

Performance models are being increasingly used to reduce string length conservatism

Codes and Standards Compliance

Method	Compliance
Simplified Linear Datasheet Calculation $(Max V_{OC} = V_{OC_{STC}} \times [1 + \beta_{VOC} \times (25 - T_{MIN})])$	NFPA 70 (NEC) 690.7(A)(1) (2014, 2017, 2020, 2023) IEC 60364-7-712:2017 IEC 62548:2016 IEC 62738:2018
Performance Model V_{OC} Simulation (PlantPredict, System Advisor Model)	NFPA 70 (NEC) 690.7(A)(3) (2017, 2020, 2023) IEC 62548:2016 IEC 62738:2018

Challenges

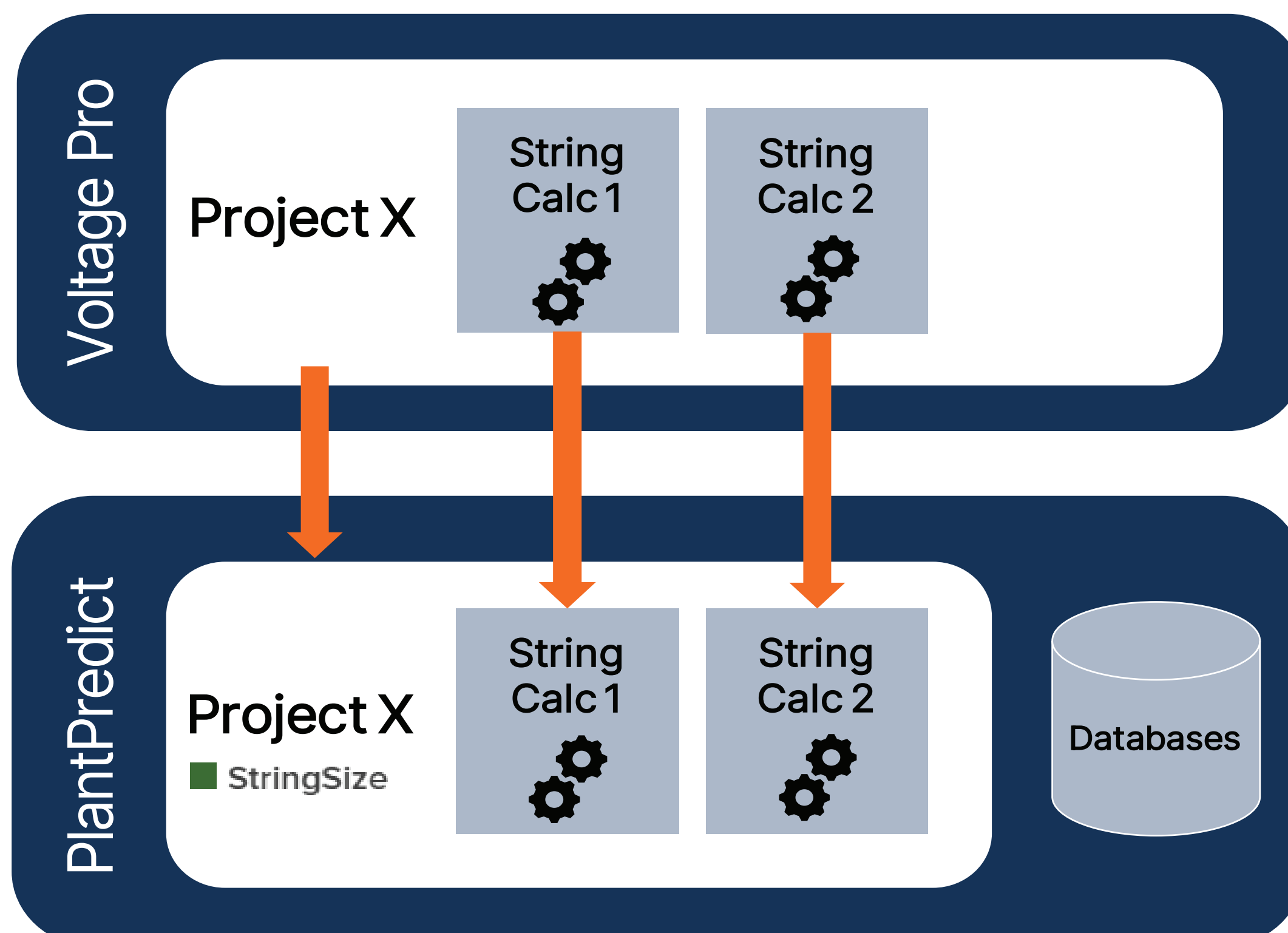
Codes and standards are vague and lack specificity

Lack of industry consensus on acceptable safety factors/margin

Inverter warranty risk for small, occasional voltage deviations

Voltage Pro takes the guesswork out of simulation-based string sizing

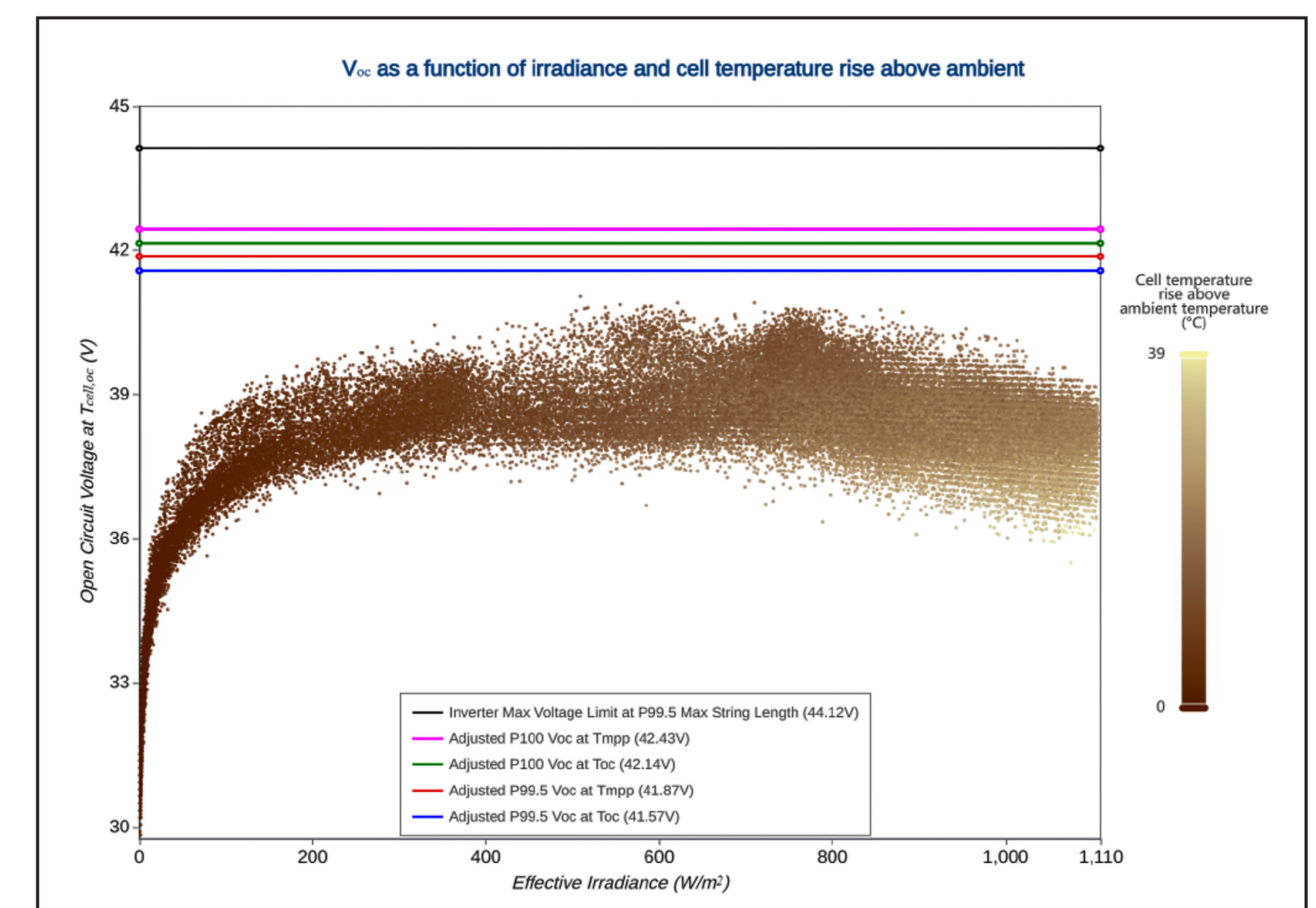
PlantPredict Integration



Safety Factory Automation

Summary	Linear method	Advanced method
Advanced calculation based on NFPA 70 2020, (NEC) 690.7(A)(3), IEC 62738, using PlantPredict single diode model.		
① Delta extreme annual mean min T	-4.14 °C	
① Air temperature data safety factor	1.076 %	
① Cell Mfg uncertainty safety factor	1 %	
① Wind speed uncertainty factor	0.6 %	
P100 Total safety factor	2.676 %	
① Cold weather variability	0.566 %	
P99.5 Total safety factor	3.242 %	
Advanced method safety adjusted simulation outputs		
	$V_{OC}/String$ (V)	$V_{OC}/Module$ (V) Max Module /String
17 years P100 V_{OC} (T_{min})	1,485.05	42.43 35
17 years P100 V_{OC} (T_{OC})	1,474.90	42.14 35
17 years P99.5 V_{OC} (T_{min})	1,465.45	41.87 35
17 years P99.5 V_{OC} (T_{OC})	1,456.52	41.57 36

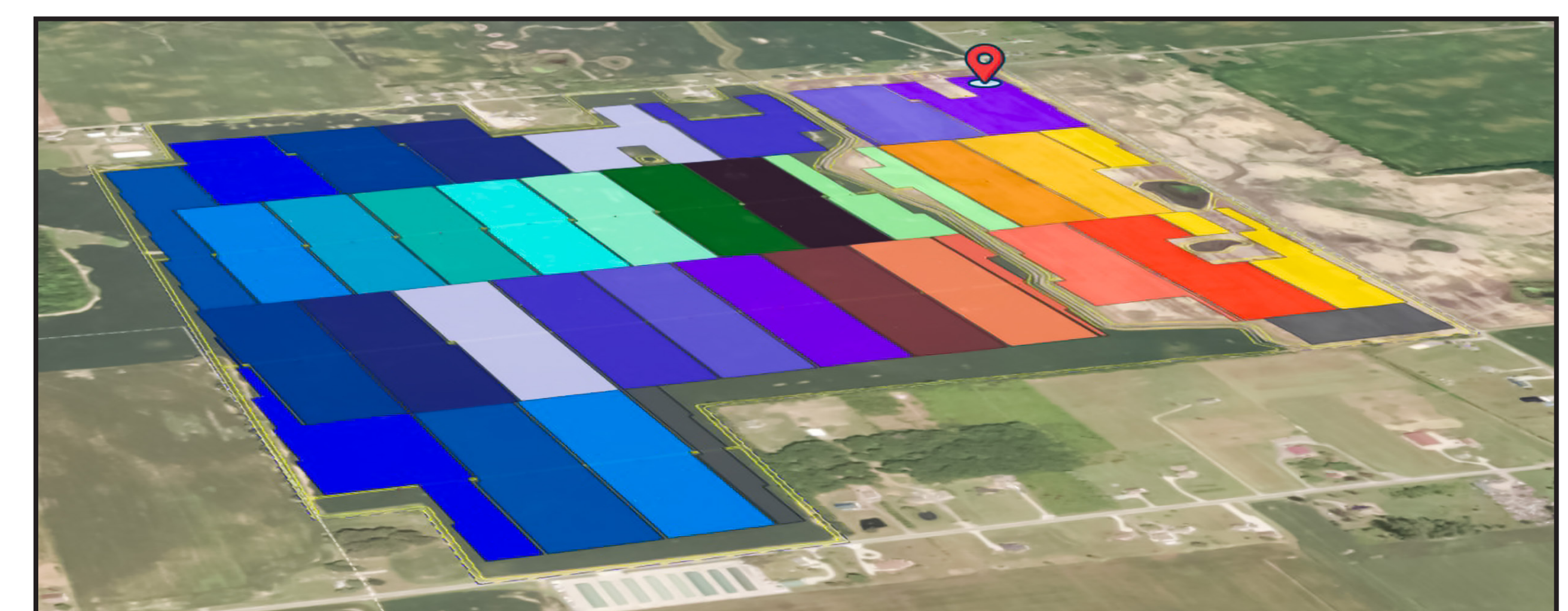
Data Visualization



Longer strings = Lower LCOE (reduced cost with minimal performance impact)

Business Case Study: 100 MW in Central Ohio, USA

	26 Mods/String (Simplified Method)	28 Mods/String (Voltage Pro)	Delta
# of Strings (ea)	7,917	7,350	-7.2%
# of Combiners / Harnesses (ea)	659	612	-7.2%
DC Installation Labor Savings	\$0.001 - \$0.003		-
DC String Cable Length (m)	1.63 M	1.51 M	-7.2%
Modules / Tracker row	78	84	+7.6%
Trackers / 100MW	2331	2173	-6.7%
Motors / Controllers / Drive Foundations	2331	2173	-6.7%
Cost Savings (\$/Wp)	\$0.006 - \$0.008		-
Energy Yield (kWh/kWp)	1,542	1,542	0



Longer strings result in significant savings to electrical and mechanical BOS material and labor without noticeable impact to yield.

\$600K to \$800K Cost Savings / 100 MW

