

STRATEGIES FOR ELECTRICAL SHADING MODELING WITH PLANTPREDICT

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May 14th, 2019
PVPMC

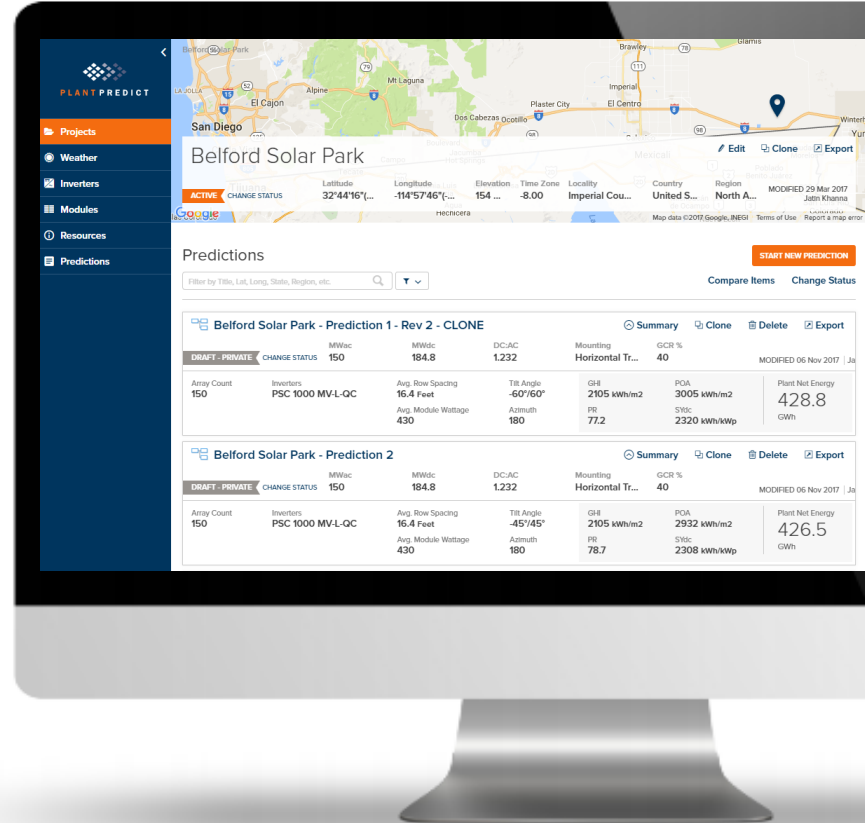


LEADING THE WORLD'S
SUSTAINABLE ENERGY FUTURE



AGENDA

1. PlantPredict Overview
2. Electrical Shading in PlantPredict
3. Analysis of Unique Electrical Shading Responses





INTRODUCTION

PLANTPREDICT OVERVIEW

- Generate **quick, contract-grade predictions** via a streamlined user interface
- Over **600 companies globally** with accounts
- Used in over **500 MWAC** of contracted utility-scale PV projects
- **Independently reviewed and benchmarked** against more than 1 GW of operating facilities
- **Recently Added Features**
 - PV + Storage Modeling
 - Bifacial Modules
 - Module File Generator
 - Electrical Shading

The screenshot displays the Soltec PlantPredict software interface. At the top, there is a section for 'Energy Storage System' with fields for 'ENERGY CAPACITY' and 'DISPATCH ALGORITHM'. Below this is the 'Module Generator' section, which includes a 'Generate Module' button and a 'Draft - Shared' status. The main focus is the 'Electrical Shading - Test Module' window, which features a 'SHADING' tab and a 'Shading Table'. The table shows a grid of values representing shading percentages across a module, with axes for 'Module Length' and 'Module Width'. The table is currently set to 'landscape orientation'. Below the table, there are options to 'Import Table Data (CSV)', 'Download Table Template', and 'Export Table As CSV'. An 'Active Cell' section shows 'Length: 100 %' and 'Width: 0 %', with a 'Shading Factor' of 1.

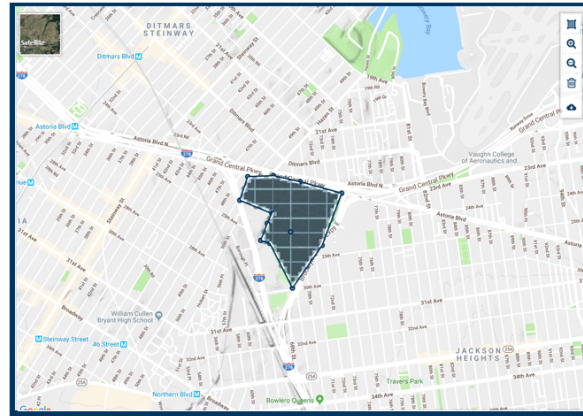
Module Shading Response	
Custom Electrical Shading	
Shading Table Note: shading table below is in landscape orientation	
Import Table Data (CSV)	
Download Table Template	
Export Table As CSV	
Active Cell	
Length	Width
100 %	0 %
Shading Factor	
1	

UPCOMING FEATURES

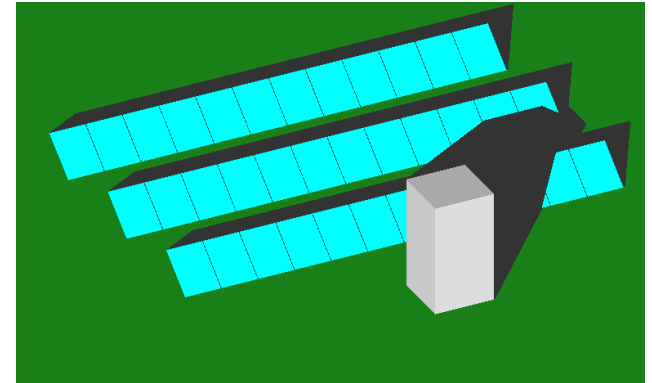
- *Time Series Parameter Import*
 - *Inverter Set-point, Tracker Angle, MST, LGIA Limit*
- *Advanced Layout Design*
- *Object Shading*



Row-to-row shading during BackTracking due to tracker error.



Map Builder example



Object Shading example

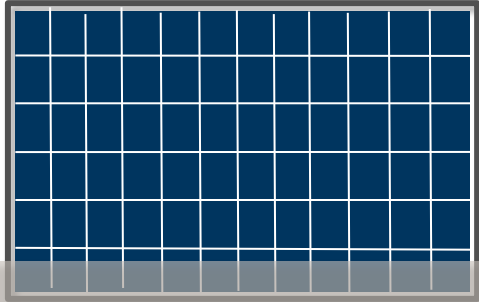


ELECTRICAL SHADING IN PLANTPREDICT

NEAR SHADING VS. ELECTRICAL SHADING

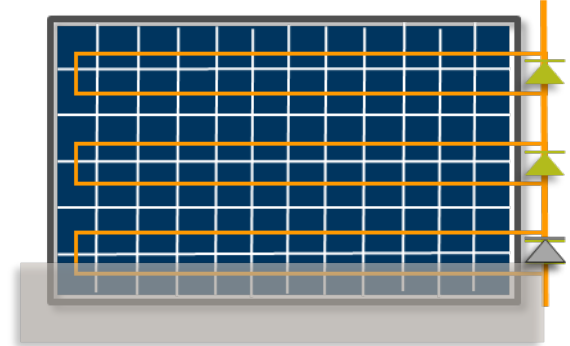
- **Near Shading:** caused by row-to-row and near object shading
- **Electrical Shading:** occurs when the bypass diodes are partially shaded

Near Shading Loss (Linear):



10% Shading  10% Power Loss

Electrical Shading Loss (Non-Linear):



10% Shading  33% Power Loss

For this hour:

Near Shading Loss = 10%

+

Electrical Shading Loss = 23%

Total Power Loss due to Shading = 33%

ELECTRICAL SHADING IN PLANTPREDICT

Navigating to the new Electrical Shading models:

Three new Direct Shading options:

1. Fractional Effect
2. 3-Diode
3. Custom Shading Response

Projects > Sprint Test 7.6 > Map Test 7.7

Map Test 7.7

Simulation Settings

Set your parameters for this specific prediction

[SAVE + CLOSE](#) [Save](#)

Timeframe

Start Date: 01 Jan 2010 00:00
End Date: 31 Dec 2010 23:00

[SHOW UNCERTAINTY ANALYSIS](#)

Weather File Name: **Meteonorm - 48.37N - 11.8E**

Start Date	End Date	Time Step	D
1 Jan 2010	31 Dec 2010	60 min	1

Model Choices

Decomposition: None
Transposition: Perez
Module Temperature: Heat Balance

Incidence Angle: None
Spectral: None

[SHOW ADVANCED MODEL CHOICES](#)

Direct Shading

- Module File Defined Shading
- Select an option
- Linear
- None
- Fractional Electrical Shading
- C-Si 3-Diode Shading
- Module File Defined Shading**

FRACTIONAL EFFECT SHADING MODEL

If fractional effect is enabled, module shading reduces the power output depending on the fractional value.

Example Case:

100% FRACTIONAL EFFECT



- 10% Shading =
- 10% Near Shading Loss
 - 90% Elec. Shading Loss
 - 100% Power Loss

50% FRACTIONAL EFFECT

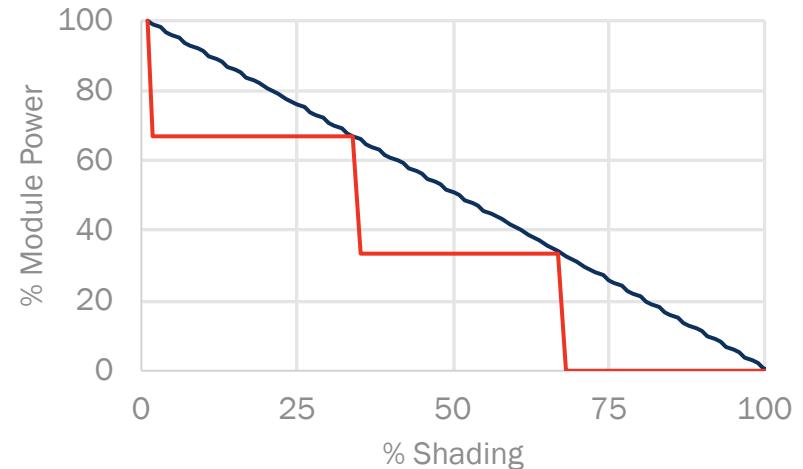
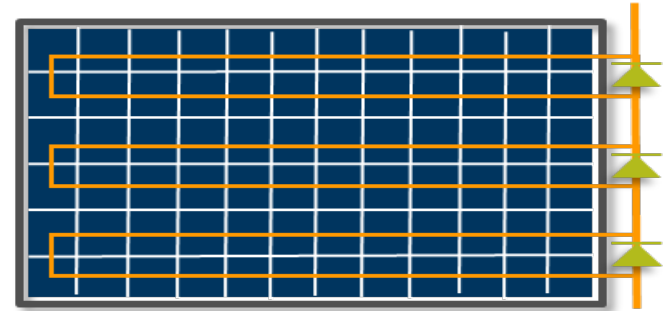


- 10% Shading =
- 10% Near Shading Loss
 - 45% Elec. Shading Loss
 - 55% Power Loss

THREE DIODE SHADING MODEL

- Most common structure in 72 cell c-Si modules is the **3 bypass diode** configuration
- Bypass diodes connect 2 rows of cells in the landscape direction
- Any shading of the series string activates the corresponding bypass diode

10% Shading  Up to **33%** Power Loss



MODULE FILE SHADING MODEL LAYOUT

Module Library > Test - Electrical Shading

Test - Electrical Shading

Draft - Private  Alex Stark | 17 Dec 2018

PHYSICAL & NAMEPLATE

1-DIODE

SPECTRAL

SHADING

IAM

MODELING DEFAULTS

Module Shading Response

C-Si 3-Diode Shading 

Shading Table Note: shading table below is in landscape orientation

100%	1	0	0	0	0
67%	1	0	0	0	0
34%	1	.33	.33	.33	.33
01%	1	0.66	0.66	0.66	0.66
00%	1	1	1	1	1
% Shaded	00%	01%	34%	67%	100%

% Shaded X and Y Axes:

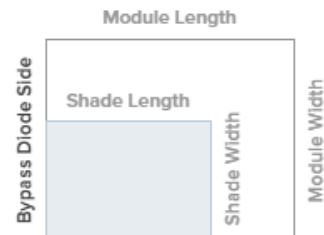
The % of the module along either the length or the width that is shaded.

Fractional Production Values:

Fraction of power produced depending on % of module shaded.

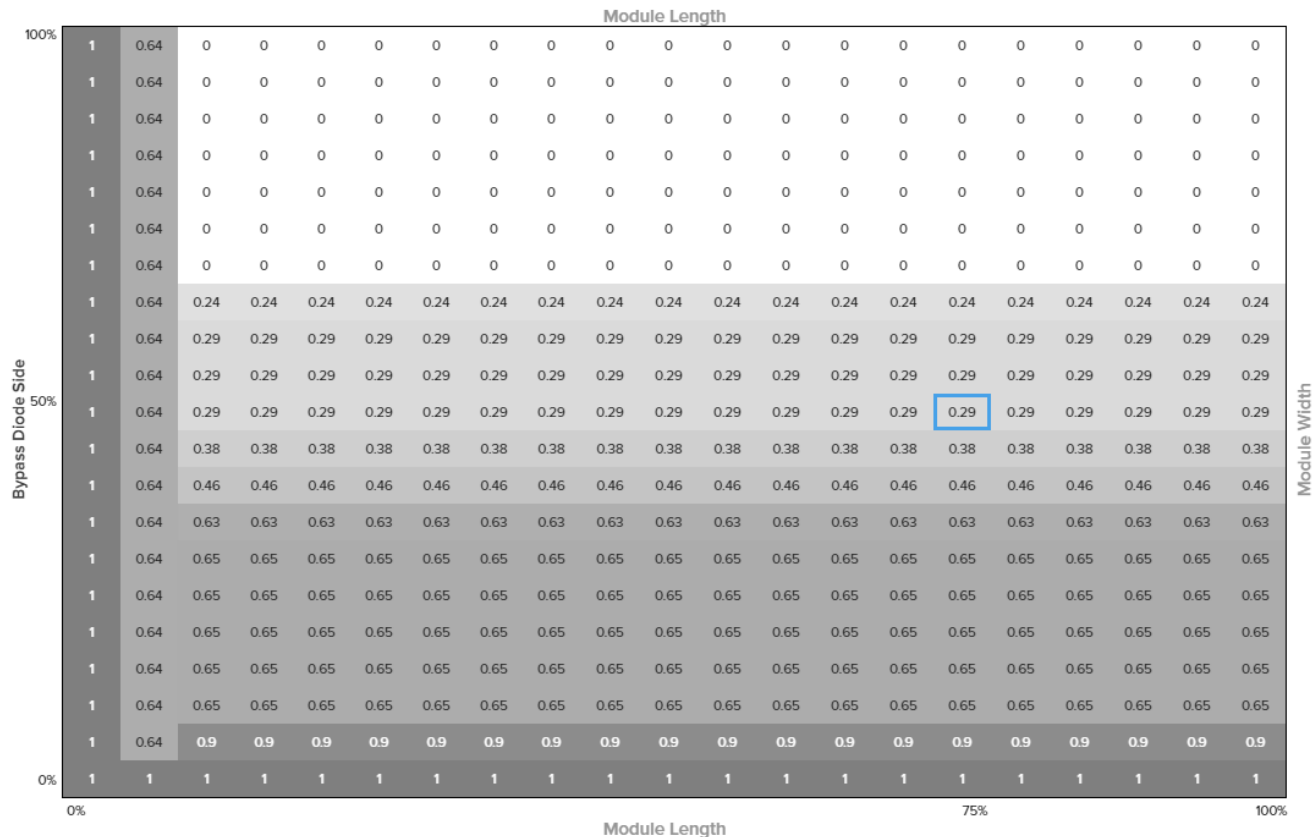
Example for C-Si 3-Diode Case:

When the module is shaded at 15% length and 15% width, the module will produce at a factor 0.66 of expected power.



CUSTOM SHADING TABLE INPUT

- For defined module length/width shaded user can define power loss
- Able to upload up to a **100x100** table
- Could represent:
 - Shingled modules
 - Half-Cut Cell modules
 - Multiple Bypass Diodes





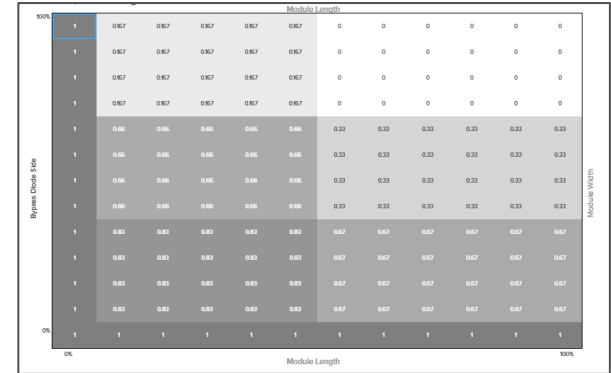
COMPLEX SHADING RESPONSES

SIMULATION SETUP

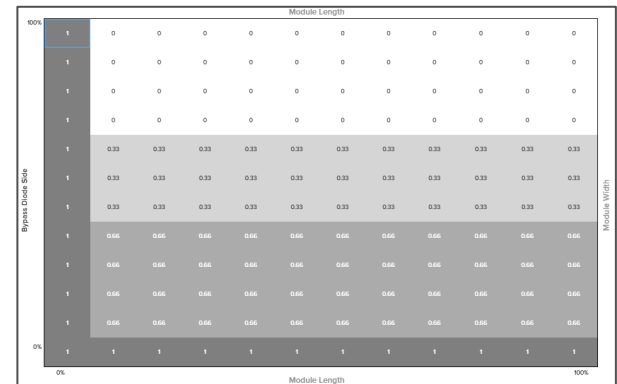
Parameters	Values
GCR	30%-80%
Tracking	Fixed Tilt True-Tracking Backtracking
Shading Responses	8 unique responses
Sites	AZ OH

*NOTE: All simulations done for non-sloped arrays

Half-Cut Cell Module Shading Response

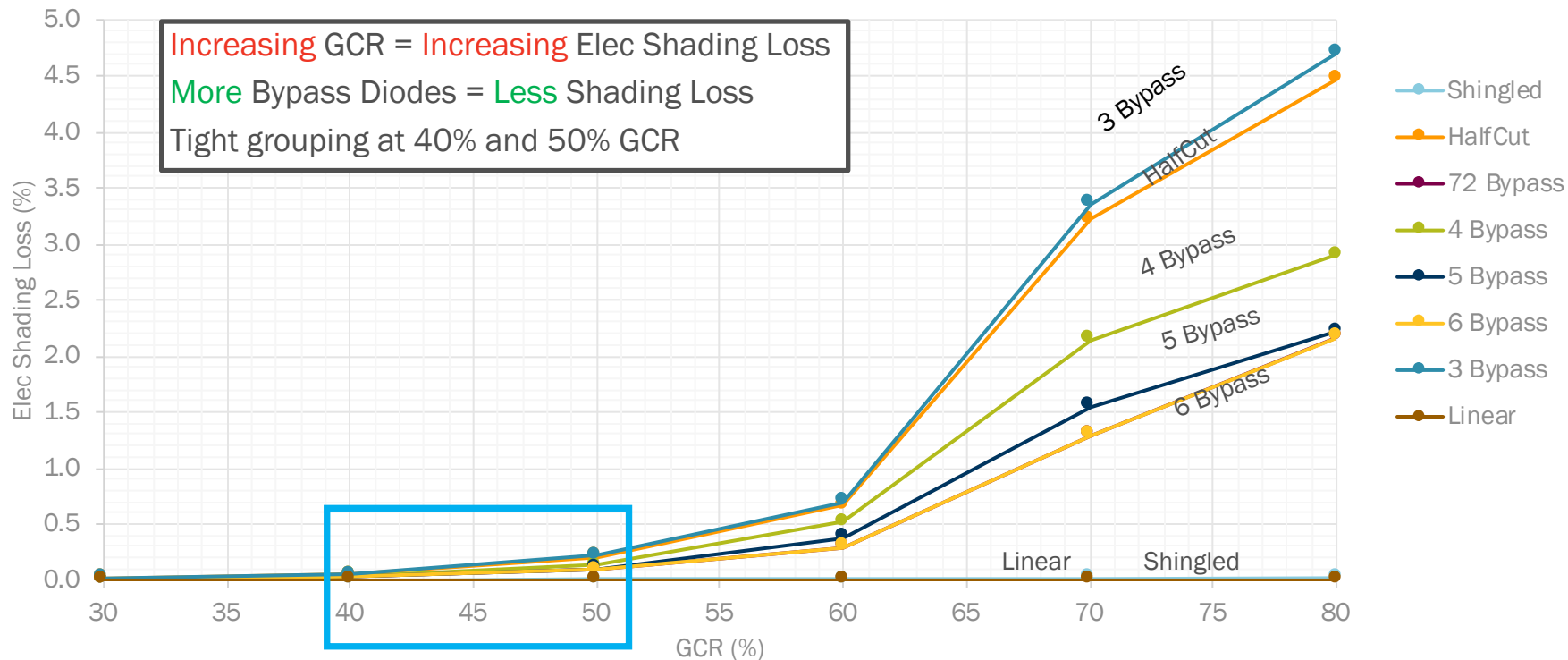


3 Bypass Diode Module



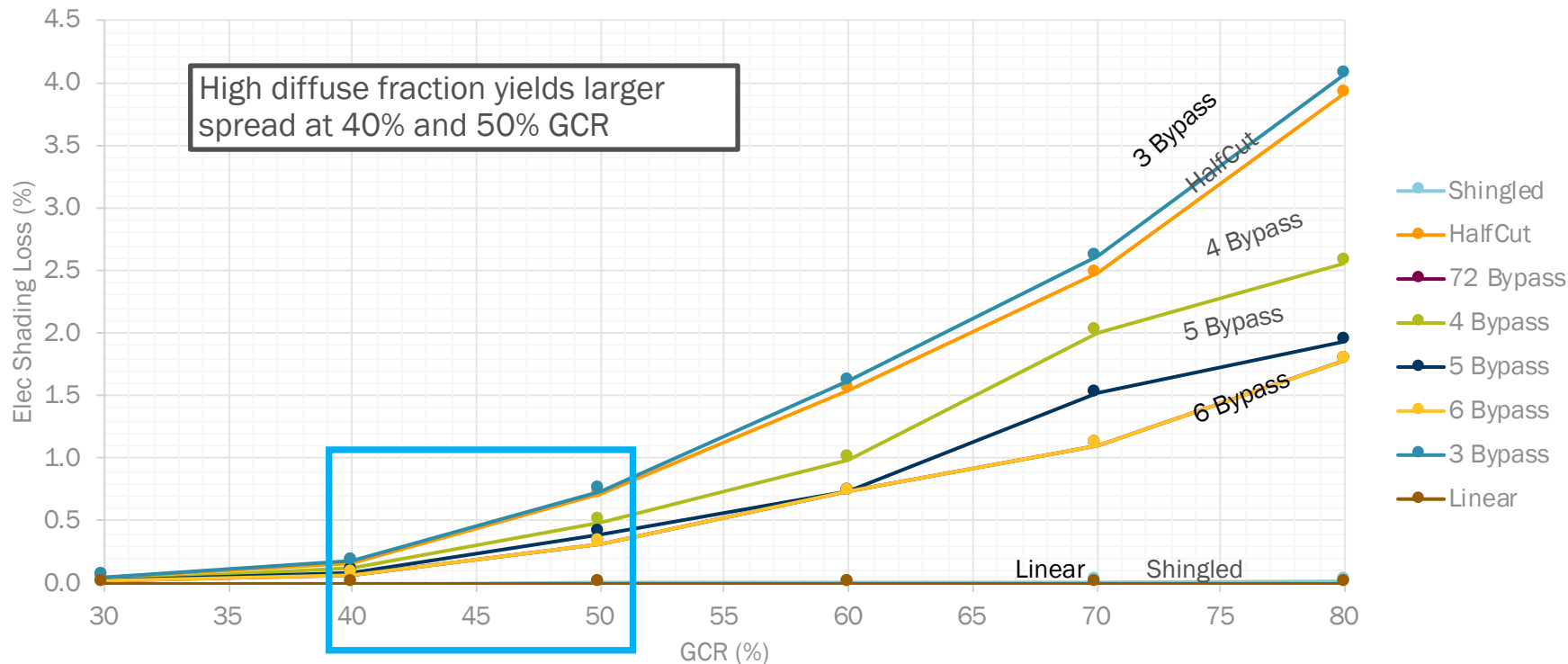
ARIZONA – HIGH DIRECT, LOW DIFFUSE IRRADIANCE

Fixed Tilt – Landscape: GCR vs. Electrical Shading Loss

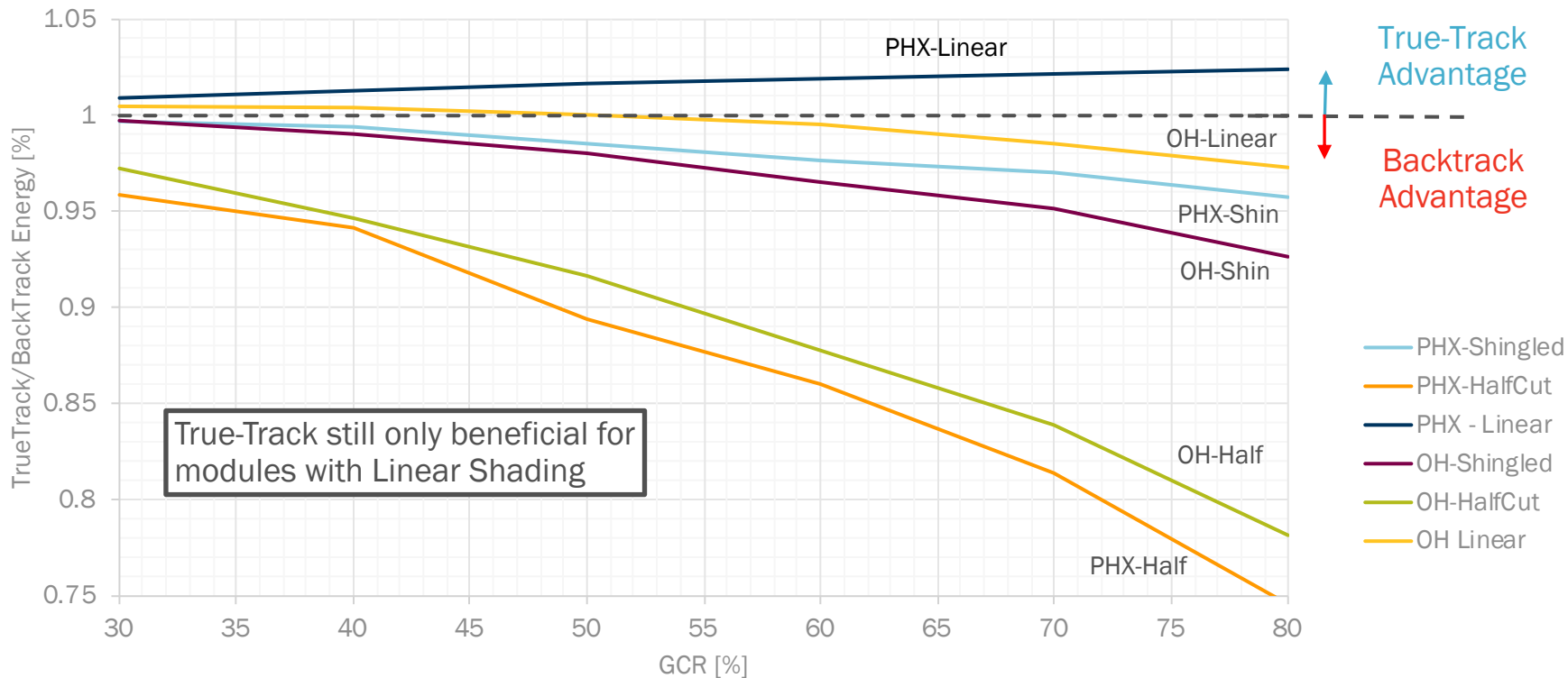


OHIO – LOW DIRECT, HIGH DIFFUSE IRRADIANCE

Fixed Tilt – Landscape: GCR vs. Electrical Shading Loss



ARIZONA VS. OHIO – TRUETRACK VS. BACKTRACK ENERGY



RESULTS: KEY TAKEAWAYS

- Fixed Tilt – Landscape
 - The more bypass diodes, the lower the electrical shading loss
 - The benefit of adding bypass diodes increases at high GCRs
- Backtracking vs. True-Tracking
 - Backtracking logical choice for all c-Si modules EXCEPT Shingled at low GCRs
 - True-Tracking logical choice for thin film CdTe modules

THANKS FOR YOUR ATTENTION!



Request your free account today by going to:

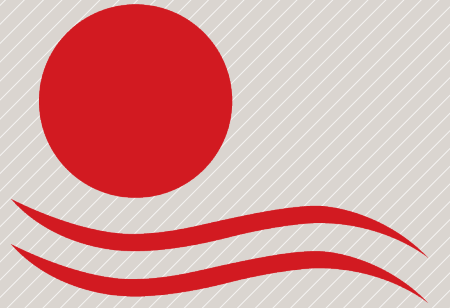
www.plantpredict.com/contact/

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View all of our documentation and algorithms at:

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