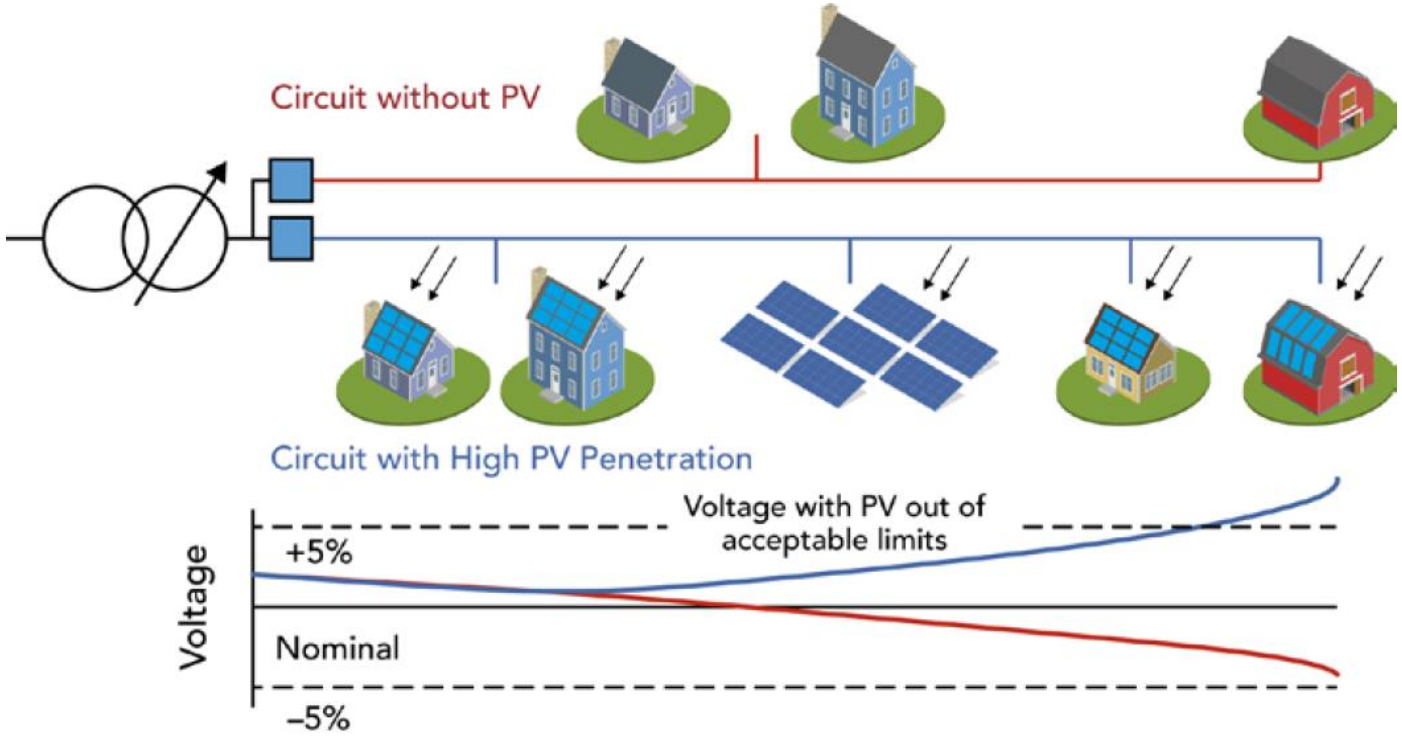
Institutional Mechanisms to Enable Efficient Integration of Rooftop Solar PV

Solutions to Facilitate Successful RE Integration at the Distribution Level

Jaquelin Cochran, NREL | June 2018

Key technical concern about distributed solar PV (DPV)

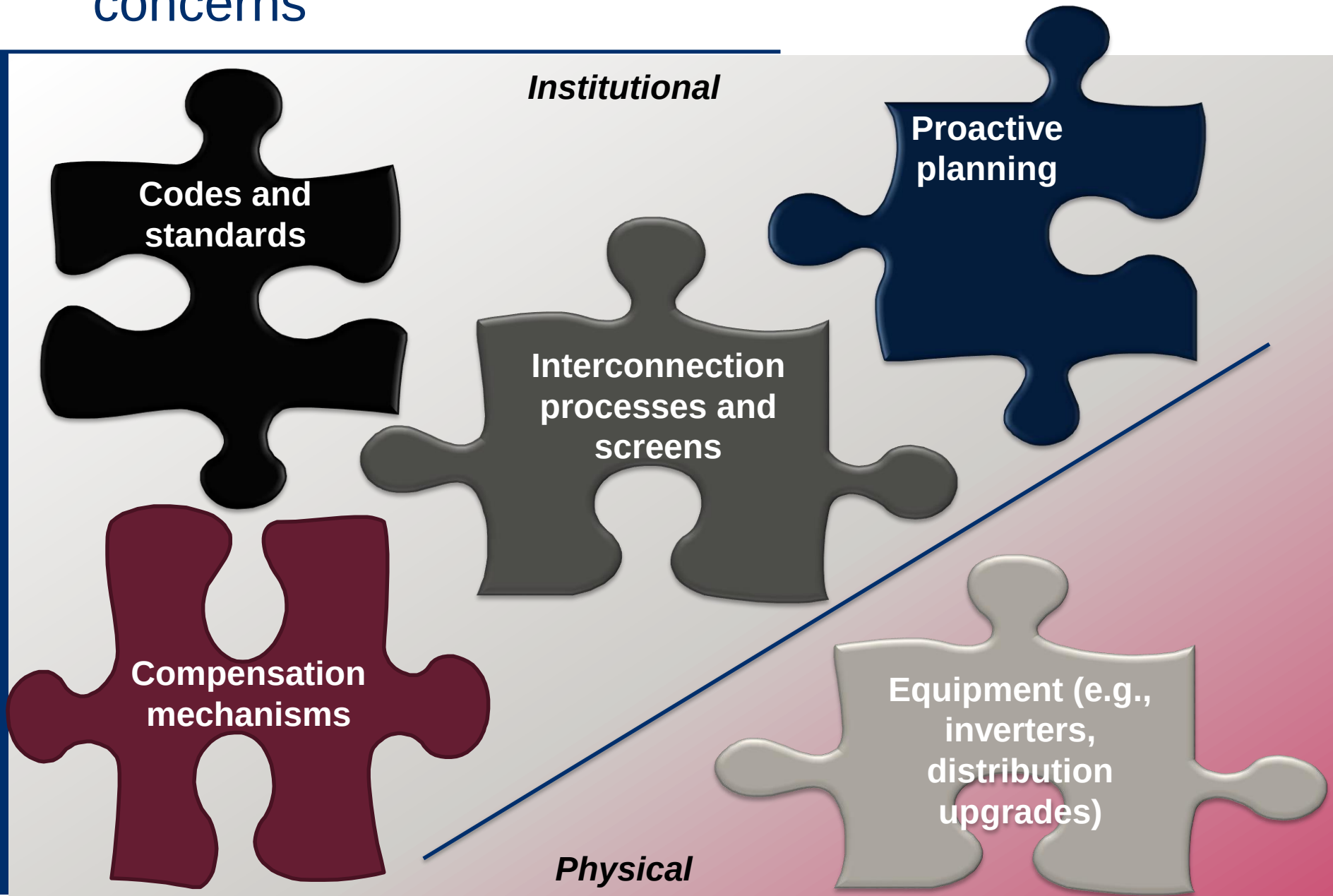


Source: Coddington, Miller, & Katz. 2016. Grid-Integrated Distributed Solar: Addressing Challenges for Operations and Planning, Greening the Grid. NREL/FS-6A20-63042. https://www.nrel.gov/docs/fy16osti/63042.pdf.

Voltage deviations

Increase in local voltage from DPV may lead to over- or under- voltages for adjacent customers

Approaches to addressing technical concerns



Foundational standards and codes establish interconnection requirements for all DPV systems

National electrical safety code

- Voltage standards for the electric utility transmission and distribution systems
- Example: ANSI C84.1 in the U.S.

Interconnection standards

- Criteria for how DPV interacts with the local distribution grid
- Example: New IEEE 1547-2018 standard requires use of smart inverters

Equipment standards

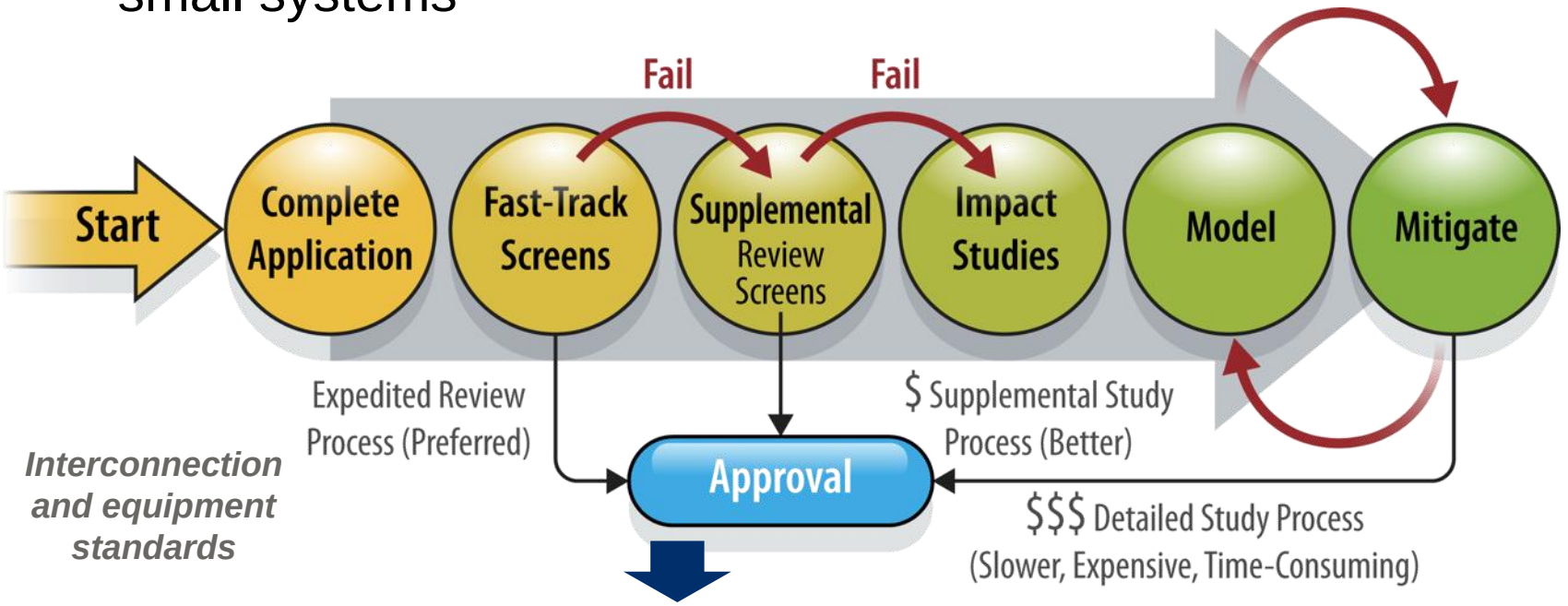
- Certification requirements for DPV equipment, harmonized with interconnection standards
- Example: UL 1741 in the U.S.

Building electrical codes

- Sets requirements for design, construction, and operation of DPV systems
- Example: National Electrical Code in the U.S.

Evolution in Planning: (systems with legacy inverters) Interconnection process reviews grid interaction of a specific DPV system and location

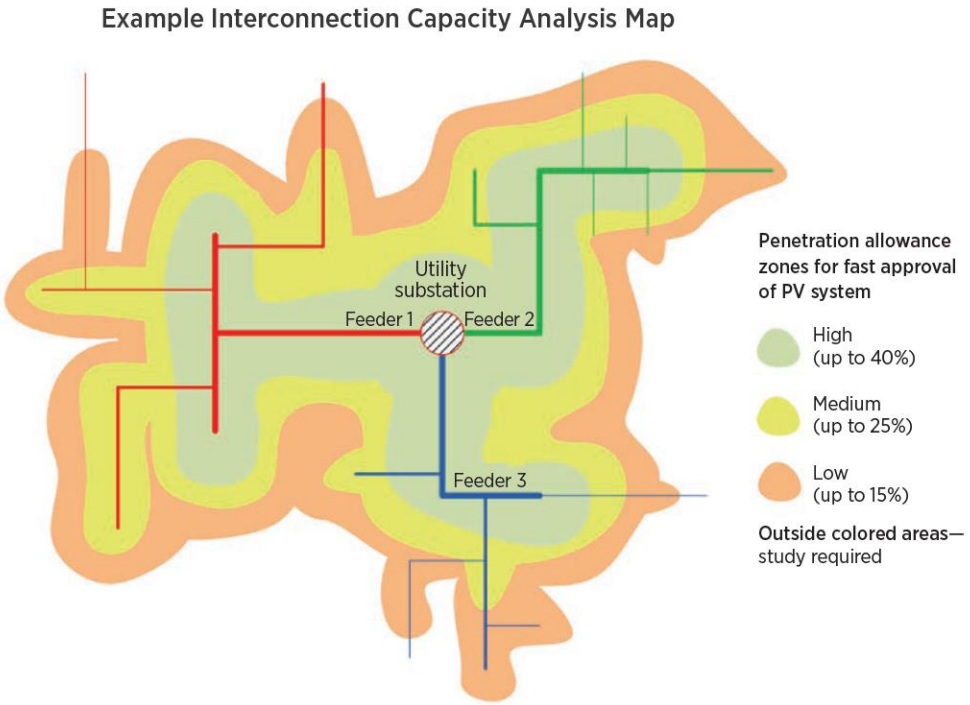
- Determines need for detailed impact studies and mitigation strategies
- Streamlined approval process can improve viability for small systems



Coddington, M. & Reiter, E. 2017. *Sun Screens: Maintaining Grid Reliability and Distributed Energy Project Viability through Improved Technical Screens.* https://www.nrel.gov/docs/fy17osti/67633.pdf.

Evolution in planning: Until 2015 (Smart Inverter Working Group) the strategy was to preemptively analyze DPV suitability

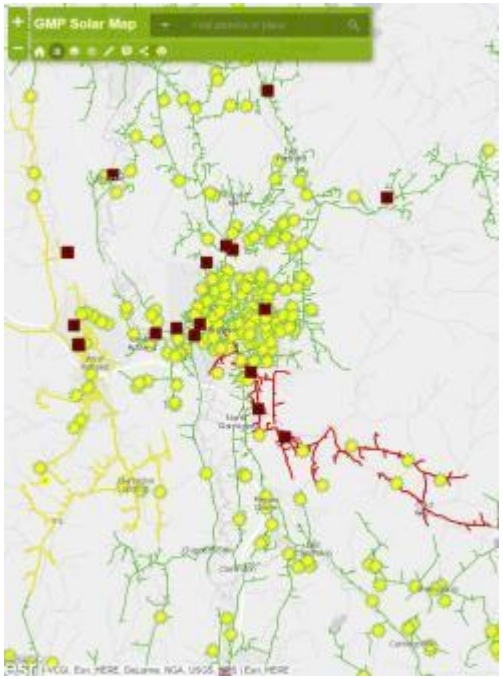
- Forecast DG growth on each circuit
- Establish the hosting capacity and allowable "penetration level"
- Determine available capacity on each distribution circuit
- Plan upgrades and expedite interconnection procedures
- Publish the results

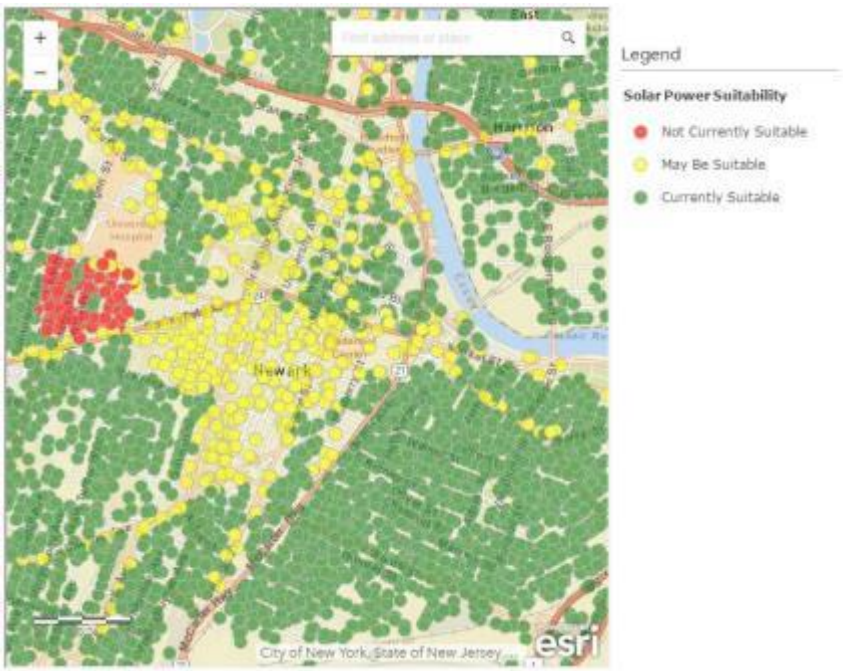


Evolution in Planning: (Still in use) Addressing interconnection concerns with capacity and mapping

- Three levels of sophistication:
  - Restricted zones (where can't I build a system?)
  - Address-level search (can I build a system here?)
  - Feeder mapping (where should I build a system?)

"Good-bad-maybe" : Burlington Electric (VT), Green Mountain Power (VT), PSE&G (NJ)





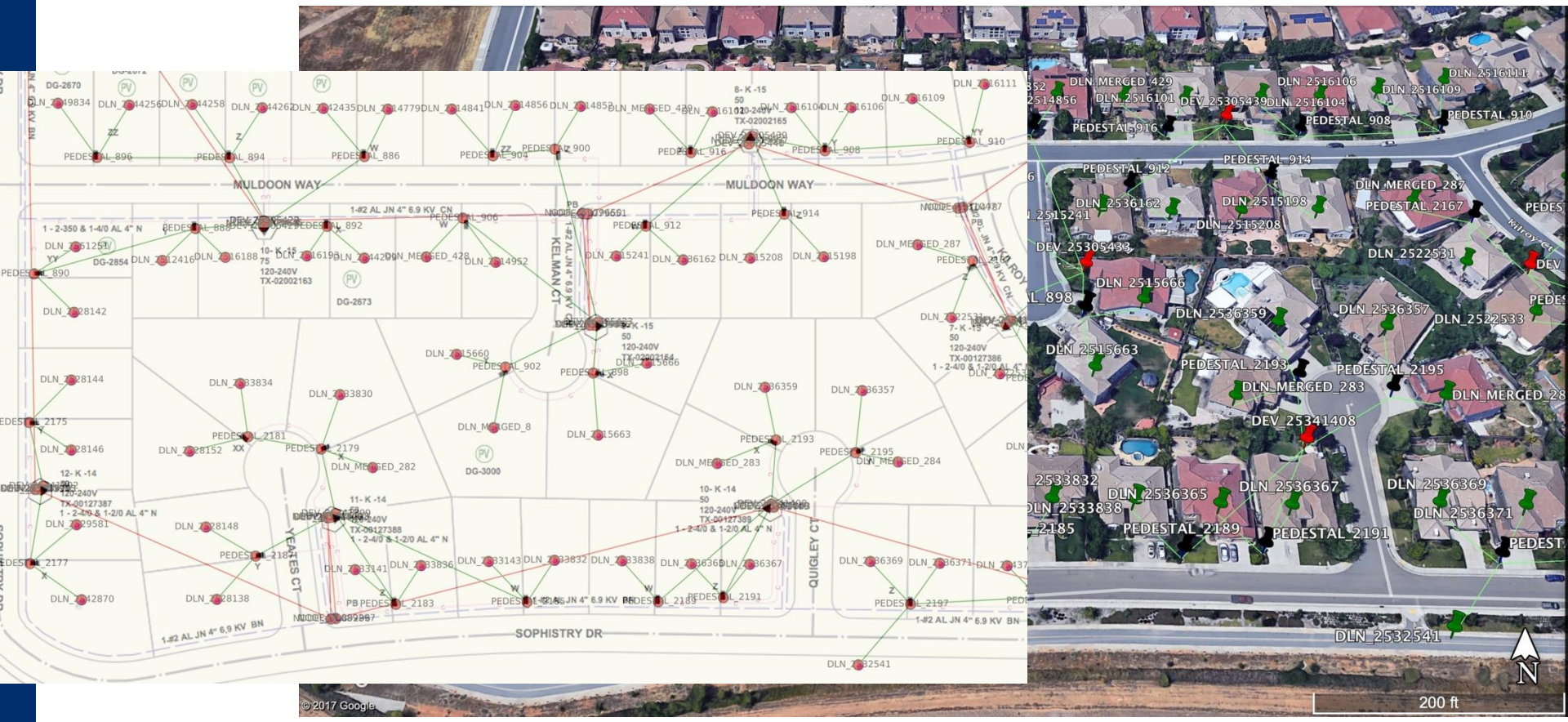
Evolution in Planning: Enabling smart inverters for voltage control

Utility-agnostic tool to pre-configure inverters and allow greater penetration levels

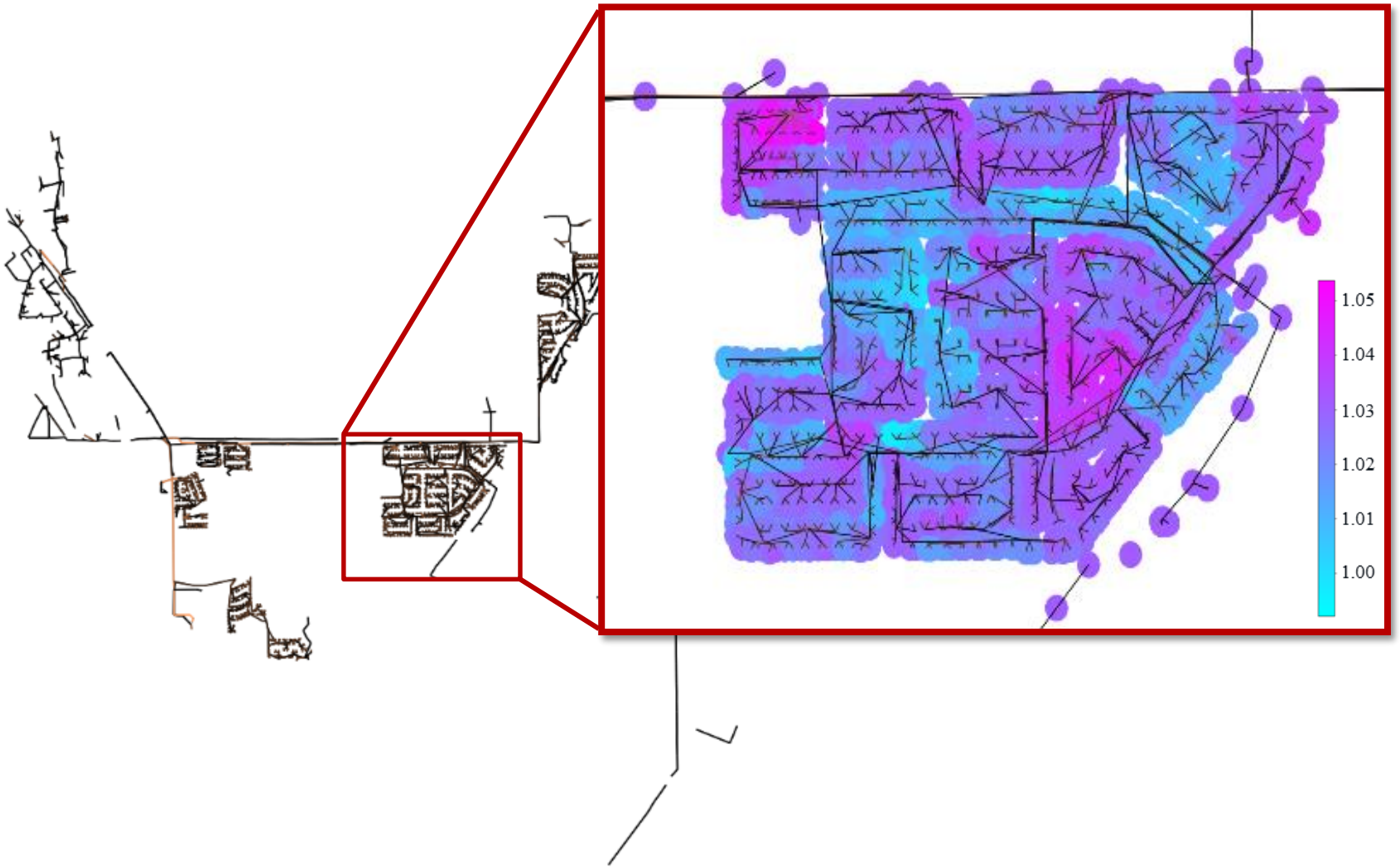
PRECISE

Step	Action
1 PV Interconnection Application	**PRECISE** obtains address of interconnection request
2 Distribution Feeder	**PRECISE** models the distribution feeder
3 Model Secondaries	**PRECISE** models secondaries using open street maps or GIS data
4 Configure Inverter Limits	**PRECISE** configures reactive power limits, active power limits, and power factor limits
5 Run Analysis	**PRECISE** runs analysis and exports the results

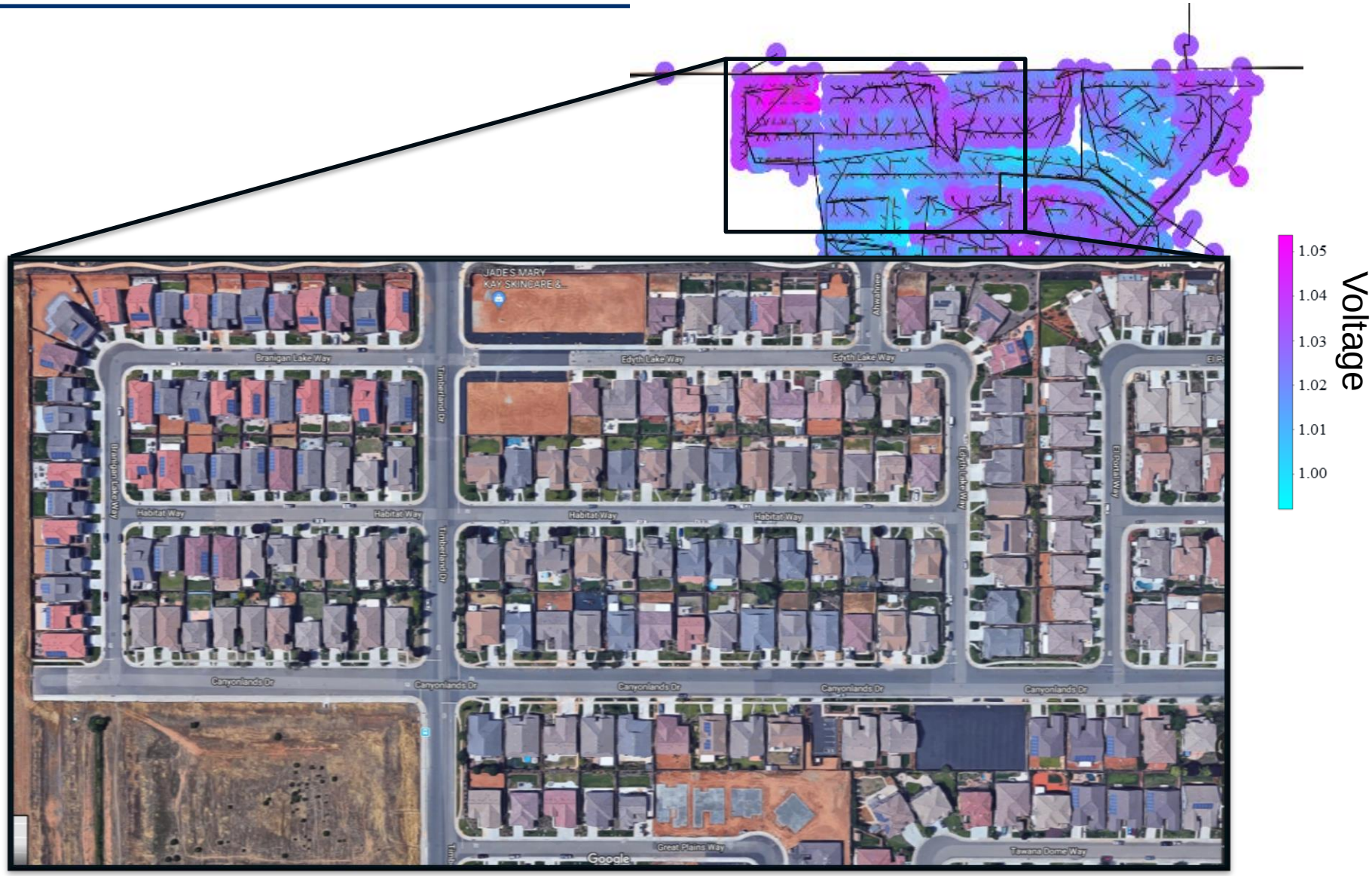
This new planning method focuses on modeling secondary lines, where voltage is most affected by rooftop PV



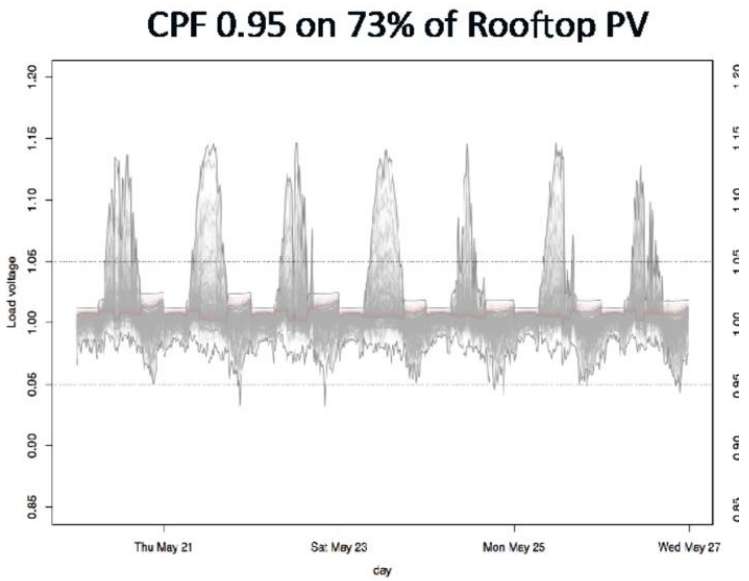
Secondary over voltages due to high PV penetration

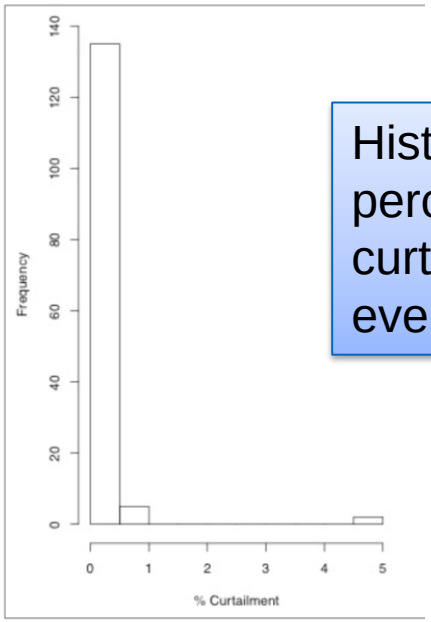


Real view of houses in the subdivision with over voltages



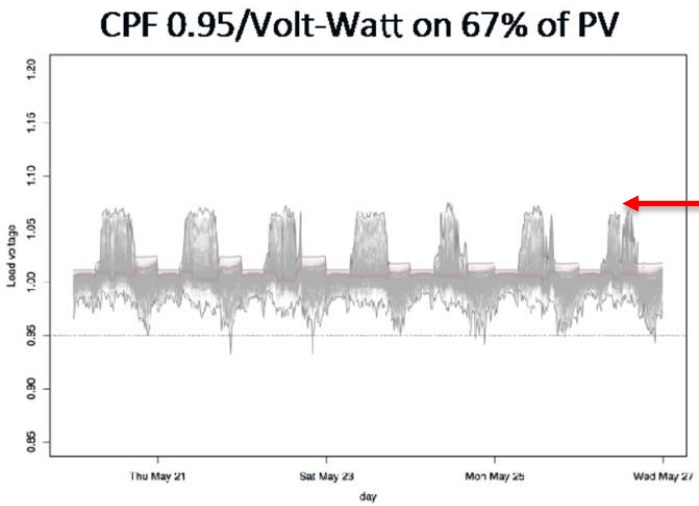
HECO example: Requiring rooftop PV to provide voltage support results in only small amounts of curtailment





Histogram of percent annual RE curtailment for every customer

Source: NREL/TP-5D00-68681



Limiting overvoltage to 1.05 results in 0% annual curtailment for most customers and up to 5% curtailment for only a handful of customers.
Analysis crucial for building stakeholder support for regulatory requirement

Another emerging measure in mature markets: "grid aware" compensation mechanisms

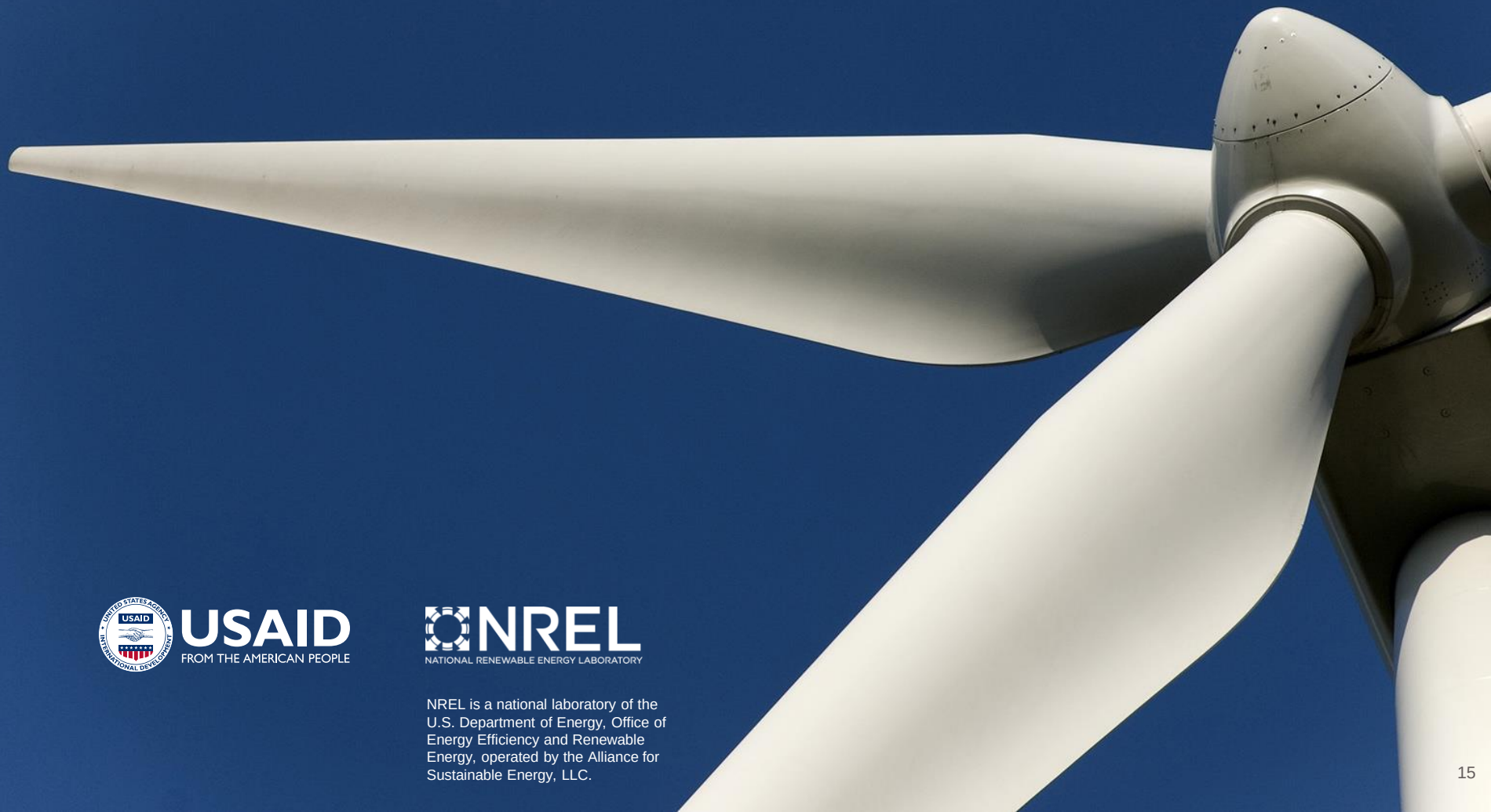
- Concept: compensate DPV generation based on time- and/or location-specific value to the distribution system
- Example approaches under consideration in California:
  - Net energy metering based on time-of-use-rates
  - Net billing or buy-all/sell-all, with exports compensated at an administratively-set locational value
  - Net billing or buy-all/sell-all, with exports compensated based on their participation in ancillary services markets (e.g., via an aggregator)

Key messages

- Stakeholder processes to evaluate the value of new requirements (such as smart inverters) can help prepare distribution grids for high PV penetration levels in the long-term
- Aligning compensation with the locational value of PV can be used to help offset infrastructure upgrades

Thank you!

For more information: http://greeningthegrid.org



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