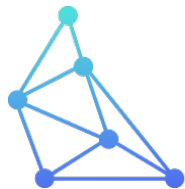


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<b>TN #:</b>	270568
<b>Document Title:</b>	California Weak Grid Screening Assessment
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# California Weak Grid Screening Assessment

9 June 2026 | California Energy Resource and Reliability Outlook Workshop

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TEL OS ENERGY

# Agenda

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- What is Grid Strength?
- Weak Grid Analysis Methodology
  - When might it happen? *Set up near-term operating scenarios*
  - Where might it happen? *Location matters – find high-risk locations*
  - What if there's an outage? *Identify critical transmission and generation outages*
  - What's the impact? *Quantify power transfer limits*
  - How much might it cost? *Economic implications of transfer limits*
- Current Status



# What is Grid Strength?



# What is Grid Strength?

- Grid strength is like the “stiffness” of a power system
- It depends on location in the grid (can have pockets of weak grids or weak points-of-interconnection)
- In strong grids, grid voltages do not change much when the system is ‘whacked’ by a disturbance like a fault
- In weak grids, grid voltages change a lot more, particularly during disturbances like faults



“Strong Grid”



“Weak Grid”



“Impending Fault”

# What Contributes to Grid Strength?

- **Synchronous generators**

The generator in a gas turbine, steam turbine, or hydro power plant

- **Synchronous motors**

Similar to a synchronous generator, but operated as a motor, found in some industrial plants

- **Synchronous condensers**

The generator from a conventional power plant without a prime mover (gas turbine or steam turbine)

- **Grid Forming Inverters**


Inverter based resources with grid forming control capabilities

Commercially available: BESS, STATCOMs, HVDC


In demonstration: Wind, PV



**A UNIQUE WINDOW OF OPPORTUNITY**  
Capturing the Reliability Benefits  
of Grid-Forming Batteries



Brief for Decisionmakers  
By Julia Matvosyan, Chief Engineer,  
Energy Systems Integration Group  
March 2023



# What Does Not Contribute to Grid Strength?

- **Grid-following** power-electronic (inverter) based resources (PV, Wind, BESS, HVDC)
  - All modern, utility-scale wind and solar photovoltaic generation is inverter-based
- Loads



# Weak Grid and Control Instability

## What is it?

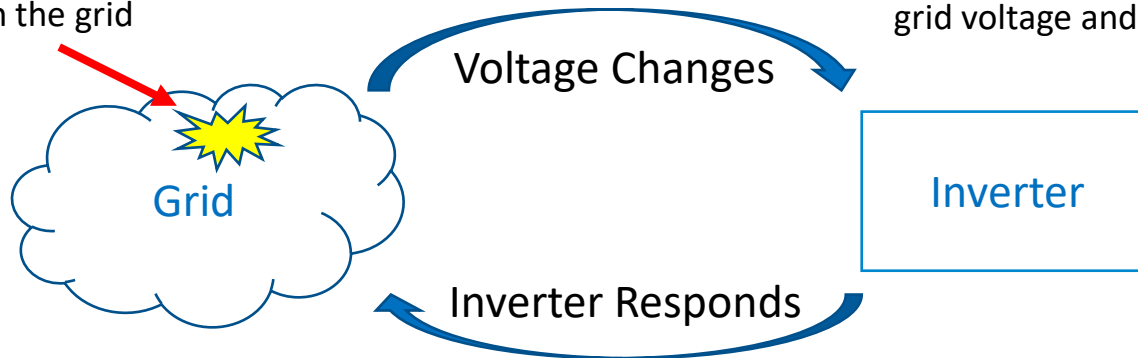
- All of today's "grid-following" inverters have many feedback control loops

## Why Care?

- Each feedback loop can become unstable, resulting in oscillatory behavior, tripping, equipment damage
- Instability is analogous to a "vicious cycle" where behavior is self-reinforcing (positive feedback)

### Step 1:

An initiating event (which is not always necessary) causes a disturbance in voltage on the grid



### Step 2:

Inverter controls measure grid voltage and respond

### Step 3+:

Grid voltage responds to the inverter's injected current – in a way that reinforces the original change – and so the cycle grows



# Weak Grid Analysis Methodology



# Weak Grid Analysis Motivation & Objective

**As California progresses towards SB100 objectives, the system will be dispatched in new ways that may introduce instability. By investigating system risks now, stakeholders can make better decisions to establish a robust analytic approach and risk mitigation options.**

## Screening Analysis

Telos is performing a weak grid screening analysis that includes an economic assessment to better communicate system stability impacts.

*This work could be complemented by more detailed analyses performed by transmission planning entities to better identify risks and possible solutions.*

## Possible Risk Mitigations

### Must-Run Generation

Identifying critical generation assets that must remain online for stability

### Grid Hardware

Synchronous condensers and other physical infrastructure upgrades

### Grid Forming Inverters

Advanced inverter technology to provide grid stability services



# Weak Grid Methodology

Initial focus is on near-term (2026) system conditions

## 1. Initialization



- Lit Review
- Data Collection
- Scenario Development

## 2. Set Up Base Case



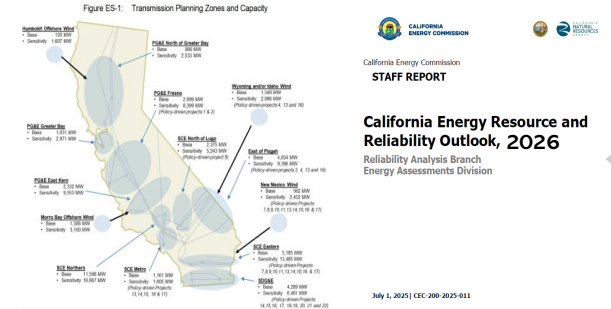
- Apply DZM<sup>1</sup> to represent IBR
- Generate contingency lists

## 3. Run Weak Grid Contingency Analysis



- Apply transmission contingencies
- Assess weak grid risks using EqSCR<sup>2</sup> + DZM

## 4. Maps & CERRO blurb



## 5. Evaluate Power Transfer limits

- Locate areas contributing to weak grid risks
- Define new and updated stability interfaces and limits

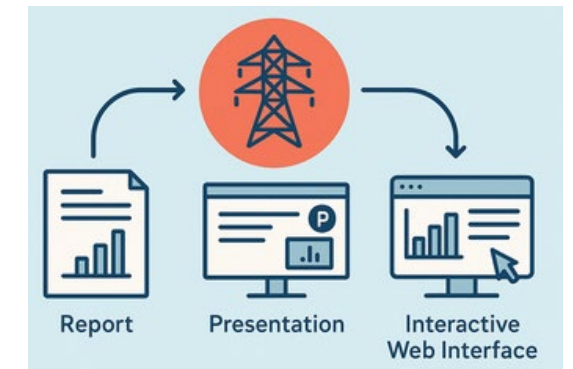
## 6. Mitigate New Transfer Constraints

- Test mitigations (GFM BESS, Tx upgrades)
- Re-assess power transfer stability limits

## 7. Economic Impact Analysis

- Quantify costs & reliability impacts of weak grid transfer limits
- Estimate frequency and severity of constraints

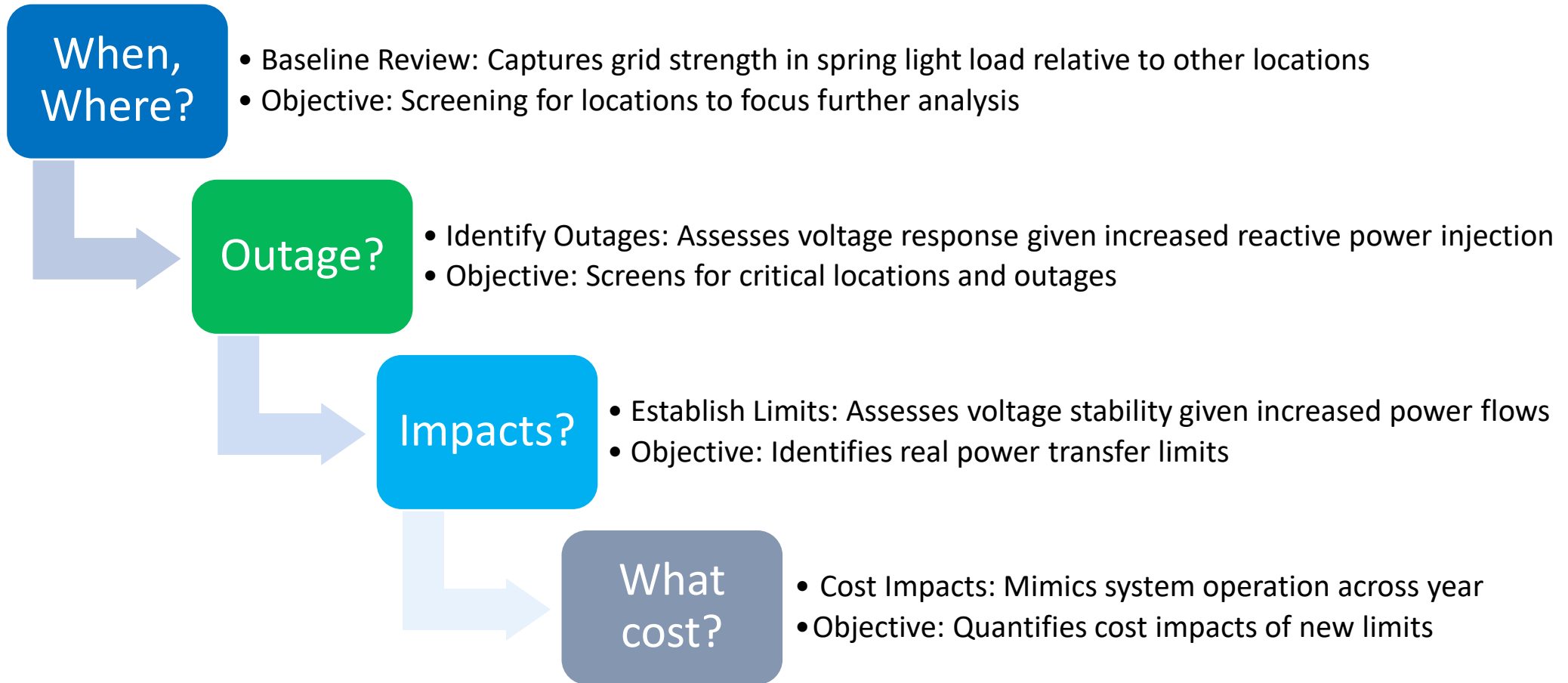
## 8. Multi-purpose reporting



1. DZM: Dynamic Impedance Method: A method to simplify but accurately represent IBR dynamic stability in steady-state analysis.  
2. EqSCR: Equivalent Short Circuit Ratio: A measure of how strong or weak a grid node is across scenarios.

# Weak Grid Analysis Process

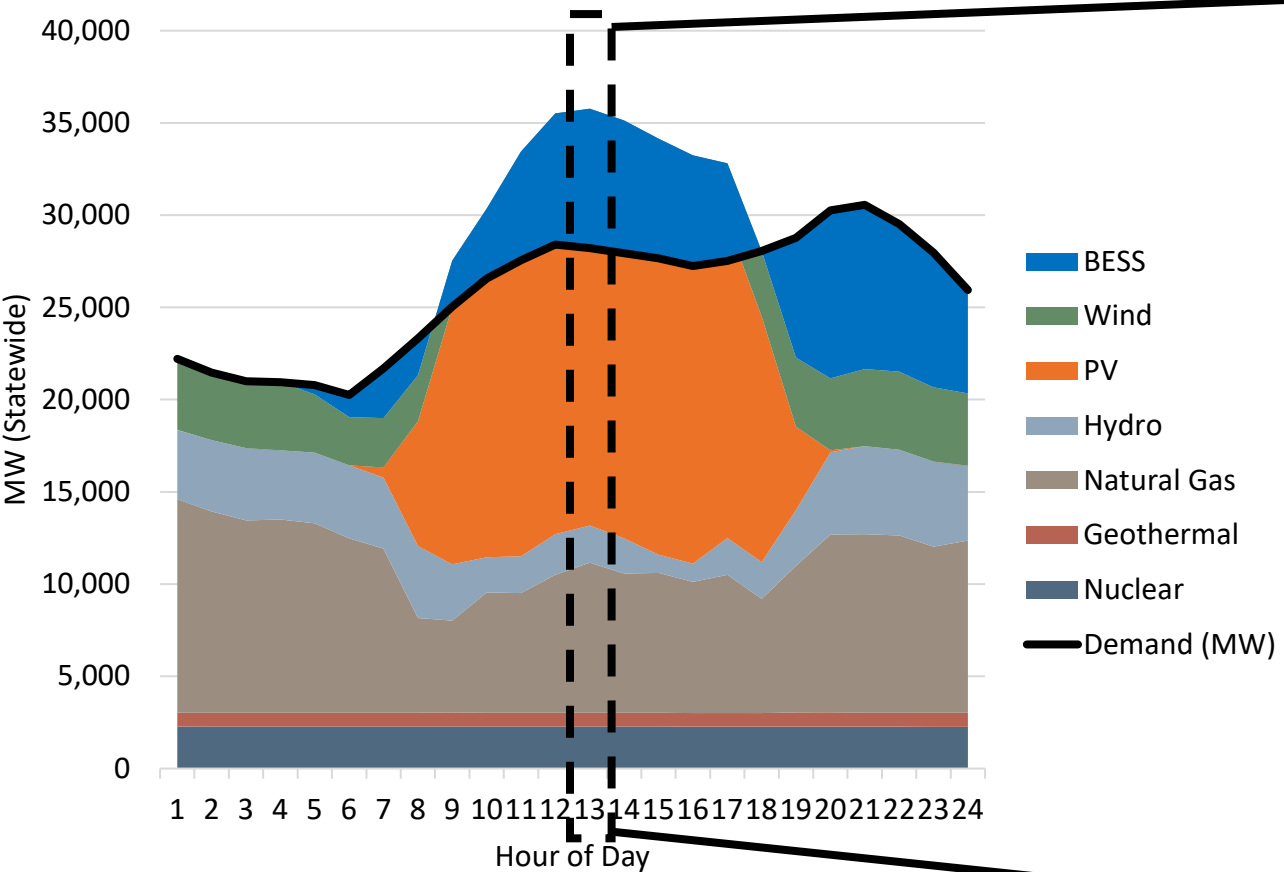
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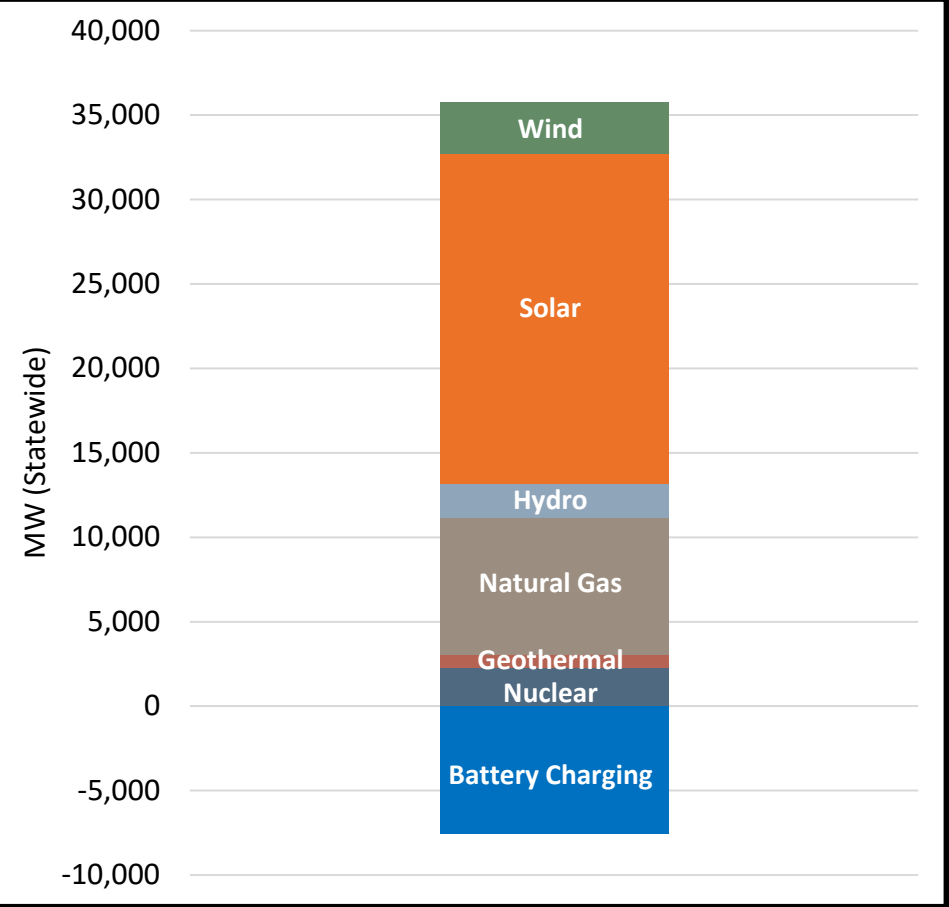
# When? – Spring Light Load Case

Dispatch is roughly aligned with April 11, 2025. This represents a somewhat high IBR day, but the system had higher IBR penetration (%) often throughout 2025.

## Sample 24-hour Dispatch for California



## Dispatch Used in Transmission Analysis



# Grid Strength Method

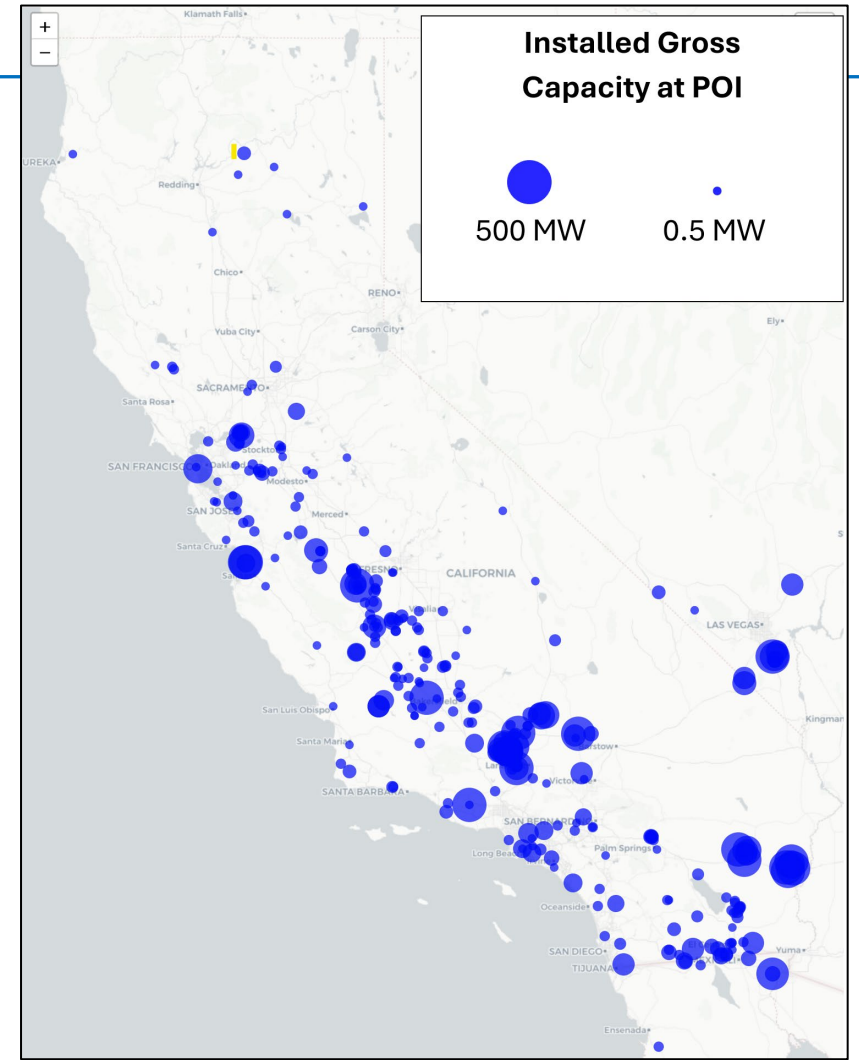


- Our Weak Grid analysis uses **Equivalent SCR with Dynamic Impedance** as the primary grid strength method
  - Accounts for interactions among surrounding inverter-based resources
  - Captures the differing dynamic responses of various IBR technologies
- On **April 28**, MISO proposed a new screening method at the Interconnection Process Working Group
  - Same method we use — MISO calls it “nSCR”
- **MISO Next Steps**
  - **June 9**: Present metric details & gather stakeholder feedback
  - **July 21**: Draft Business Practice Manual redlines
  - **Sept 1**: Final redlines



# Where? Location Screening

- Identify all grid locations where inverter-based resources (IBRs) are interconnected
- Assess grid strength at each IBR location to enable direct comparison across sites
- Refine the grid strength scale through this process for use in future assessments
- Focus on transmission infrastructure at 230 kV and above



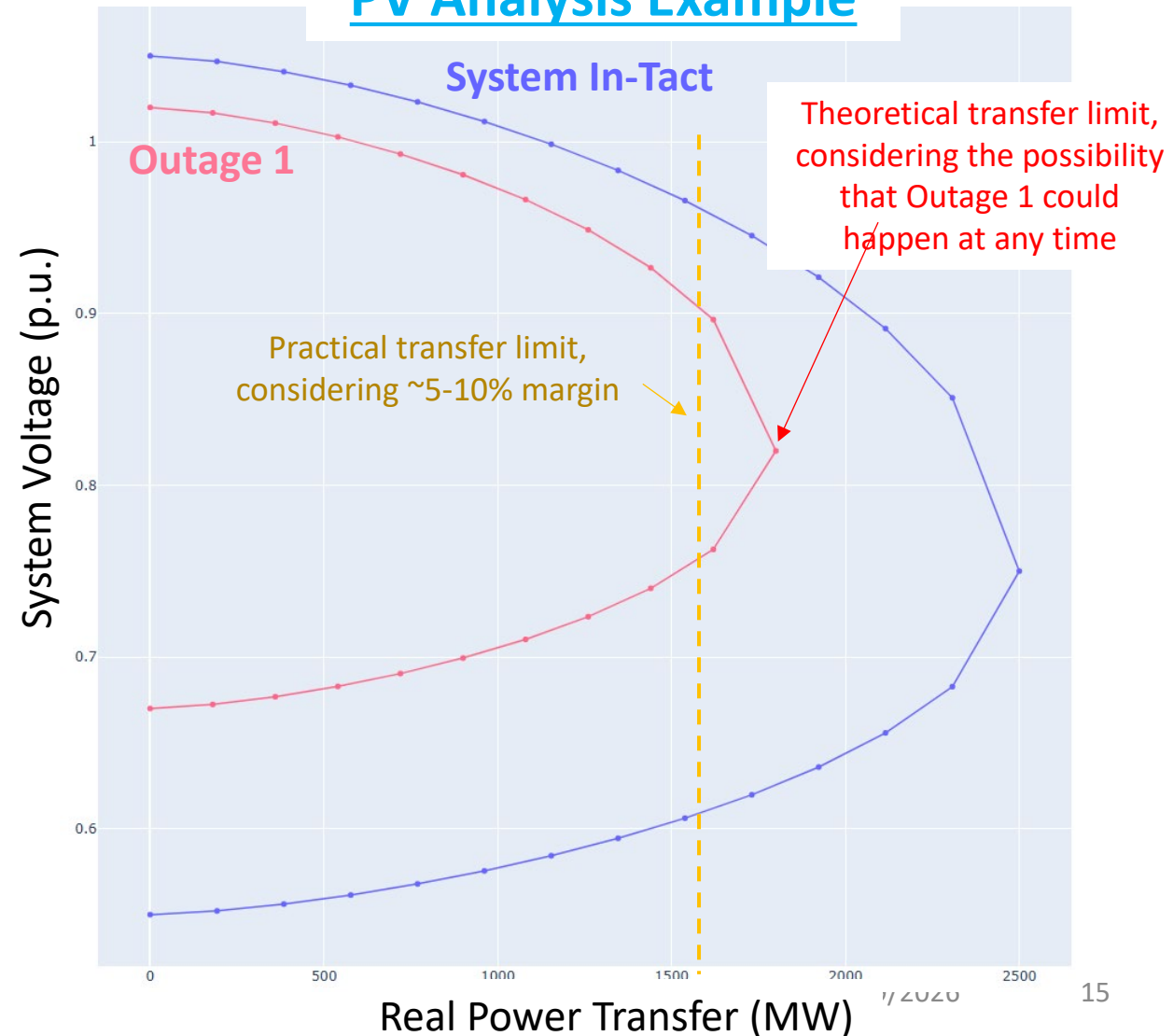
Installed IBRs Across California



# Outages inform Transfer Limits

- Method: Real Power and Voltage Analysis (PV Analysis)
- Focus on location and outages identified in previous steps
- Determines the relationship of system voltage and real power
- Establishes a maximum real power transfer limit

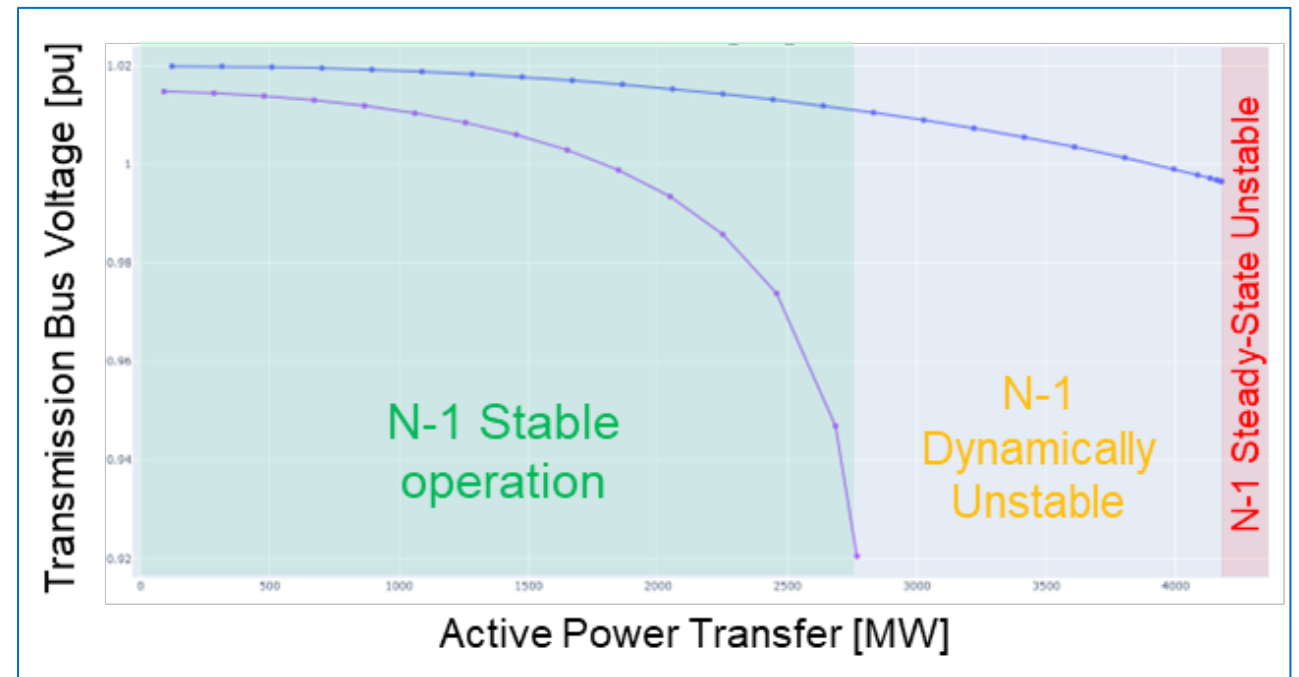
## PV Analysis Example



# Weak Grid Risks Translate to Stability Limits

- System stability, not just infrastructure, is increasingly limiting how much power can be transferred
- Higher concentrations of IBRs increase the risk of transfer limits being dynamically limited
- By extending the traditional grid assessments we can include these additional limitations

## PV Analysis Example

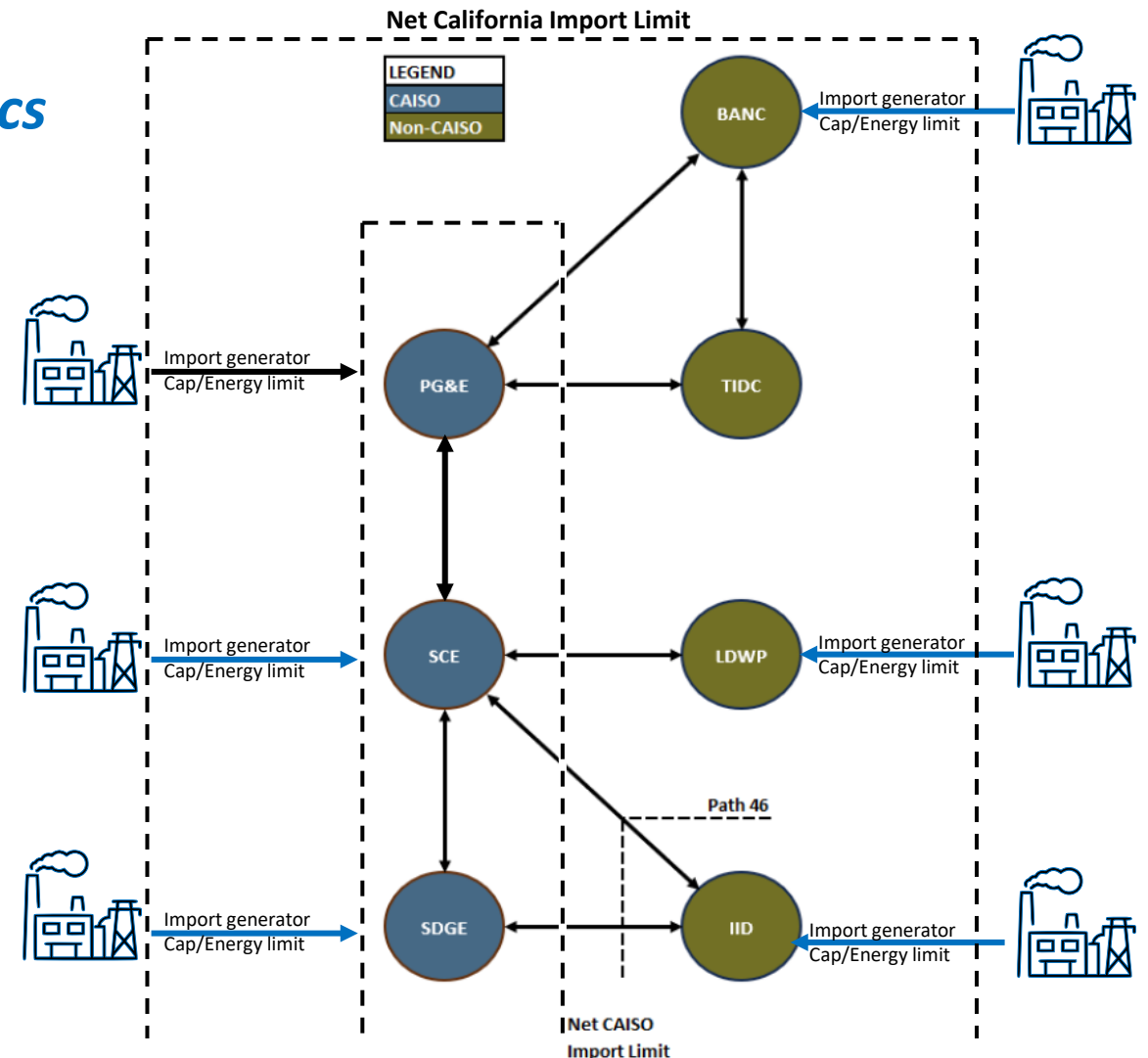


# Assessing Cost Impacts

## Quantify weak grid solution value via economics

- Evaluate cost and reliability impacts of weak grid considerations through
  - A full-year hourly dispatch simulation using the PLEXOS modeling software evaluated against the baseline system
  - Congestion costs and suboptimal dispatch from stability constraints
- Weak grid risk solutions to be reflected in the CEC's zonal dispatch model may include:
  - Transfer limits between zones
  - New zone definitions
  - Dispatch limits for select resource groups

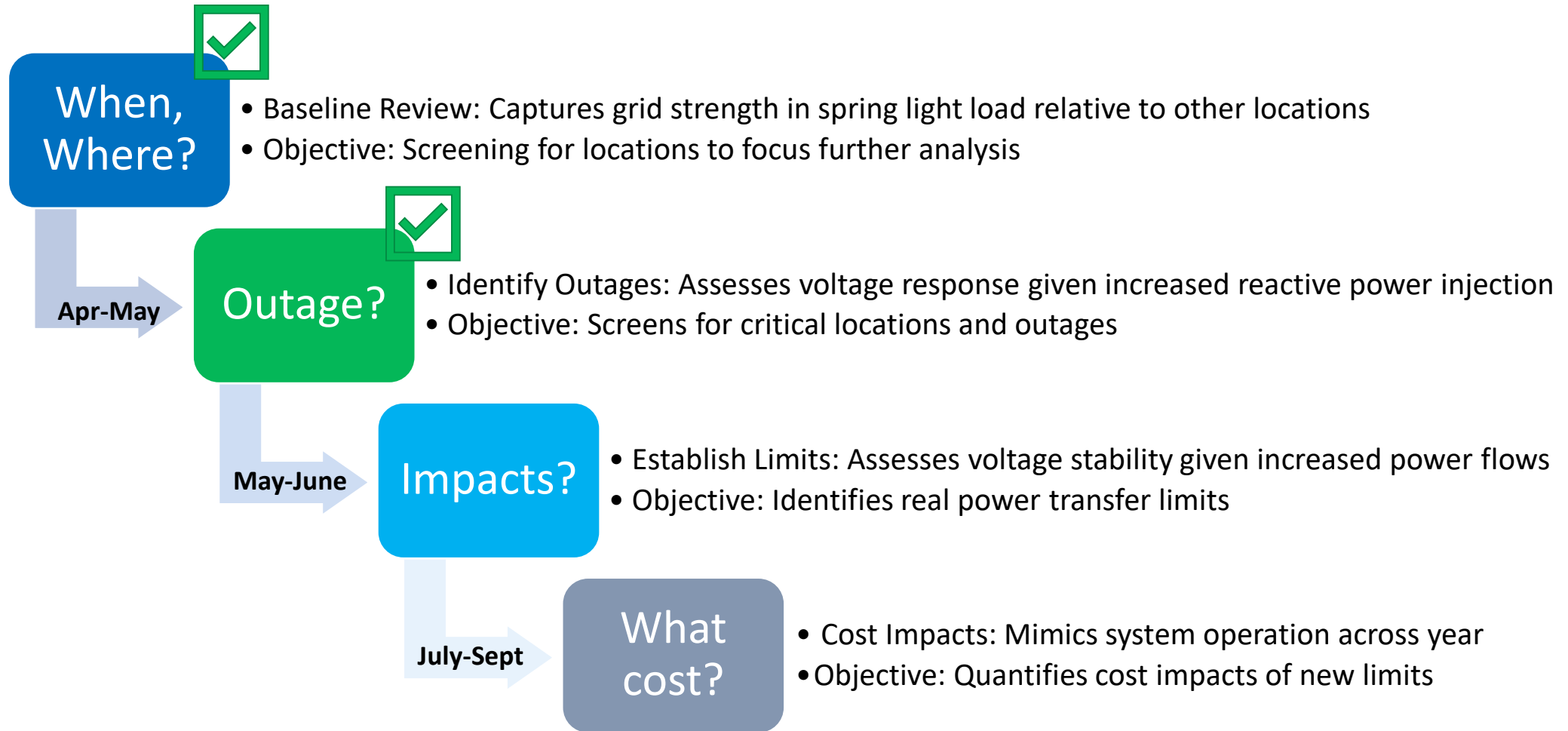
## Baseline CEC Zonal Model Topology



# Current Project Status



# Weak Grid Analysis Process



# Questions?

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