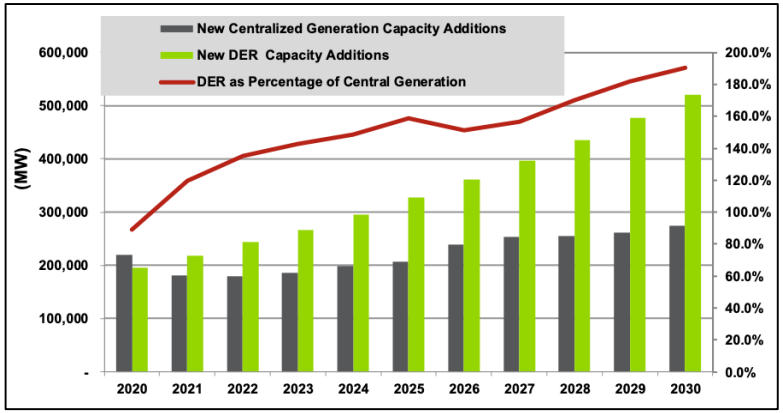
The Future of Energy

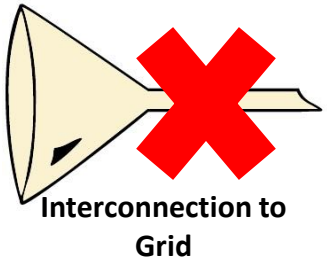
FLEXIBLE INTERCONNECTION SOLUTION

(DERCOM TECHNOLOGY)

The Problem for Utilities

DER exponential growth is destabilizing the electric grid



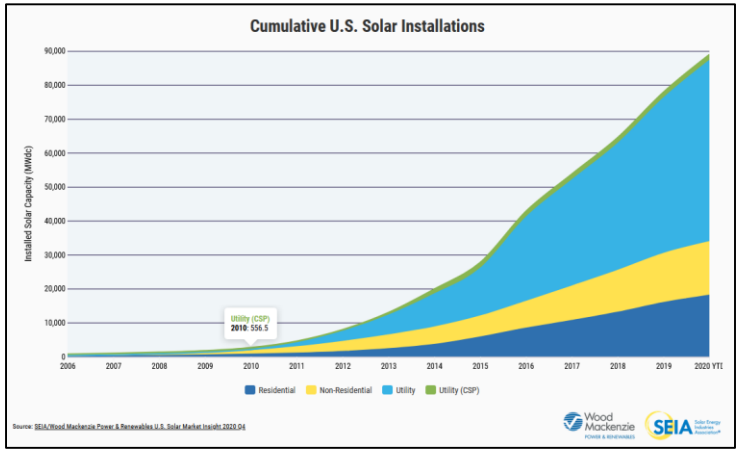


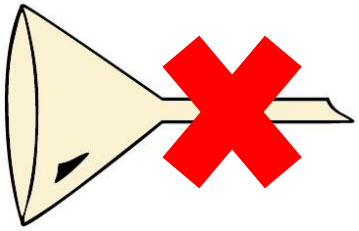
"Because of the soaring number of grid-tied devices, **[grid] operators *will no longer be able to use centralized control*[1]** in the not-so-distant future."

- NREL

The Problem for Developers

"Interconnection is broken: Radical rethinking is needed to achieve clean energy goals"[1] (National)





Interconnection to Grid

"The distributed solar projects…in Massachusetts so far have been facing ***increasingly difficult—and costly—challenges to interconnection*** with the distribution grid... The Department of Public Utilities is actively pursuing changes to the way the power grid is planned and the way upgrade costs are shared, **but *in the short-term grid interconnection is a major drag on decarbonization.***"[2] (MA)

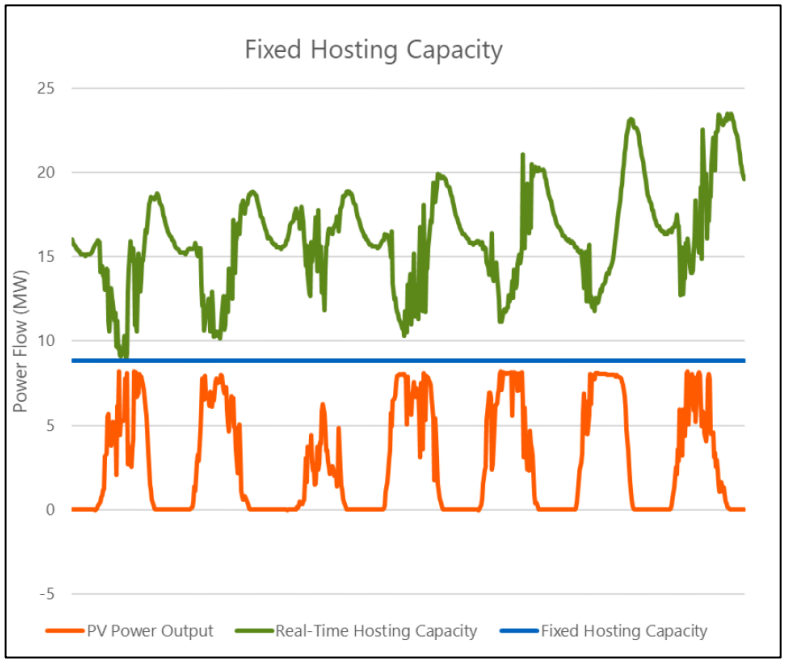
"Solar industry baffled as Maine energy provider cites ***costly upgrades*** to accommodate them"[3] (ME)

1. PV Magazine May 12, 2021
2. Commonwealth April 29, 2021
3. Union Leader Feb 4, 2021

Fixed Interconnection

Fixed Interconnection - Use of physical infrastructure to expand grid capacity for interconnection by sizing capacity to maximum possible generation parameters of interconnecting project plus a buffer margin.

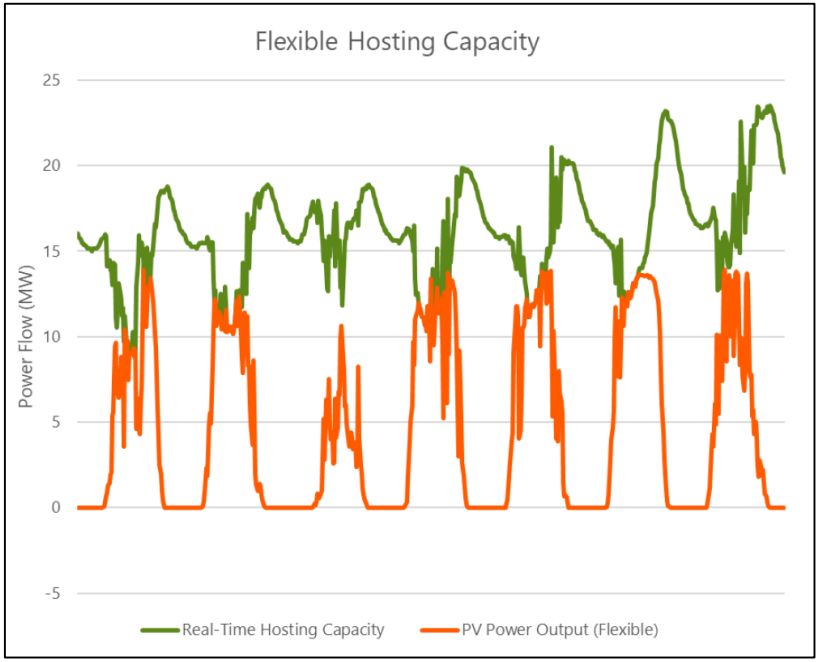
- Simulate several worst case scenarios for DER output and grid conditions to determine if any grid constraints are violated
- Determine what upgrades must be made in order to allow DER to interconnect at full capacity based on the results of these simulations
- The “worst case” scenario may occur 1 hour a day, or 1 hour a month or 1 hour a year or 1 hour every 5 years



Flexible Interconnection

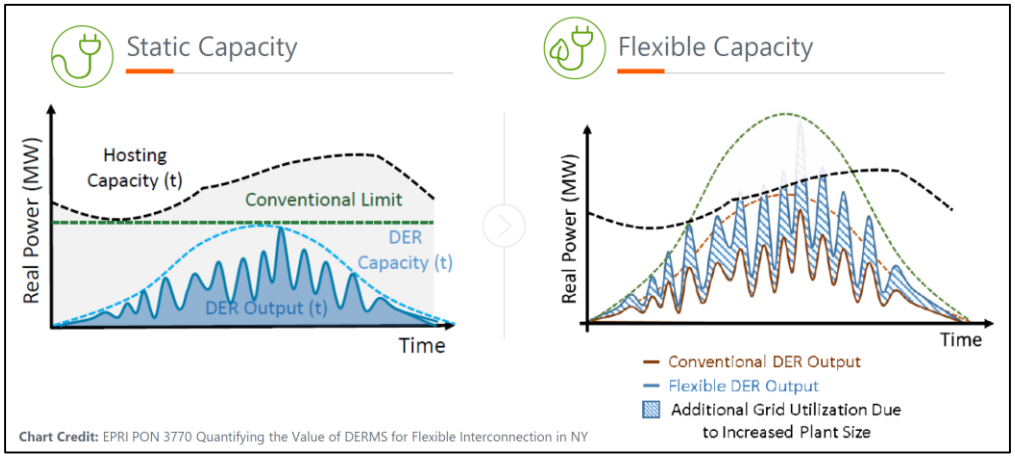
Flexible Interconnection - The ability to control the DER in real time (software controlled), enables the utility to reduce its margins by limiting DER production during worst-case scenarios instead of overbuilding the grid to accommodate them.

- DERCOM – It is a software platform installed on dedicated hardware at the Substation and DERs with redundant communication.
- Install a monitoring and control system that automatically curtails the output of the participating DER.
- Additional Energy from Additional Capacity Installed Under Flexible Interconnection > Lost Energy from infrequent Curtailment Events.
- Curtailment probability is further reduced when there is a subsequent DER project on the same feeder which will be curtailed first.



Fixed vs Flexible Interconnections

	Fixed Interconnection	Flexible Interconnection
Definition	Use of physical infrastructure to expand grid capacity for interconnection by sizing capacity to maximum possible generation parameters of interconnecting project plus a buffer margin.	Intelligent software control of interconnecting DERs to curtail or adjust settings to ensure grid reliability as a substitute for more costly Fixed Interconnection options.
Cost	High CapEx, Millions of dollars in high congestion areas.	Low CapEx plus software subscription.
Pros	Increases grid capacity Known equipment Uses existing procedures	Rapidly deployed Increases hosting capacity of existing grid with lower investment Lower cost generation Adds intelligence to the grid
Cons	Expensive and less efficient Can take long time to deploy	New and requires training



FICS Value Proposition

More Renewable DERs, Faster, and at Lower Cost

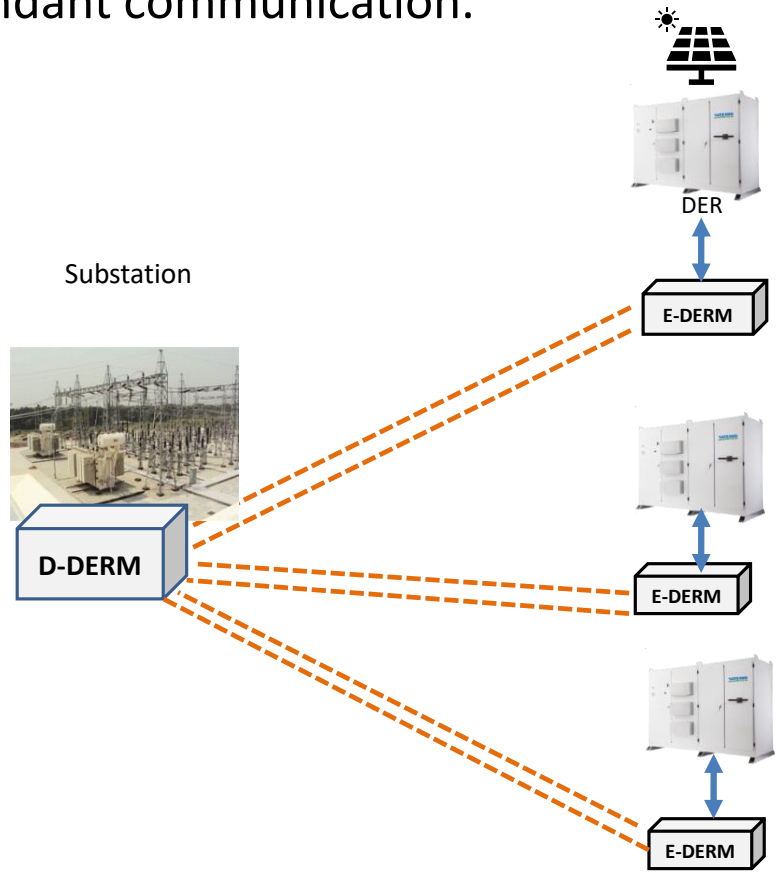
Customer / Stakeholders	Value
Utility	• Address DER caused Grid Instability • Plug and play with existing infrastructure • Modular, gradual adoption + Future Proof Platform • Address pressure from all other stakeholders to enable renewables at low cost
Developer/IPP	• Increase hosting capacity = More projects get built • Lower cost interconnection • Faster interconnection • Participation in wholesale markets (FERC 2222)
Regulators	Achieve dual mandates of implementing legislative renewables requirements AND grid reliability.
Ratepayers	More clean energy, faster and cheaper. No effect on rate base.

The Solution

DERCOM: Distributed Control for a Distributed Grid

DERCOM is a software platform installed on dedicated hardware at the Substation and DER sites with redundant communication.

- **Stand-alone edge-intelligence** and **redundancy**.
- Communication is **direct, local** and **secure**.
- Closed-loop algorithms **optimize locally.**
- **Plug-and-play** with existing systems.
- **Modular** and **Scalable Platform** for Grid-wide intelligence.



DER Integration Platform

RTO & Utility

GridEdge DERCOM

DER

Transmission Operator

Utility Control Center

SCADA

C-DERM (optional)

Localized DERM software platform

Substation

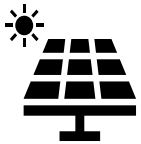
D-DERM

E-DERM

E-DERM

E-DERM

Front of the Meter
Solar <20 MW



Front of the Meter
Storage <20 MW

Behind the Meter
Aggregator

DERCOM Summary

NO Financial Risk	No cost to utility and rate payer. Interconnection costs fully paid by Developer/IPP.
NO Operational Risk	Integrates using existing operational procedures. Autonomous, closed-loop operation eliminates disruption and manual operator control.
NO Reliability Risk	Multi-layers of reliability. DER curtailed before a limit is reached and tripped if curtailment is not sufficient.
YES Future Proof Platform	Intelligent software uses the IEEE 1547-2018 (DER IC standard) data set for future applications. New closed loop algorithms can be easily added to the platform.
YES Modular and Scalable	Deployed where needed and as needed with no upfront sunk cost investment risk.
YES Fast and Simple to Deploy	Trusted hardware plus software configured to the use case.

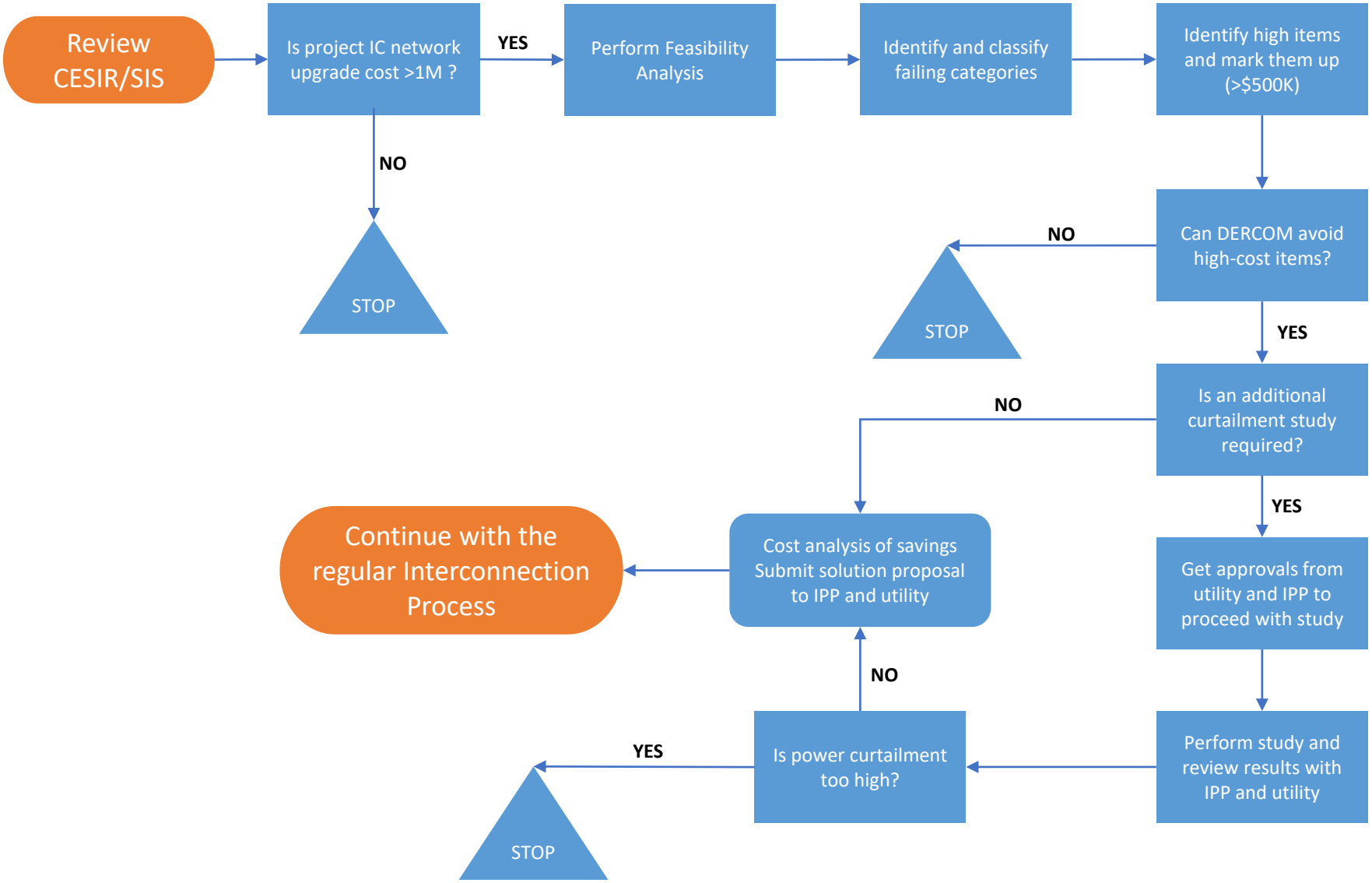
Feasibility Analysis

How to find out if a project is a potential candidate for a DERCOM solution?

Initial criteria:

1. Project interconnection/network upgrade costs > $1M
2. Mitigation items such as substation and line upgrade with a aggregate cost > $0.5M
3. Aggregated savings of > $1M with DERCOM
4. Overvoltage, over thermal, and power quality conditions that trigger utility equipment upgrades
5. Flexible mitigation (replacing some fixed items in 4) with curtailment levels below 5%

Project Selection Flow Diagram



Curtailment Study

Input

- 8760 – # of hours of expected generation dispatch from the project
- Load profile of study circuit
- PQ Diagram/Reactive Capability of the projects inverter
- Recloser control

Criteria

- Only steady state (voltage and thermal)
- Not for voltage fluctuation, voltage regulation tests and voltage flicker.

Study

- Project modeling
- Run power flow simulations – with different combinations of Generation Dispatch and Circuit Load Level
- Determine annual EEC to mitigate the steady state violation

Result

- EEC With Mitigation – Curtailment Percentage
- EEC Without Mitigation – Curtailment Percentage
- Tabulated Result with curtailment for different combinations of Generation Dispatch and Circuit Load Level

- **Software – CYME Version 9.0**
- **EEC - Expected Energy Curtailment**

Flexible vs Fixed Interconnection Cost

IC Method	Capacity (MW)	Project Size DC (MW)	IC Cost Assump.	DERCOM Cost	Loss of Gen Revenue from Curtailment ($)	TOTAL I/C Cost	Cost/w
Fixed IC	3.75	4.6875	3,475,809	$0	$0	$3,475,809	$0.74
Fixed IC (Reduced Gen)	2.5	3.125	$650,000	$0	$0	$650,000	$0.21
Flexible IC	3.75	4.6875	$650,000	$286,000	$230,334	$1,166,334	$0.25

*** Includes costs of DERCOM and curtailment's revenue loss over 25 years**

Flexible Interconnection

Enables additional 1.25MW generation capacity (+33%)

I/C Savings - $2,309,475 (66.4%)

Incremental generation revenue - $3,348,665

Thank You

Please reach out to us if you have any questions.

Ishaan Jena – Senior Power Engineer at AMP Energy
Email – ijena@amp.energy

Nachum Sadan - CEO of GridEdge Networks
Email - nachum@grideedgenetworks.com