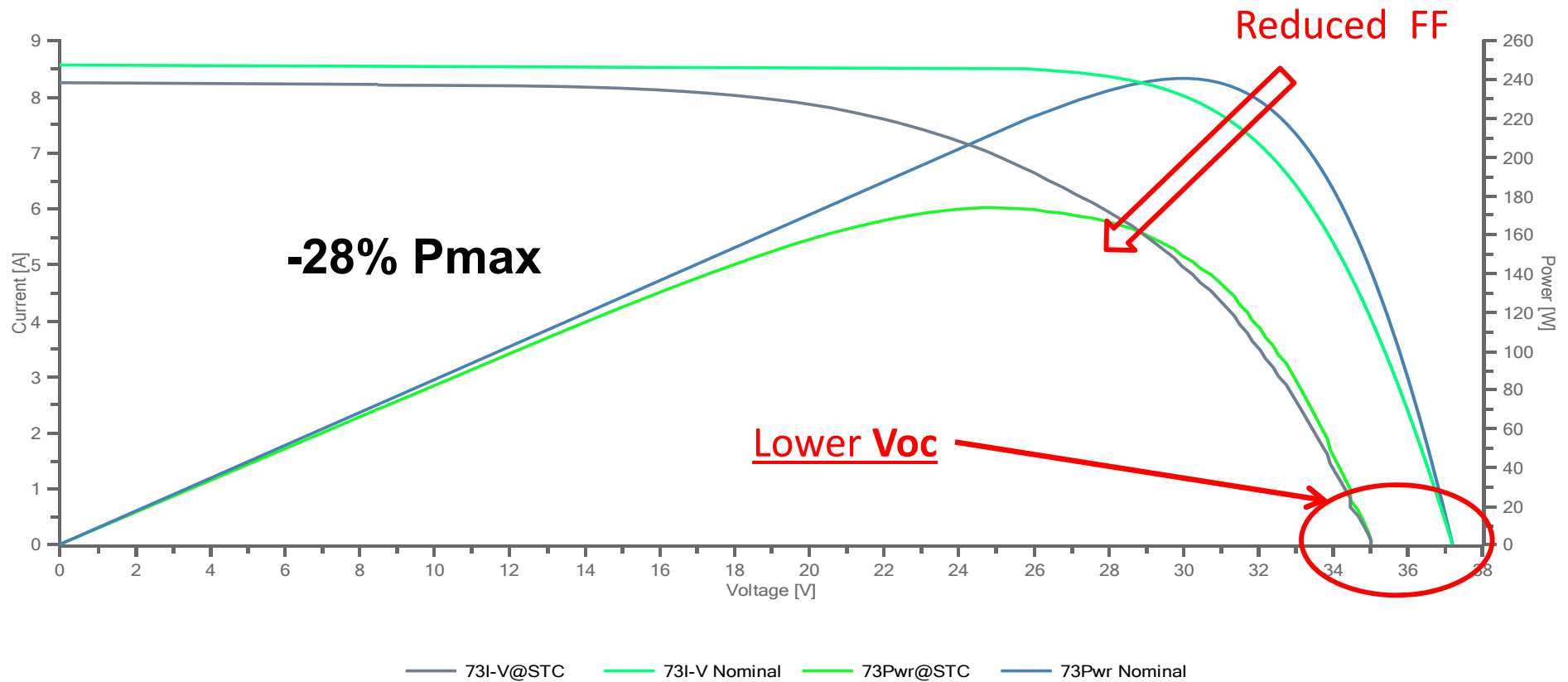
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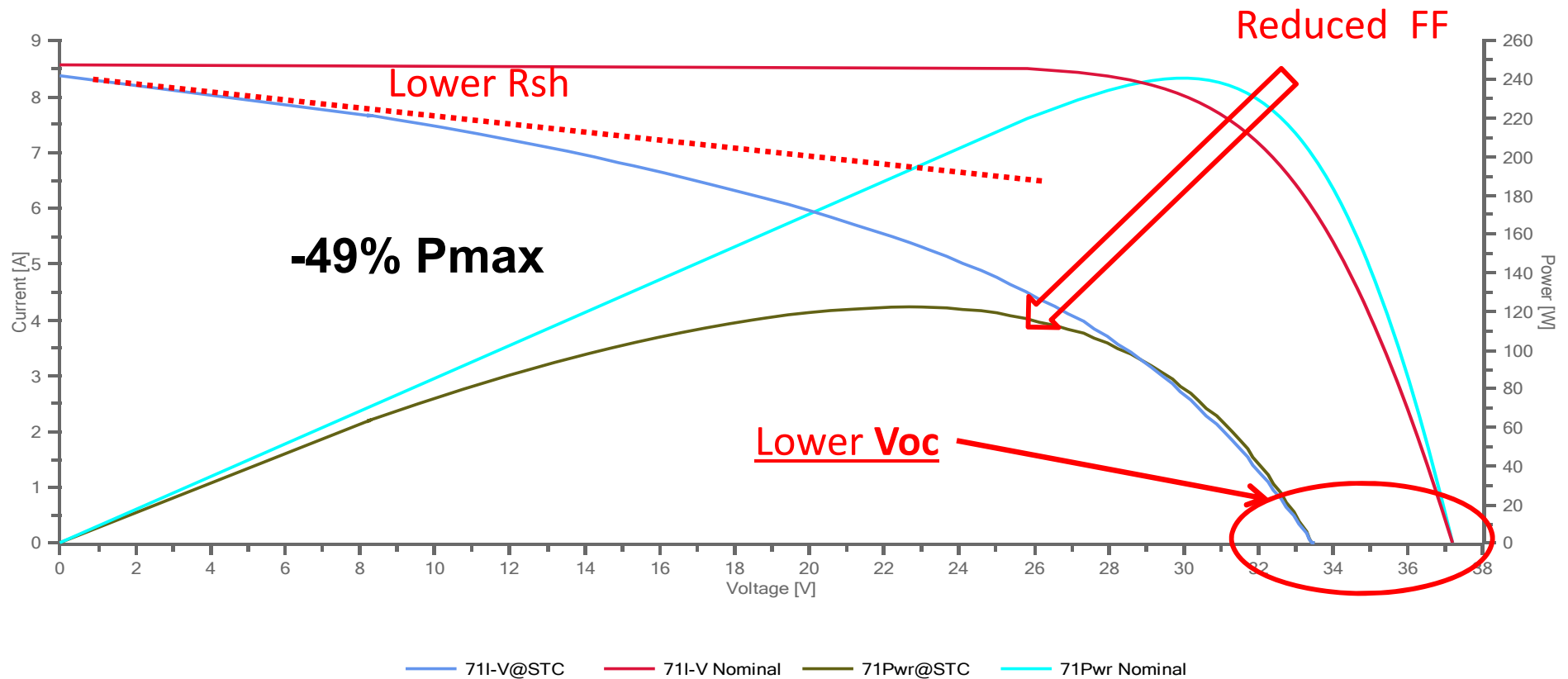
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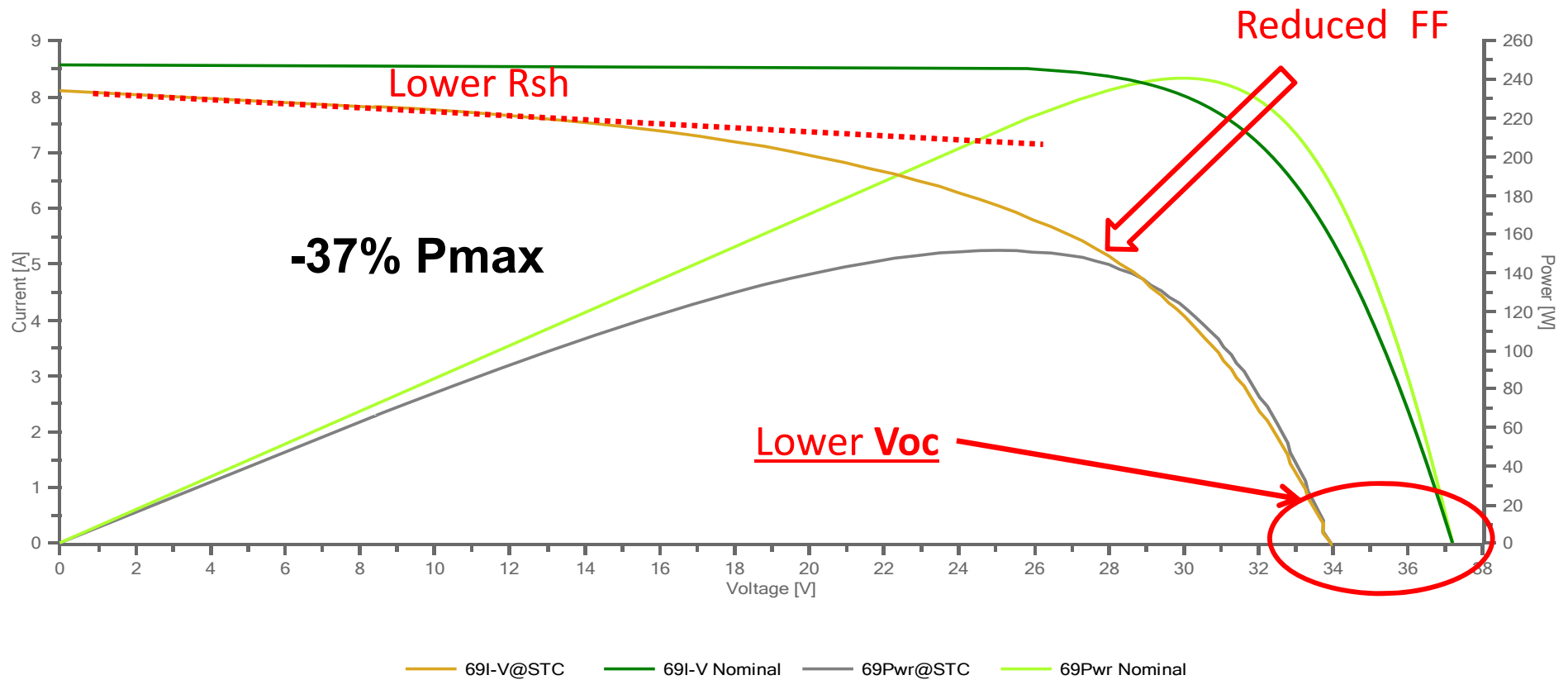
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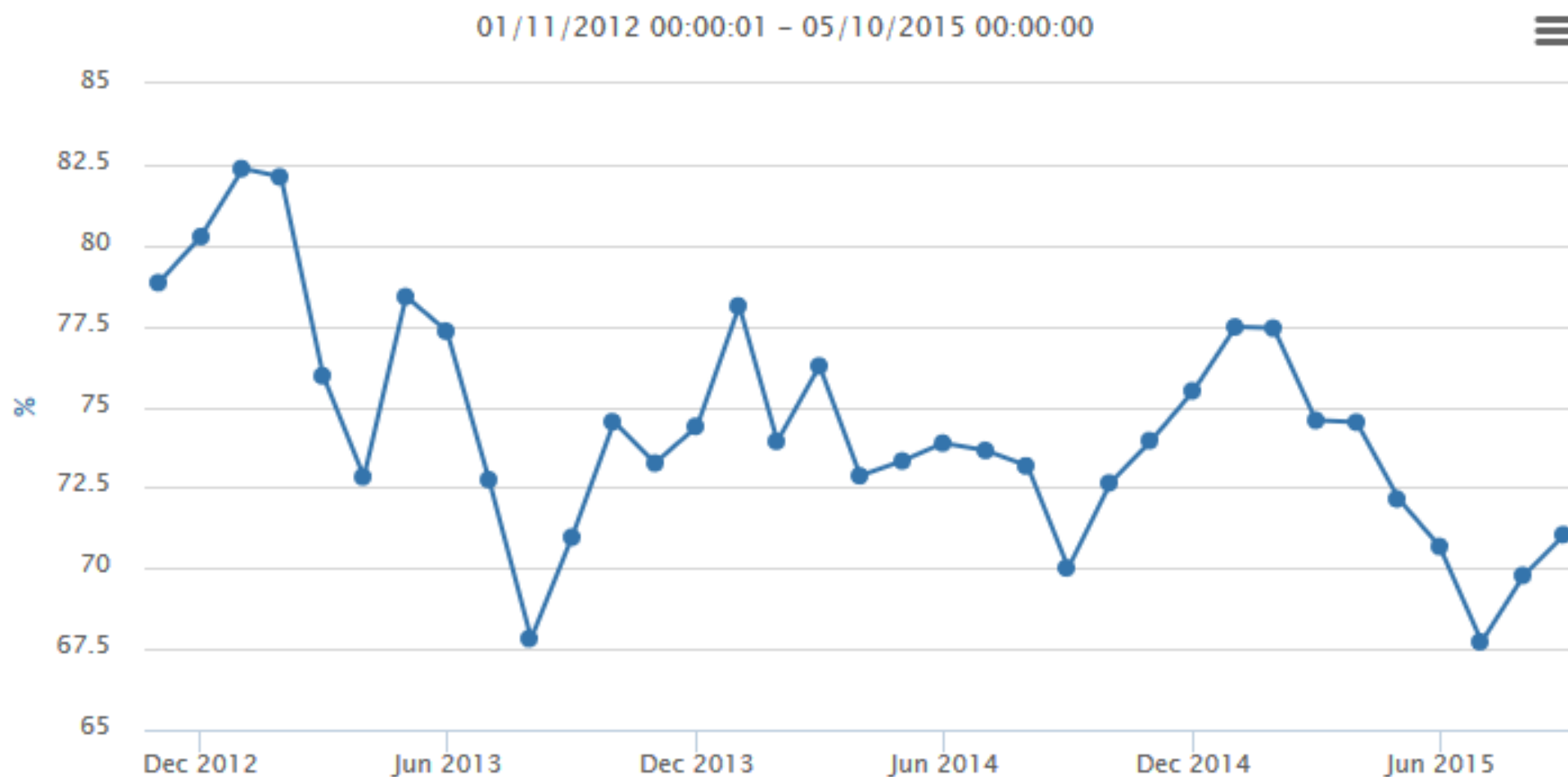
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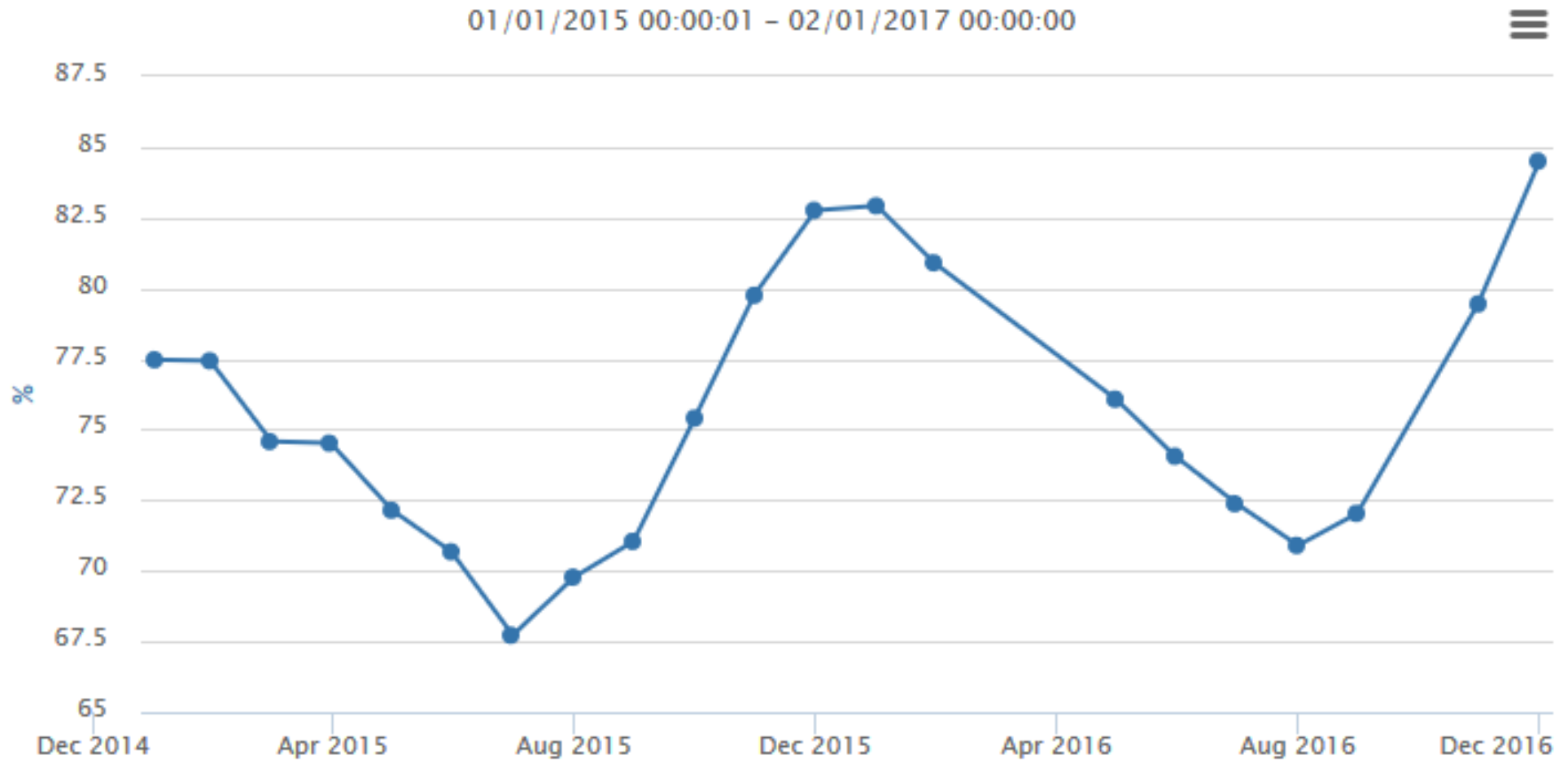
PID case study



PV plant PR decreasing trend during PID development phase



PV plant PR increasing trend after recovery solution implementation



PID-Resistance: The “Eagle” Series

No Corrective or Preventive Actions for PID

Typical Installation Topology and Flexibility

Maximized Production

First PID-resistant Module
(IEC62804 Standard)
85°C/85% RH, 192 hrs.



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