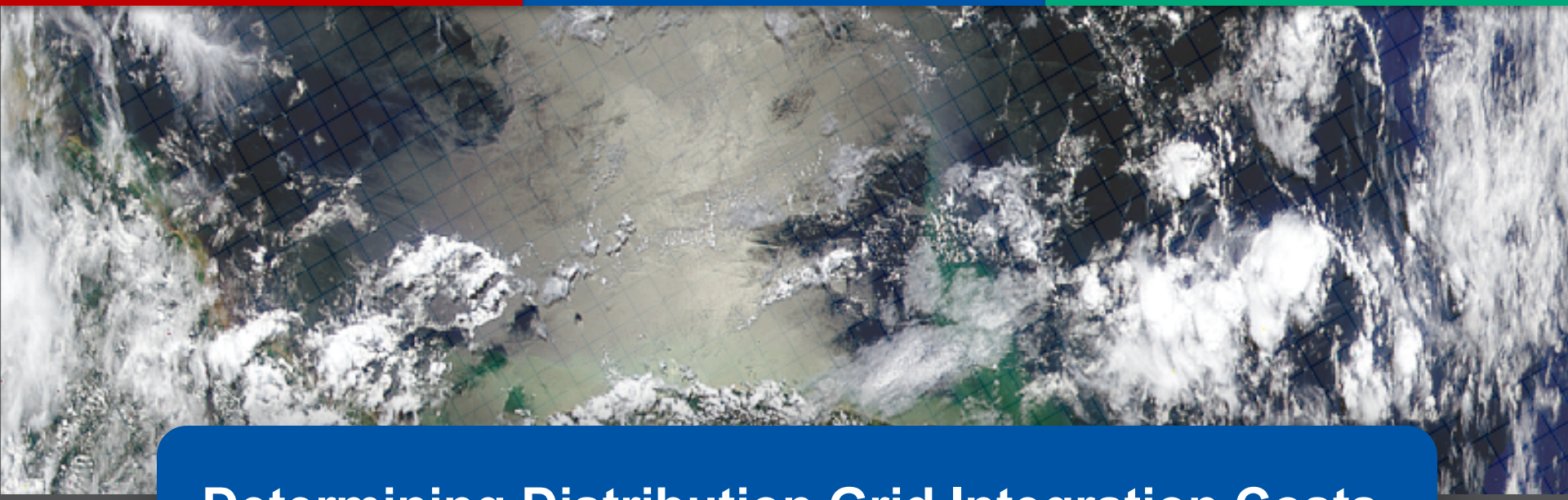


Determining Distribution Grid Integration Costs Under High Distributed PV Penetrations

Morgan Putnam
Director of Business Development

Clean Power Research®

September 19, 2017

Copyright © 2014 -2017 Clean Power Research, L.L.C

v083116

Value of Solar (VOS) Studies

VOS Calculation Table:

25 Year Levelized Value	Gross Value ($/kWh)	×	Load Match Factor (%)	× (1 +	Loss Savings Factor (%)	) =	Distributed PV Value ($/kWh)
Avoided Fuel Cost	GV1				LSF-Energy		V1
Avoided Plant O&M - Fixed	GV2				LSF-Energy		V2
Avoided Plant O&M - Variable	GV3				LSF-Energy		V3
Avoided Gen Capacity Cost	GV4		ELCC		LSF-ELCC		V4
Avoided Reserve Capacity Cost	GV5		ELCC		LSF-ELCC		V5
Avoided Trans. Capacity Cost	GV6		ELCC		LSF-ELCC		V6
Avoided Dist. Capacity Cost	GV7		PLR		LSF-PLR		V7
Avoided Environmental Cost	GV8				LSF-Energy		V8
Avoided Voltage Control Cost							
Solar Integration Cost							
							Value of Solar

This framework is useful conceptually, but processes and tools are needed to perform these calculations in detail

Example VOS Results

Minnesota VOS

Summer-Peaking, Displace Gas Generation

25 Year Levelized Value

	Economic Value ($/kWh)	Load Match (No Losses) (%)	Distributed Loss Savings (%)	Distributed PV Value ($/kWh)
Avoided Fuel Cost	$0.056		8%	$0.061
Avoided Plant O&M - Fixed	$0.003	40%	9%	$0.001
Avoided Plant O&M - Variable	$0.001		8%	$0.001
Avoided Gen Capacity Cost	$0.048	40%	9%	$0.021
Avoided Reserve Capacity Cost	$0.007	40%	9%	$0.003
Avoided Trans. Capacity Cost	$0.018	40%	9%	$0.008
Avoided Dist. Capacity Cost	$0.008	30%	5%	$0.003
Avoided Environmental Cost	$0.027		8%	$0.029
Avoided Voltage Control Cost				
Solar Integration Cost				

$0.127

Tacoma Power VOS

Winter-Peaking, >90% Hydro

25 Year Levelized Value

		Gross Value A ($/kWh)	× Load Match Factor B (%)	× Loss Savings Factor (1+C) (%)	= Distributed PV Value D ($/kWh)
Energy Supply	Market Value of Energy	$0.0395		12.0%	$0.0442
	Avoided Plant O&M - Fixed	$0.0043	2.7%	21.3%	$0.0001
	Avoided Gen. Capacity Cost	$0.0336	2.7%	21.3%	$0.0011
	Avoided Res. Gen. Capacity Cost	$0.0017	2.7%	21.3%	$0.0001
	(Solar Integration Cost)	-$0.0010		12.0%	-$0.0011
Transmission Delivery Service	Avoided Trans. Capacity Cost	$0.0204	2.7%	21.3%	$0.0007
Distribution Delivery	Avoided Dist. Capacity Cost	$0.0067	0.0%	0.0%	$0.0000
	Voltage Regulation	-			-
Environmental	Avoided Environmental Cost	$0.0010		12.0%	$0.0011
					$0.0462

$0.0462

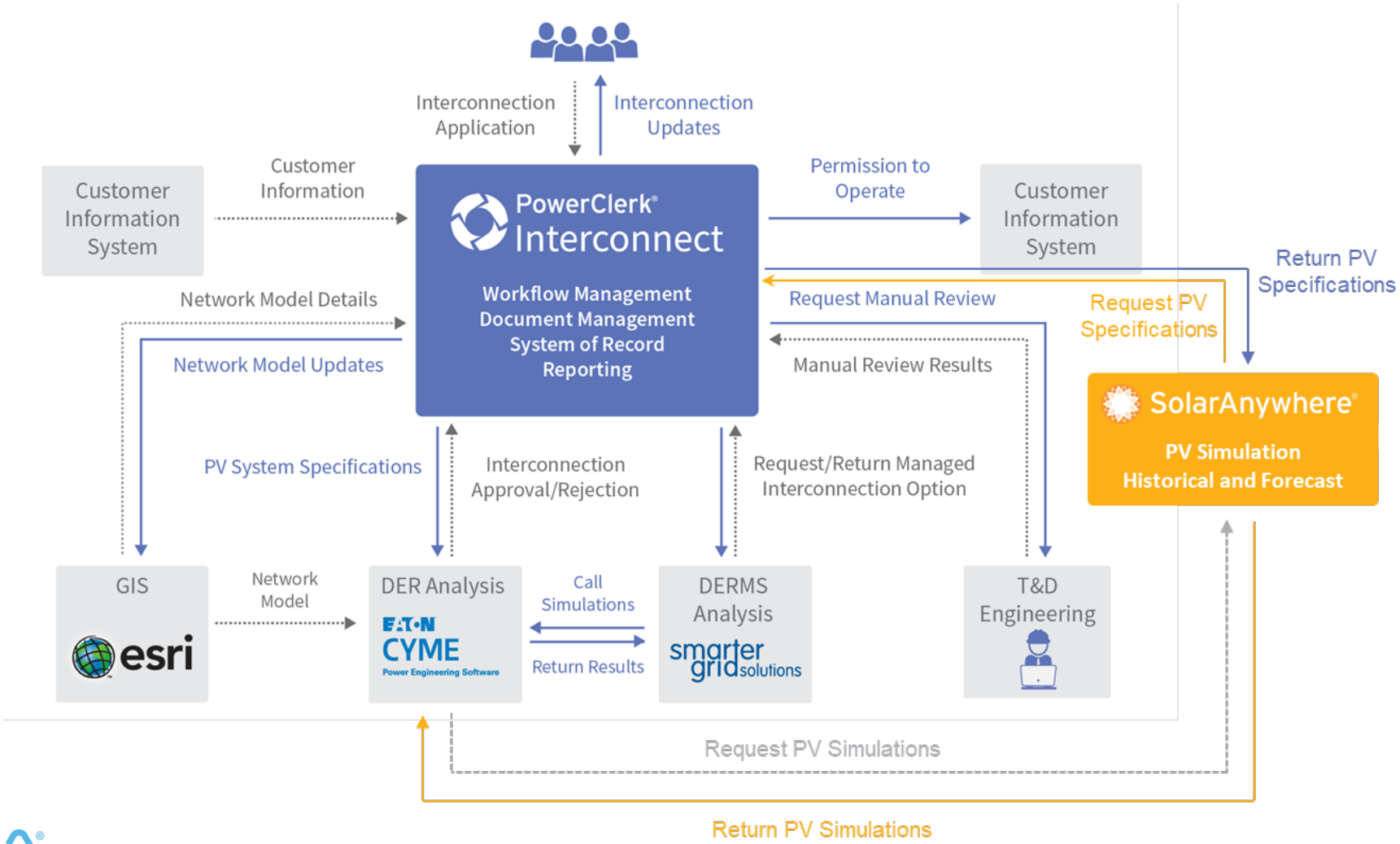
Nonetheless, VOS does deliver useful results that can advance stakeholder discussions

How Can Software Reduce the Cost of Integrating High Penetrations of Distributed PV?

- **It can't**
- Unless software <u>systems</u> are integrated

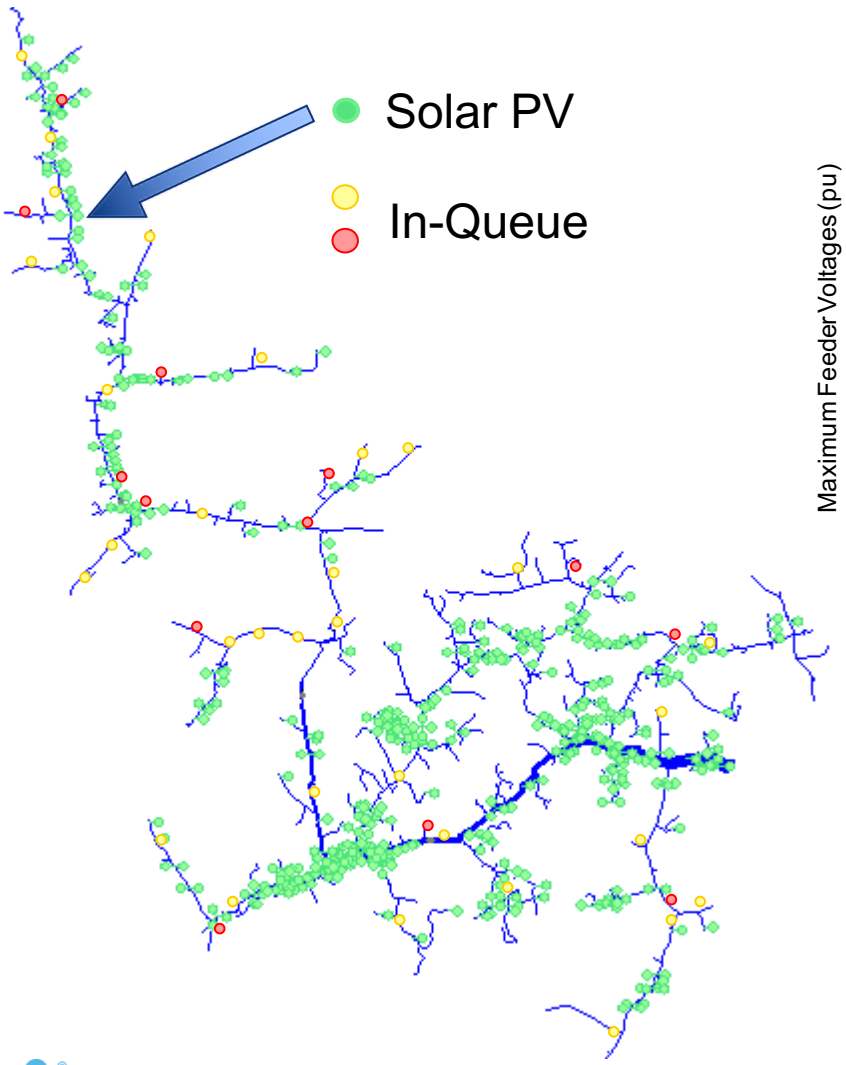
Clean Power Research®

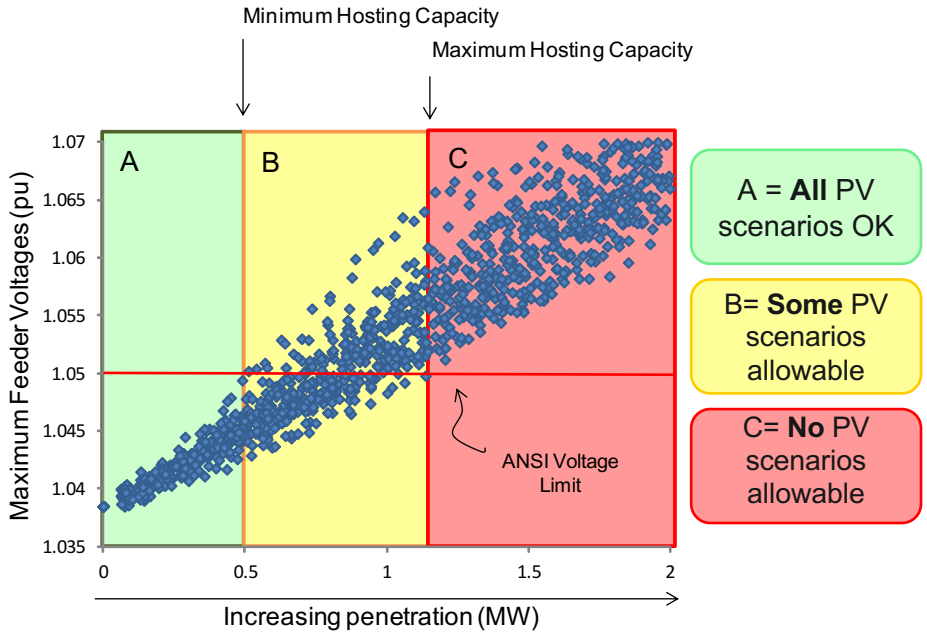
By Integrating Software Systems



Clean Power Research®

… Distribution Engineers Can See This

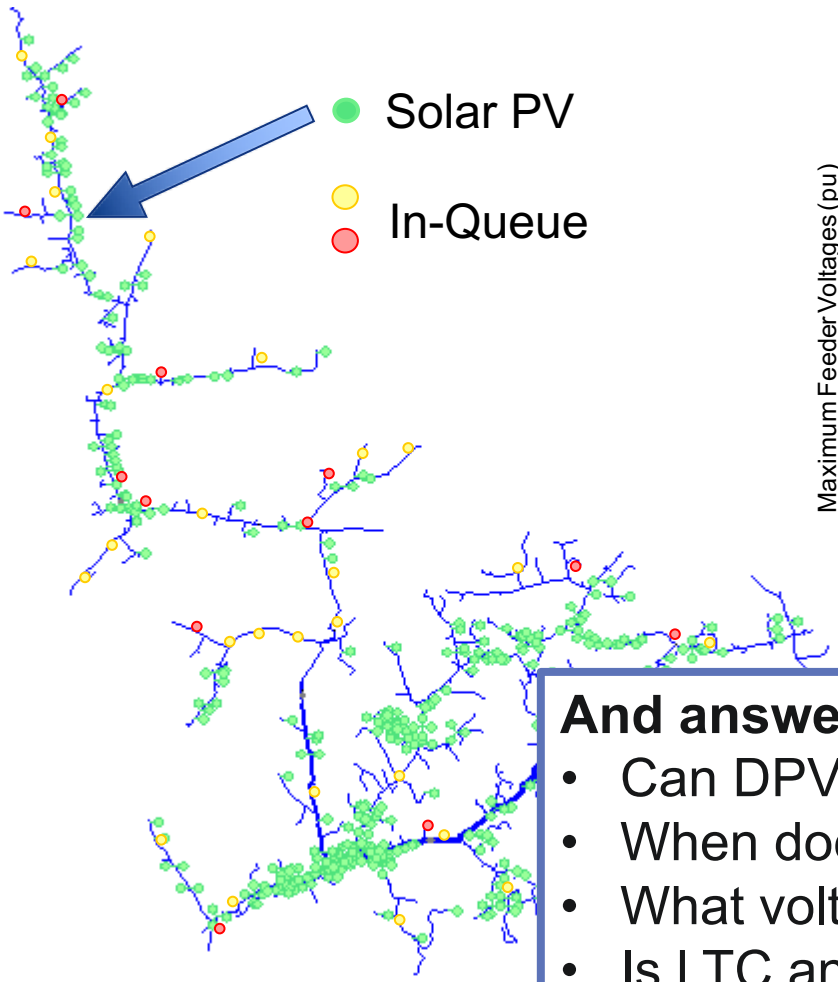


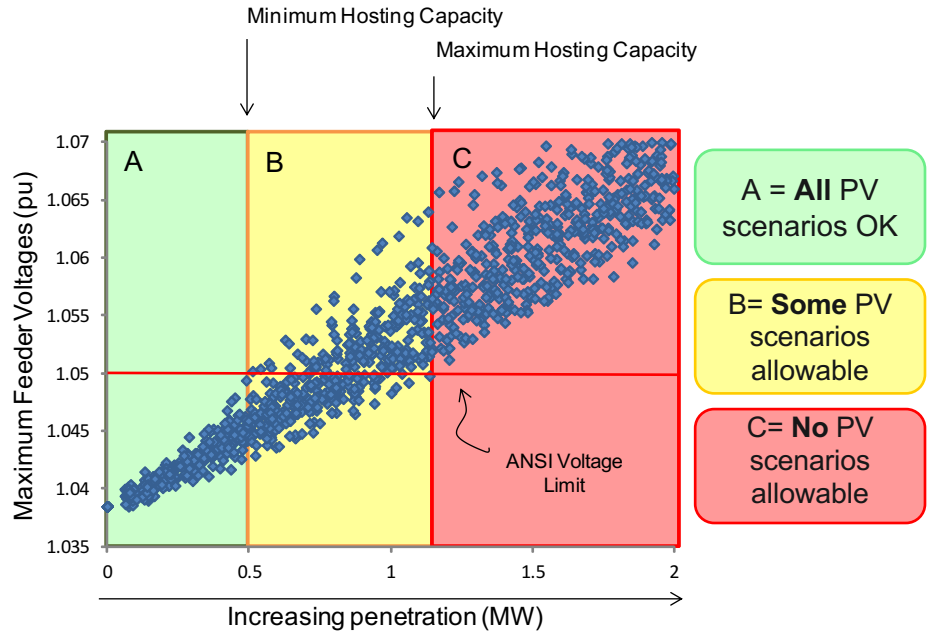


Clean Power Research®

Source: EPRI SHINES Kickoff – June 2016

… Distribution Engineers Can See This





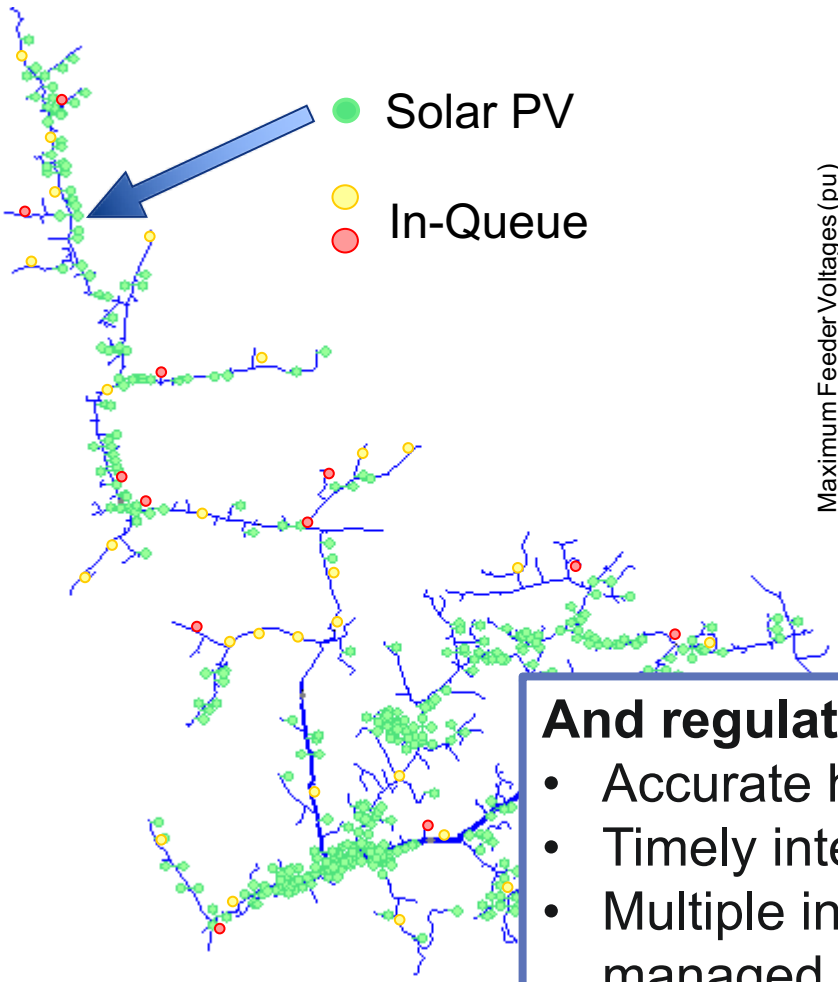
And answer these questions:

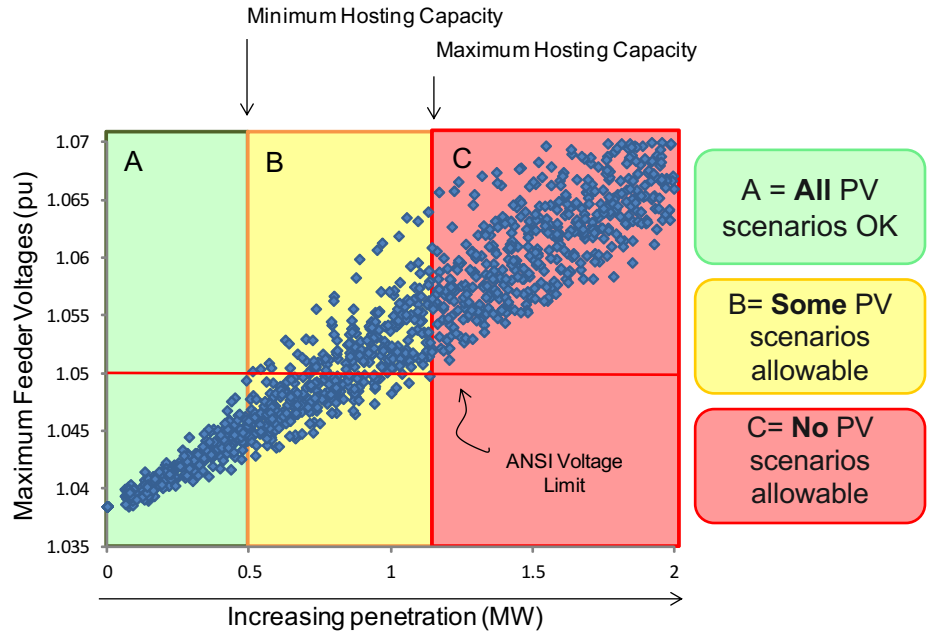
- Can DPV be utilized for peak load reduction?
- When does feeder backflow start to occur?
- What voltage effects are occurring?
- Is LTC and Cap Bank cycling an issue?

Clean Power Research®

Source: EPRI SHINES Kickoff – June 2016

… Distribution Engineers Can See This





And regulators and installers can have:

- Accurate hosting capacity maps
- Timely interconnection reviews
- Multiple interconnection options (including managed interconnections)

Clean Power Research®

Source: EPRI SHINES Kickoff – June 2016

CPR's On-Going Software Integrations:

- CYME, Smarter Grid Solutions and PowerClerk for Avangrid (NYSERDA)
- EDD's DEW with PowerClerk and SolarAnywhere for ORU (NYSERDA)
- EDD's DEW with SolarAnywhere for PEPCO (DOE SUNRISE)
- EPRI's DRIVE tool with PowerClerk and SolarAnywhere (DOE SHINES)
- DNV-GL's Synergi with PowerClerk and SolarAnywhere (Utility customers)

CYME Power Engineering Software
EATON

smarter grid solutions

edd

DNV·GL

EPRI
ELECTRIC POWER RESEARCH INSTITUTE

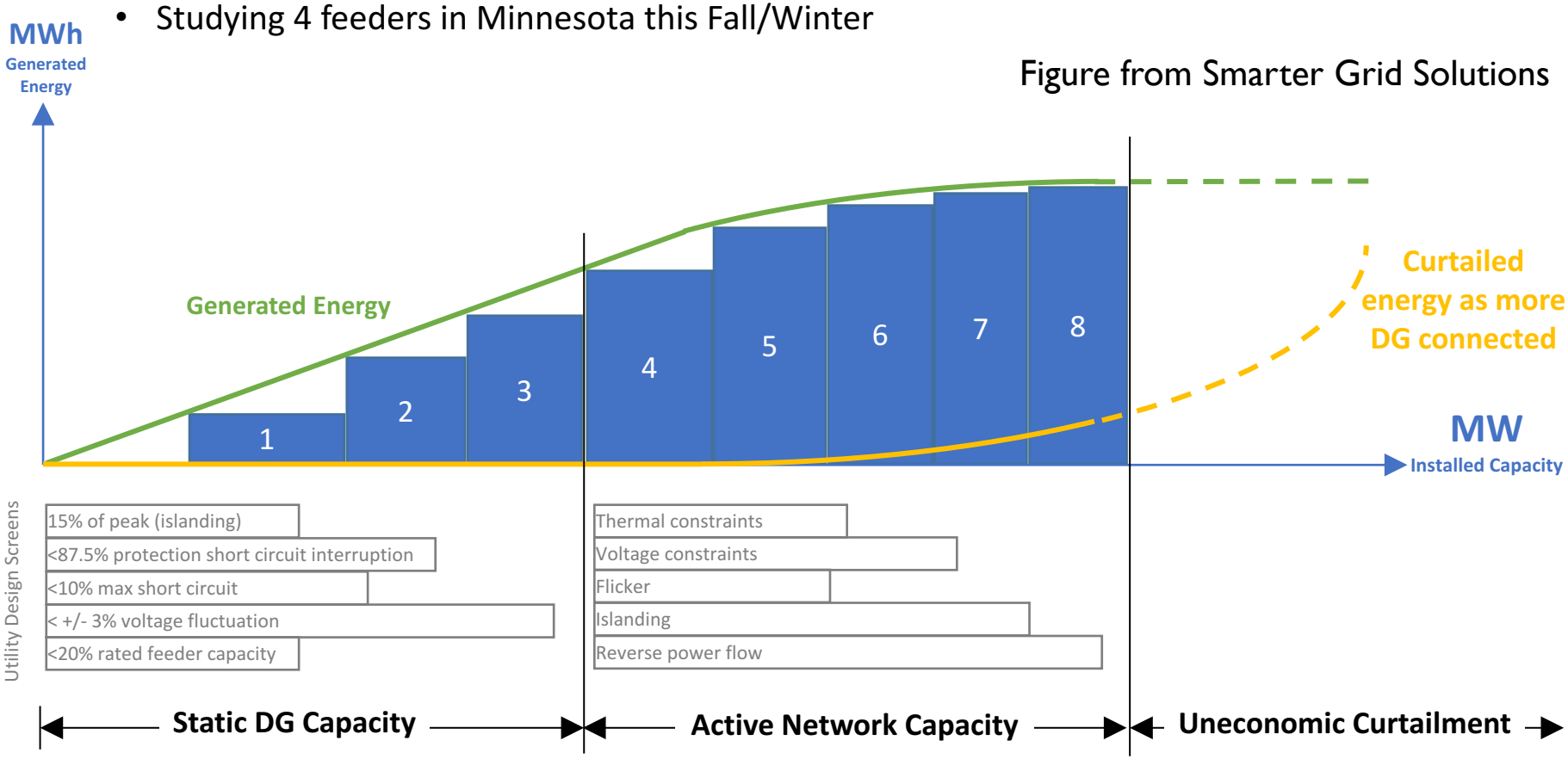
esri Partner Network Silver

Clean Power Research®

'Enhanced' Hosting Capacity Analysis

- Evaluate the ability of smart inverters, energy storage, load shifting, and smart curtailment to increase PV hosting capacity
- Studying 4 feeders in Minnesota this Fall/Winter

Figure from Smarter Grid Solutions



Most Pressing Challenges

1) Determining Why We Care about Accurate Valuation

- Cost-shifting? (Some amount is inherent to any rate design)
- Rising grid costs? (A legitimate concern)

2) Determine How to Build Customer Trust & Accurately Value

Method / Value Component	New Rates (e.g., TOU, Demand, CPP)	Competitive Sourcing (e.g., NWA)	Market Enablement (e.g., grid edge transactions)
Energy	Stable payment	Stable payment	High price uncertainty – will values be separated? Grid security challenges?
Distribution	Hard to make feeder specific	One-time payment	

Clean Power Research®