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# Alternative to Direct Transfer Trip: Low Cost Islanding Detection

Power Consulting

Sal Gill and Khoi Vu

# Sal Gill

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**Education**
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**Experience**
Sal Gill heads global business development for ABB's Power Consulting business, advising the power and energy sector on how to adapt to the continuously evolving energy ecosystem transformation. Through providing holistic consulting services, Sal has developed strategies to help clients optimize capital investment plans and develop decision-making frameworks, targeting the digitalization, decarbonization, and decentralization domains of the industry.

Prior to joining ABB, Sal was with S&C Electric Company as its Manager of Strategic Planning, reporting to its Executive Chairman. Prior to S&C, Sal lead the regional sales management organization in Canada with Hubbell Power Systems. Sal received his Bachelor of Science degree in Electrical Engineering from Marquette University, in Milwaukee, Wisconsin and has an MBA with a focus in Strategy & Finance from Duke University's Fuqua School of Business. He has authored several technical papers in the power industry and leads engagement activities with major industry think tanks globally.

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# Dr. Khoi Vu

## Consulting Director, ABB Power Consulting

**Education**
BSEE, MSEE & PhD, University of Washington, Seattle, WA
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**Experience**
Khoi Vu is with ABB Power Consulting in Raleigh, NC. His expertise is in analytics, modeling and simulations of power systems and components. Prior to joining ABB Power Consulting, he was with KEMA (now DNV GL) for 10 years, where he was responsible for developing advanced analytics to support the company's consulting business. His contribution includes energy storage tools, ES-Select, ES-Screen, ES-Solar, and KERMIT, DNV GL's proprietary tool to analyze the impact of solar and wind resources on the operation (esp. frequency regulation) of bulk power systems.

Before his time with KEMA, Khoi spent 12 years with ABB in research and development related to protection, control, and modeling. One of his inventions (Voltage Instability Predictor) was implemented on a relay platform, and several units were deployed on the transmission grid of Norway. Prior to joining the industry, Vu was on the faculty at Clemson University, teaching electric power machinery and power-systems stability. He holds 6 patents, and has authored many technical papers.

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# Power Consulting

Leveraging our unique domain expertise to solve the toughest customer challenges

**Systems studies and analysis**
AC and DC power systems analysis

**Asset/Power systems assessment**
Audits, diagnosis and failure assessment

**Training**
Standard/Tailor-made courses

**Digitalization**
Big Data Analytics and Augmented Intelligence

**Analytical tools**
Customized Software and Support

**Power & Energy Economics**
Technical and Economical system optimization

## Customer benefits

**Improve Network Performance**

**Mitigate Risks**

**Optimize Investment Decisions**

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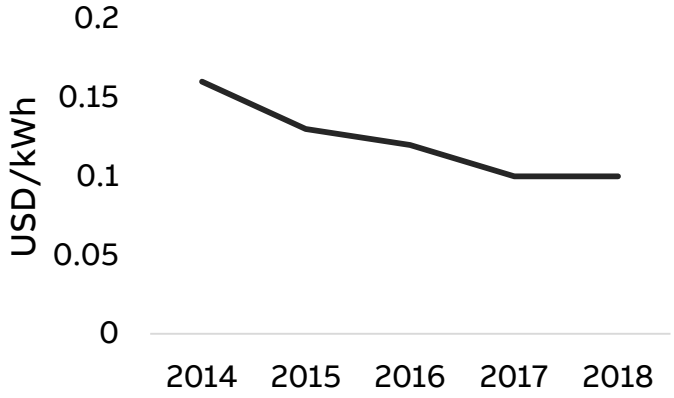
# Costs of Renewables are decreasing

Solar, wind, and battery storage cost per kWh show decreasing trends

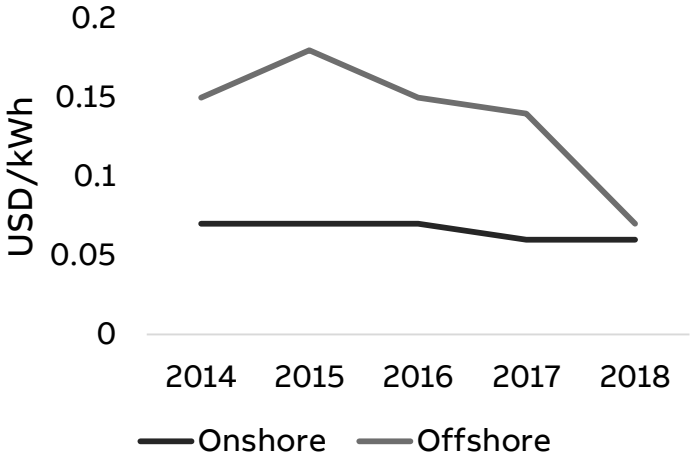
**Solar PV**

**$0.10** per kWh



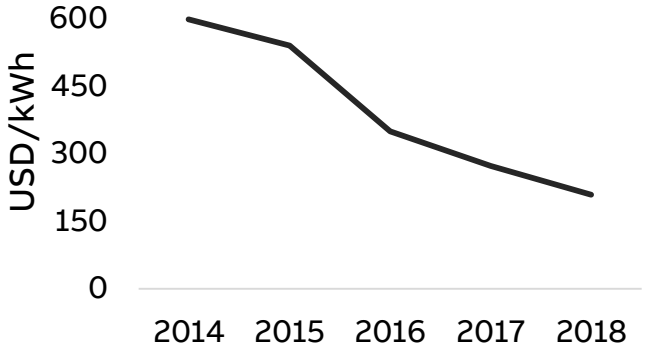

**Wind**

**$0.06** per kWh




**Lithium Ion**

**$225** per kWh

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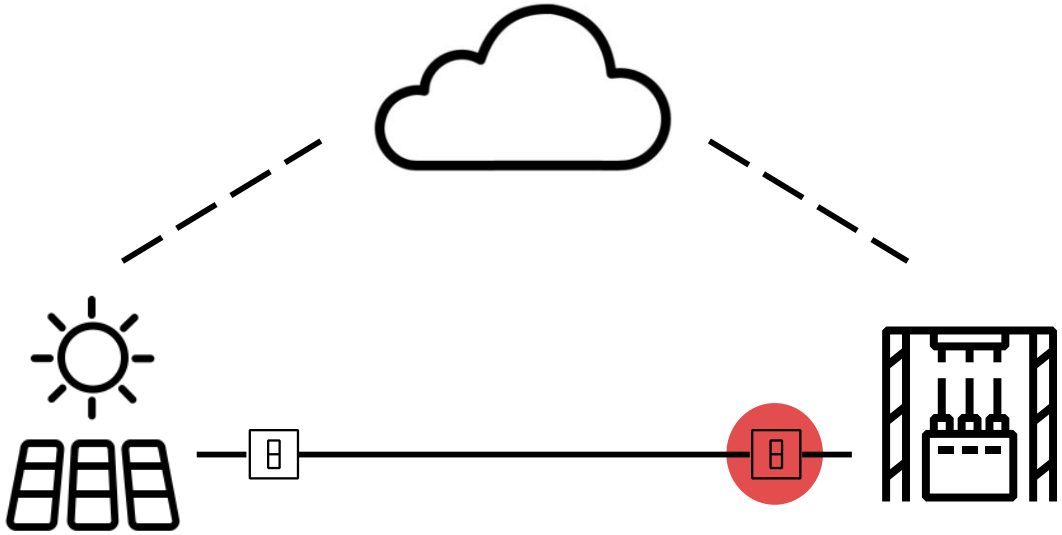
Source: GTM Research, Forbes, IRENA, Renewable Energy World, SEPA

# Costs of Renewables are decreasing BUT…

## Communication between DERs and the grid is costly

**Situation in New York**

"Innovation supporting DER interconnection is not occurring passively in the scope or scale needed to support the increasing number and size of DER projects requesting to interconnect with New York's electric grid. As a result, **DER projects are increasingly required to make expensive and time consuming electric grid infrastructure upgrades** before they can be interconnected."



Direct Transfer Trip occurs when circuit breaker is **tripped off** and it sends a signal to solar farm to turn off

When there are multiple DERs on the grid, communication gets costly and complicated

- Associated engineering time
- Radio communication costs **$300k** per circuit breaker
- Fiber link is fool proof but costs up to **$2M**

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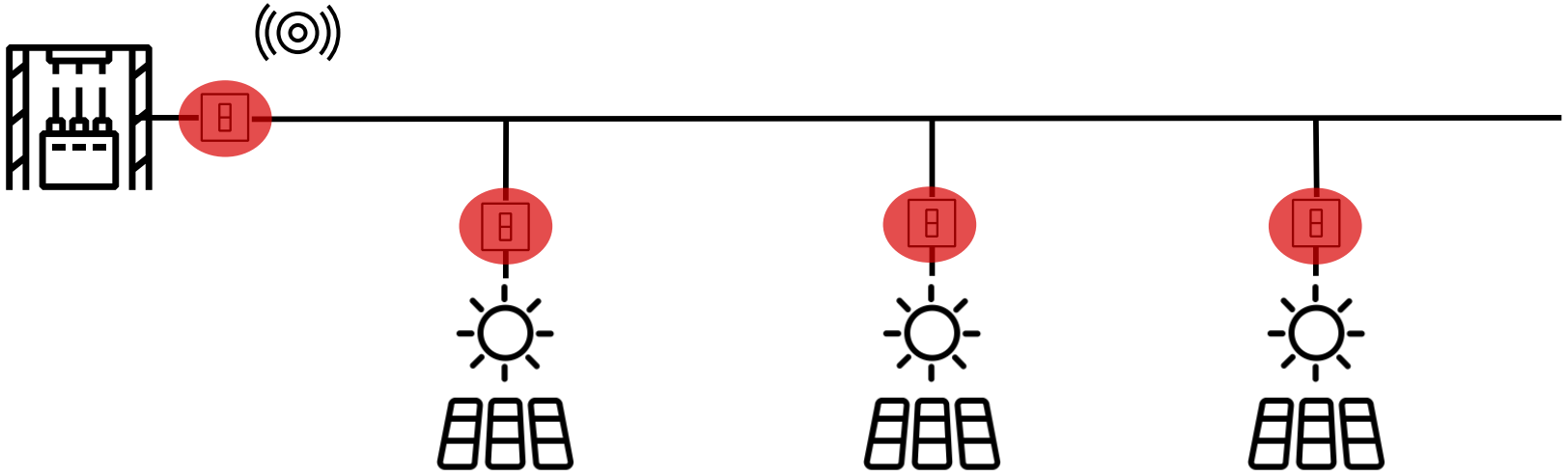
# Existing Industry Standards and Anti-Islanding

Current standards do not protect against blind spots

- IEEE 1547 (Standard for Interconnecting Distributed Resources with Electric Power Systems)
- Provides a set of criteria and requirements for the interconnection of distributed resources into the power grid
- Anti-islanding protection is a **safety feature**, which disables DERs when the grid enters an islanded condition
- According to IEEE 1547 section 4, an Area EPS must be de-energized within **two seconds** of the formation of an island



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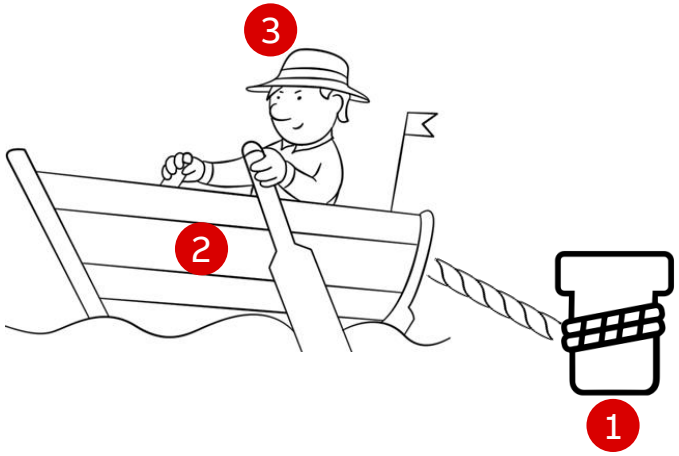
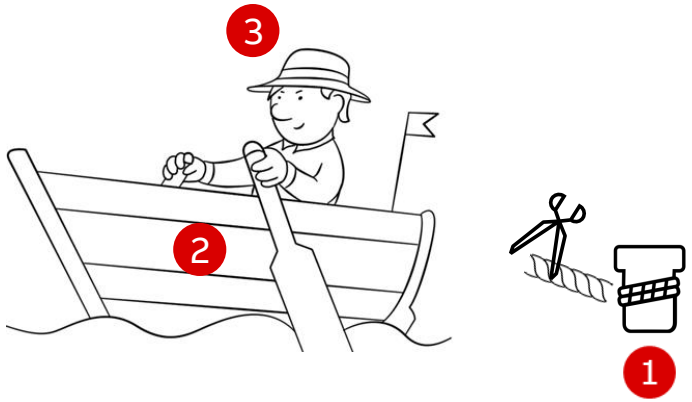
# Electrical Islanding – An Analogy

## Grid Connected




## Islanding




**1**: Utility Grid
**2**: Distribution Circuit
**3**: DERs

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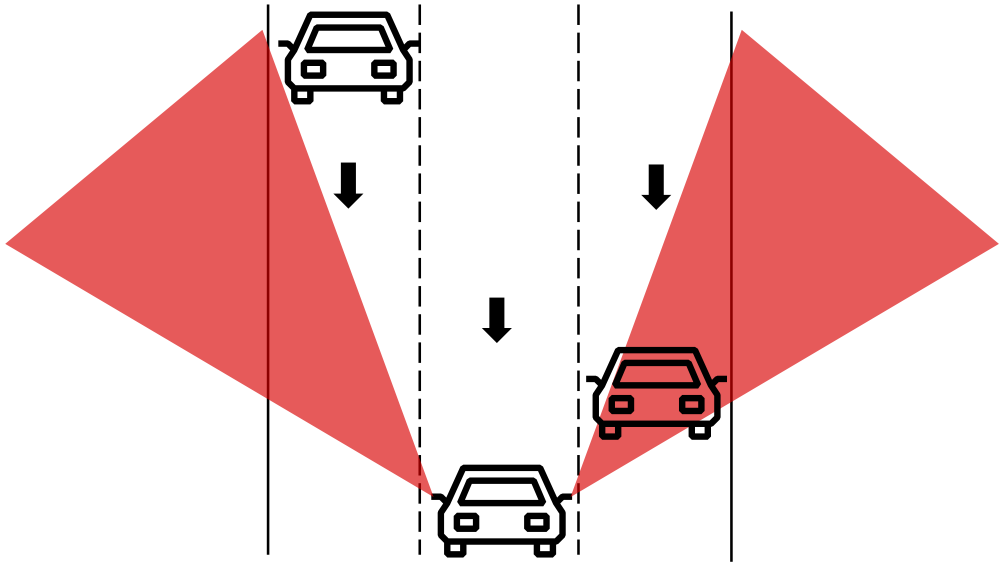
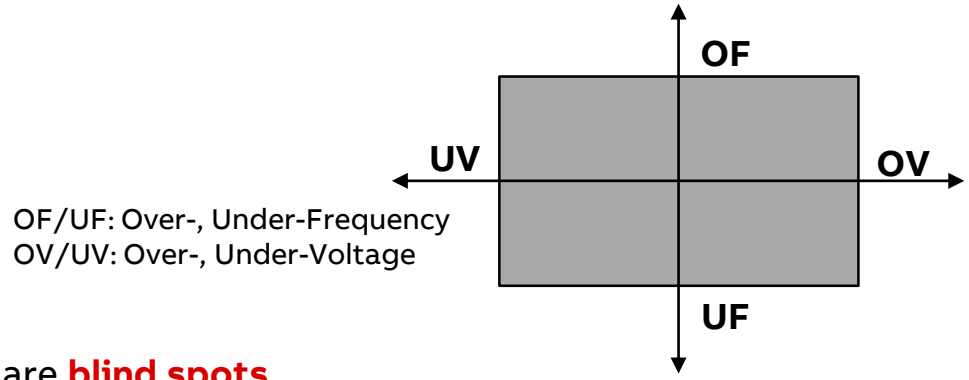
# Following Blindly

A “blind spot” occurs when monitoring DERs on the grid






OF/UF: Over-, Under-Frequency
OV/UV: Over-, Under-Voltage

Shaded regions are **blind spots**

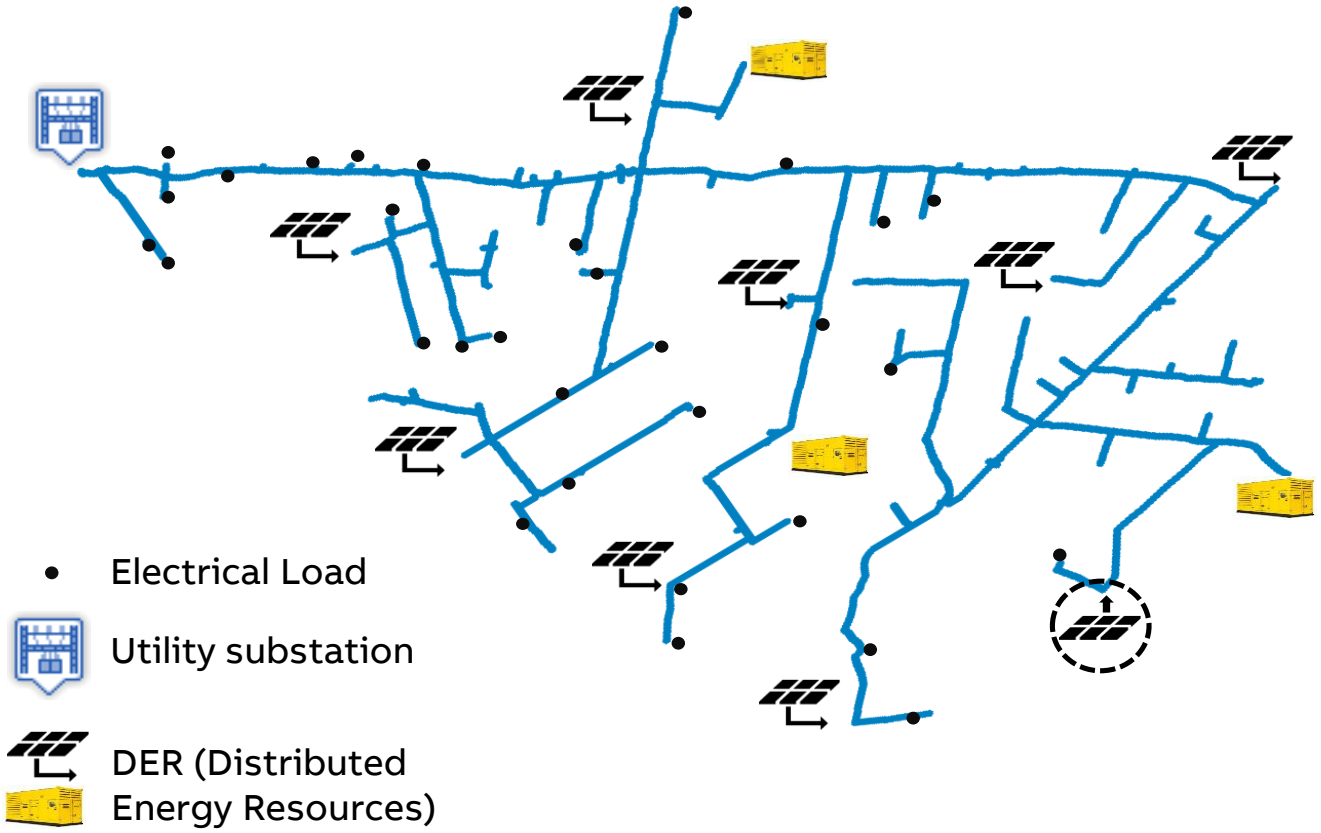
Traditionally, DER **tracks voltage and frequency**, based on which it infers about islanding condition

- If voltage (V) or frequency (F) get out of the shaded region, it judges that an **island has been formed**
- If voltage (V) or frequency (F) stays within the shaded region, it thinks that the **distribution circuit is still connected to the power grid**

Blind spots are dangerous:

- Safety of linemen
- Equipment damage

# Principle of Islanding Detection




Looking from each DER location into the grid, there is a **System Strength**

System strength is dependent on DER location

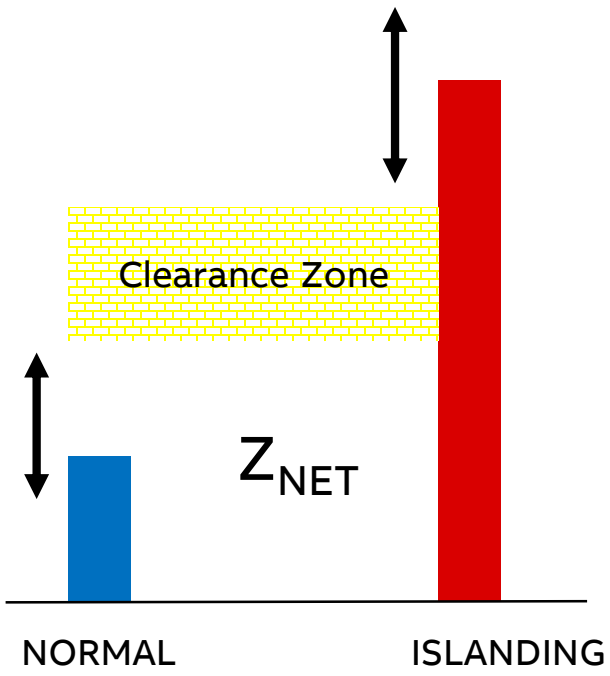
In normal conditions, **System Strength is large**

# Results from NYSERDA collaboration

We can track the system strength in a simulation environment

Existence of Clearance Zone for chosen circuits:

- to set a threshold for detection
- there are many possible normal and islanding conditions to consider.

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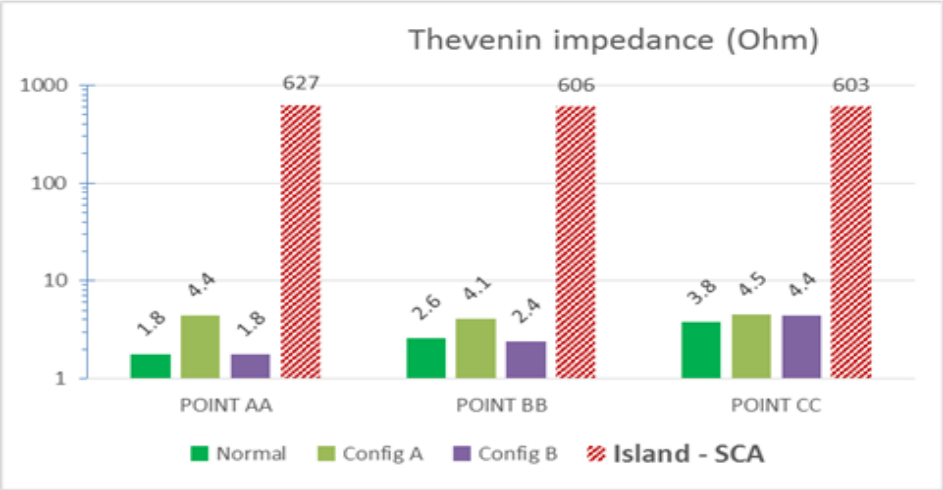
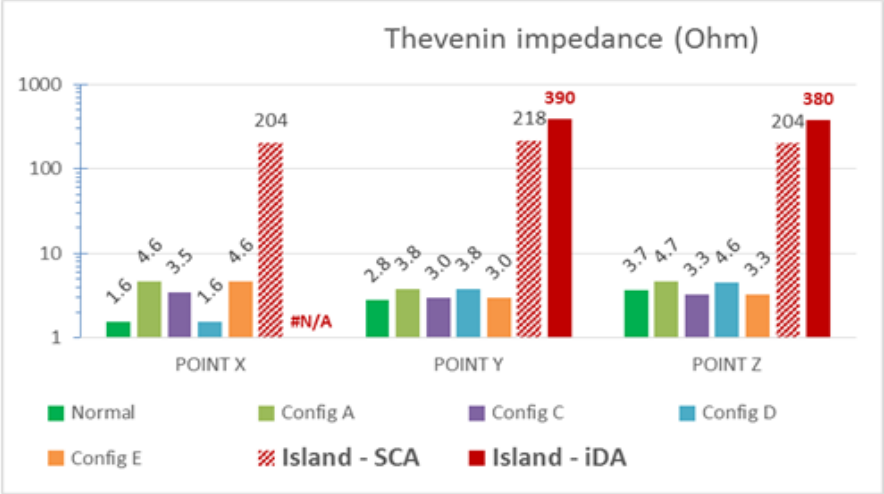
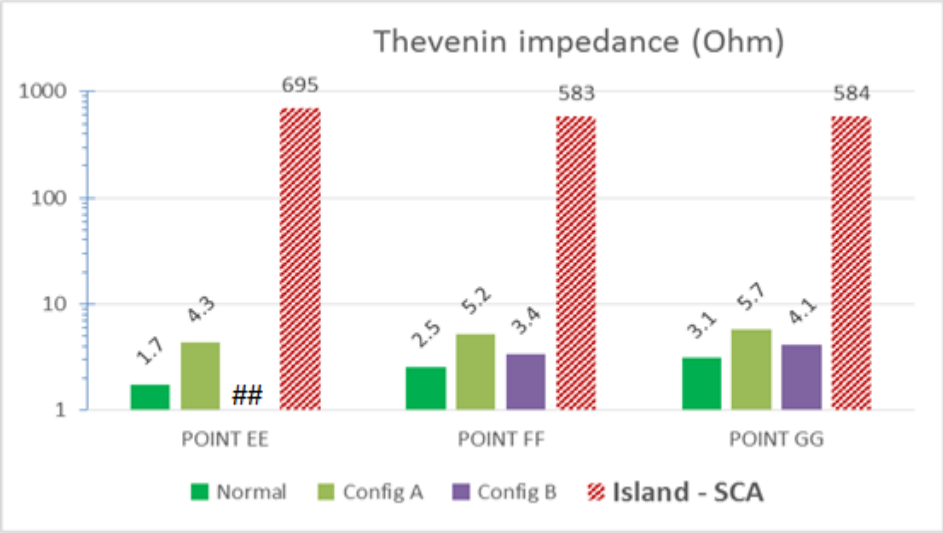
# Results from NYSERDA collaboration



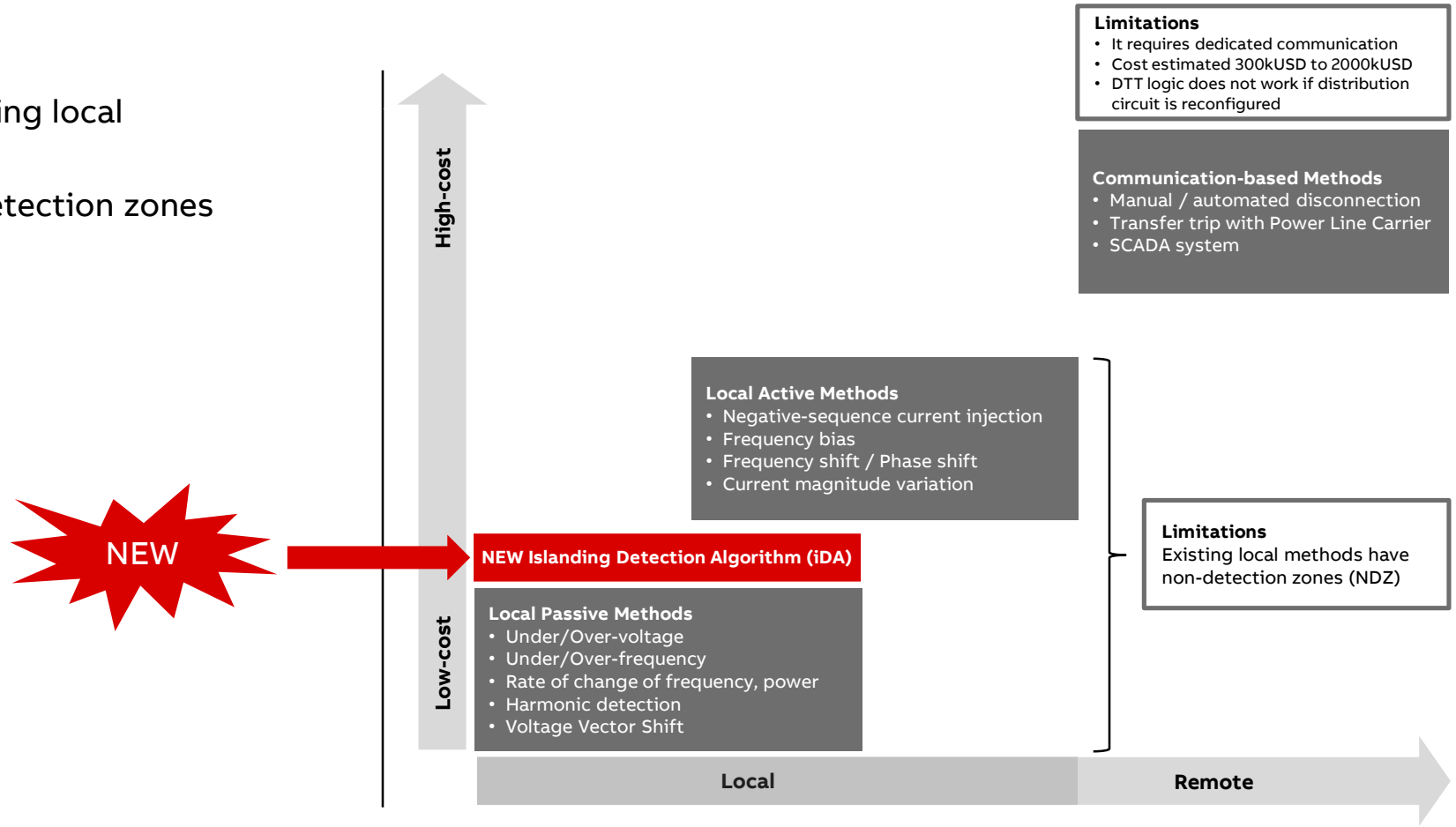

***The impedance clusters have a clear separation.***

# Low-Cost Anti-Islanding Detection

## Concluding Remarks

New methodology to be an add-on to existing local methods to enhance islanding detection

– Goal is to eliminate blind spots or non-detection zones



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