

# The Challenge of Distributed Energy Resources



IEEE PES Fort Worth

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## About Me...

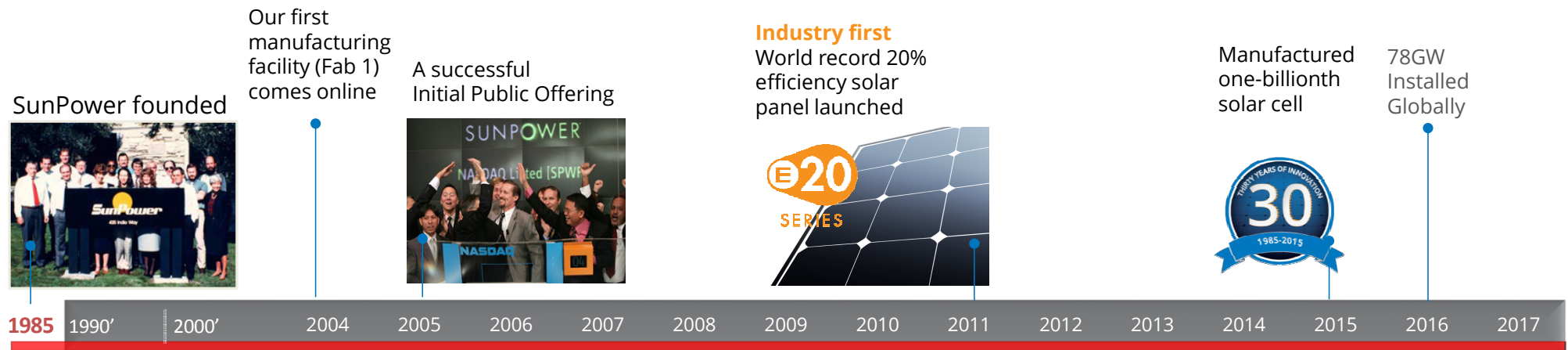
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- Tasha McCarter, BSEE, MBA, PMP, PE
- 15 years as an Electrical Design Engineer
- 10 years in technical and business development roles
- 6 years experience in Solar EPC with SunPower Corporation

Established and Proven. Technology Leaders.



# About SunPower...



- Vertically integrated solar company
- 6,000+ Employees worldwide; HQ San Jose, CA
- World record solar cell efficiency (24%)
- Majority owned by Total SA, one of the world's largest companies
- \$2.6 Billion in annual revenues (NASDAQ: SPWR)
- Manufacturing facilities in North America & Asia

# About SunPower...

## California Valley Solar Ranch (CVSR) – Utility Scale



The 250-megawatt (AC) California Valley Solar Ranch (CVSR) is located in San Luis Obispo County, California.

CVSR delivers enough electricity to power the equivalent of nearly **100,000 homes** and injected an estimated \$315 million of economic development into the local economy.

## Solar Star – Utility Scale



The 579-megawatt Solar Star projects (formerly Antelope Valley Solar projects) are two co-located solar installations in Kern and Los Angeles counties in California.

Completed in March of 2015, the Solar Star Projects deliver enough electricity to power the equivalent of approximately **255,000 homes**,



# About SunPower...

## New Apple Headquarters Commercial DG



March 3, 2017 /Renewable Energy World/ -- [Apple](#) announced that it will open its new 175-acre campus to employees beginning in April. The campus is powered 100 percent by renewable energy and will include 17 MW of rooftop solar. Apple Park will be one of the largest on-site solar installations in the world.

## Macys Stores Commercial DG



April 21, 2017 /[PRNewswire](#)/ -- Today, several Macy's, Inc. locations will reveal their solar energy makeovers. This marks the completion of 21 high-efficiency SunPower® solar energy systems installed this past year at Macy's and Bloomingdale's locations in seven states, totaling 15 megawatts and adding to the nearly 24 megawatts of SunPower solar that have been operating since 2007.

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# The Challenge of Distributed Energy Resources

# The Basics...

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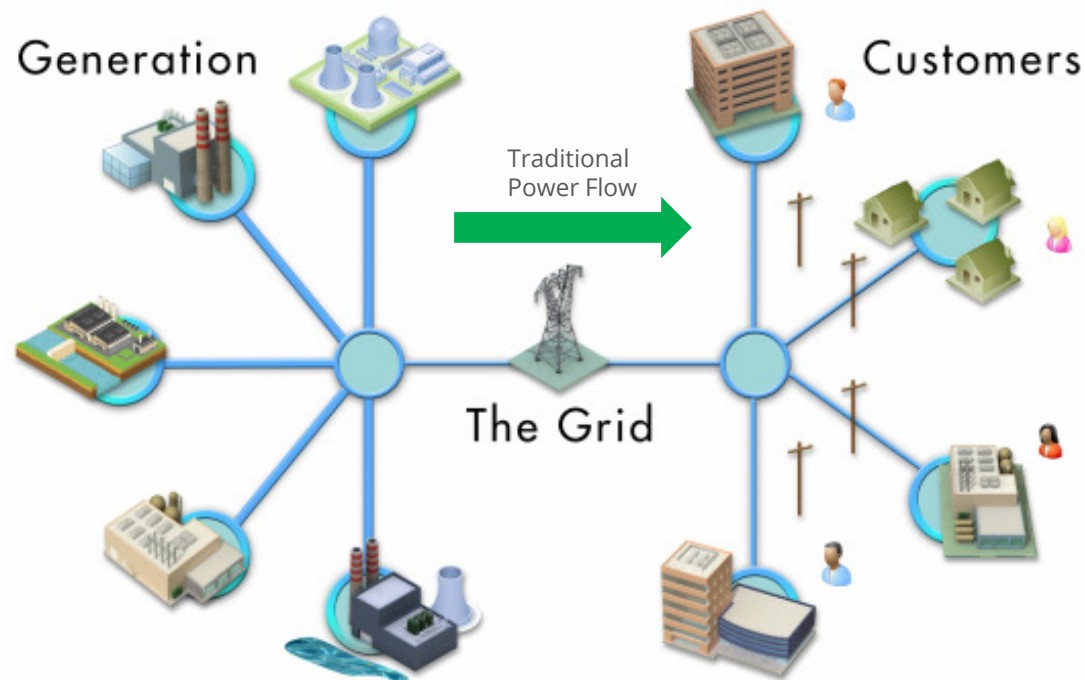
- **What are Distributed Energy Resources (DERs)?**

- DERs include distributed generation, which are non-centralized sources of electricity generation. Typically interconnected to a Utility's distribution system and located at or near a customer's home or businesses

- **Examples of DERs**

- Solar Panels
  - Energy Storage
  - Fuel Cells
  - Micro turbines
  - Reciprocating engines
  - Small Wind
- Backup Generators
  - Combined heat and power (CHP) systems
  - Hydro
  - Biomass
  - Landfill methane

# Conventional Power Flow...



## PLANNING

- Anticipate load profiles
- Forecast demand
- Strategies to meet demand
  - Load shifting
  - System upgrades

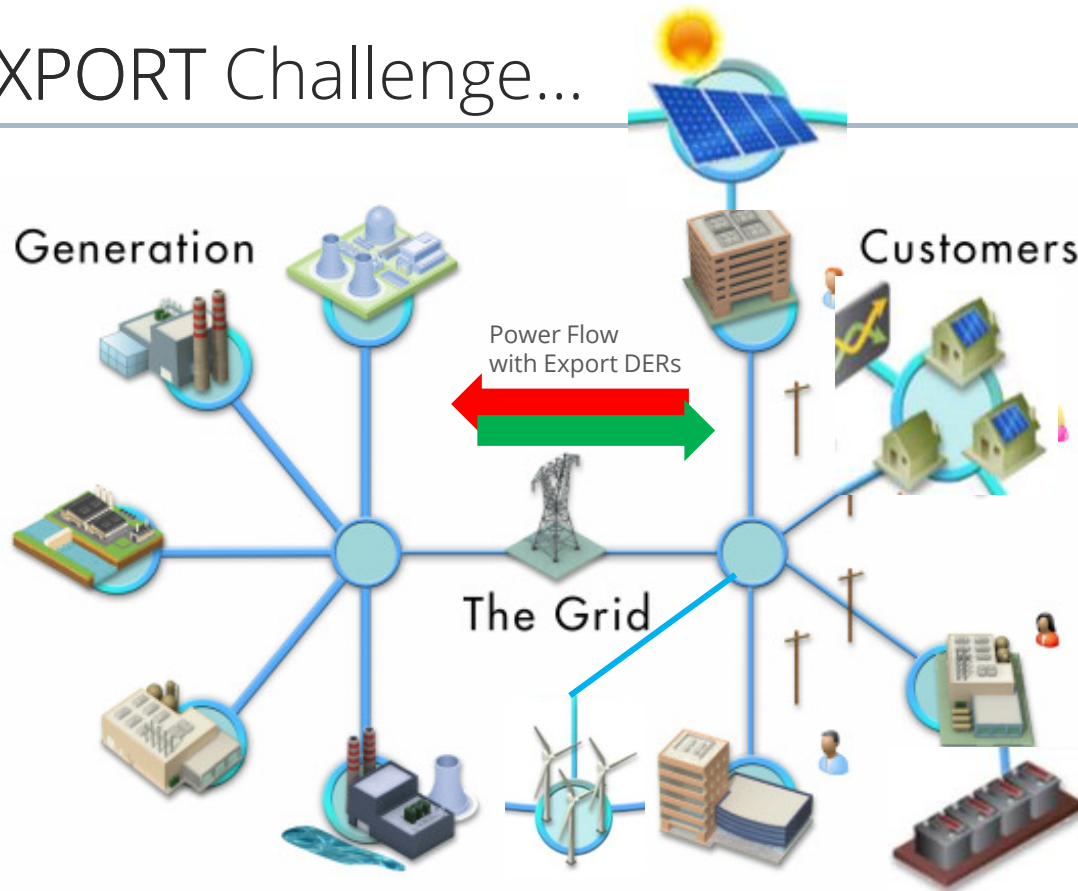
## POWER QUALITY & SYSTEM RELIABILITY

- Voltages & Frequency Stability
- Ramp Rates
- Equipment useful life

Figure 1: Today's Power System Characterized by Central Generation of Electricity, Transmission, and Distribution to End-Use Consumers



# The EXPORT Challenge...



## PLANNING

- Anticipate load profiles
- Forecast demand
- Strategies to meet demand
  - Load shifting
  - System upgrades

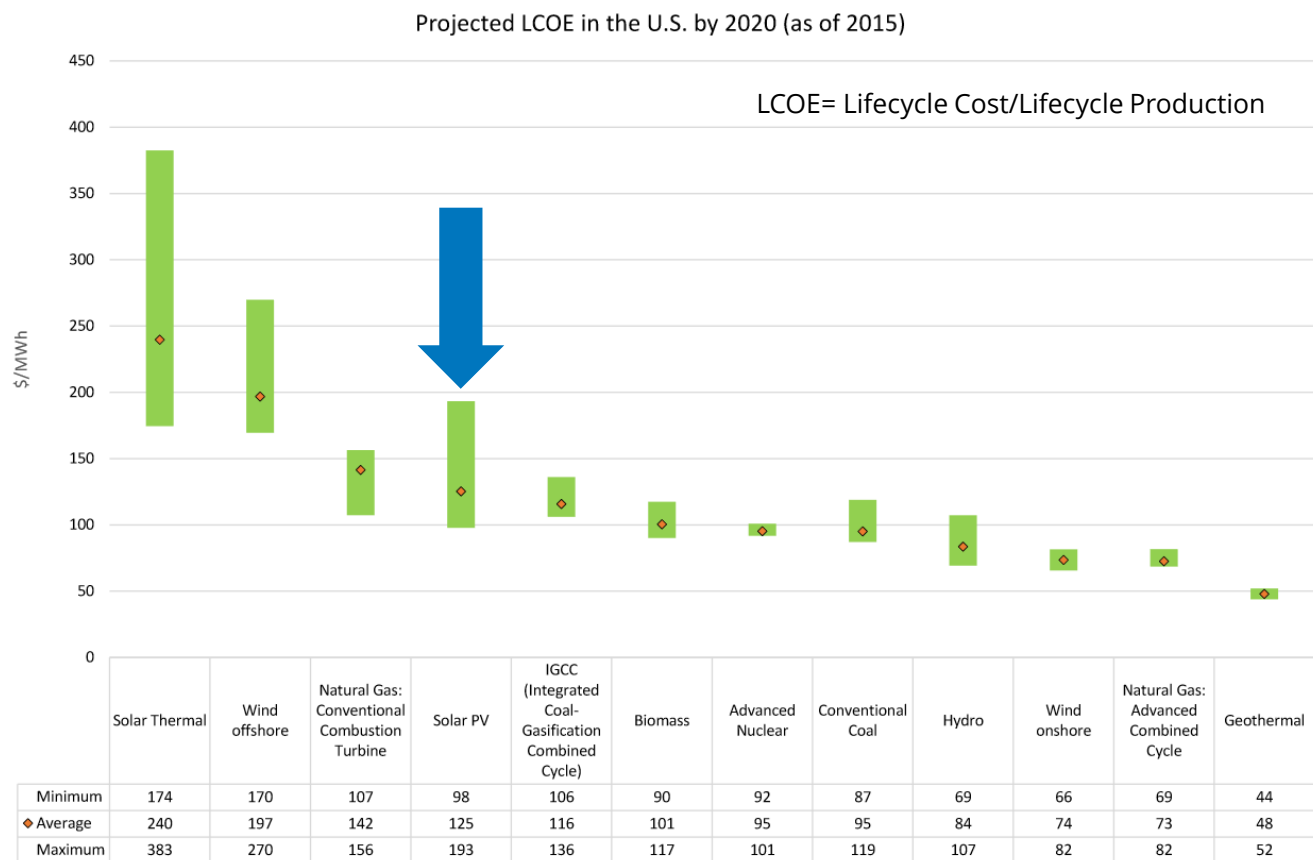
## POWER QUALITY & SYSTEM RELIABILITY

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The Solar Industry

# Key Driver: Economics

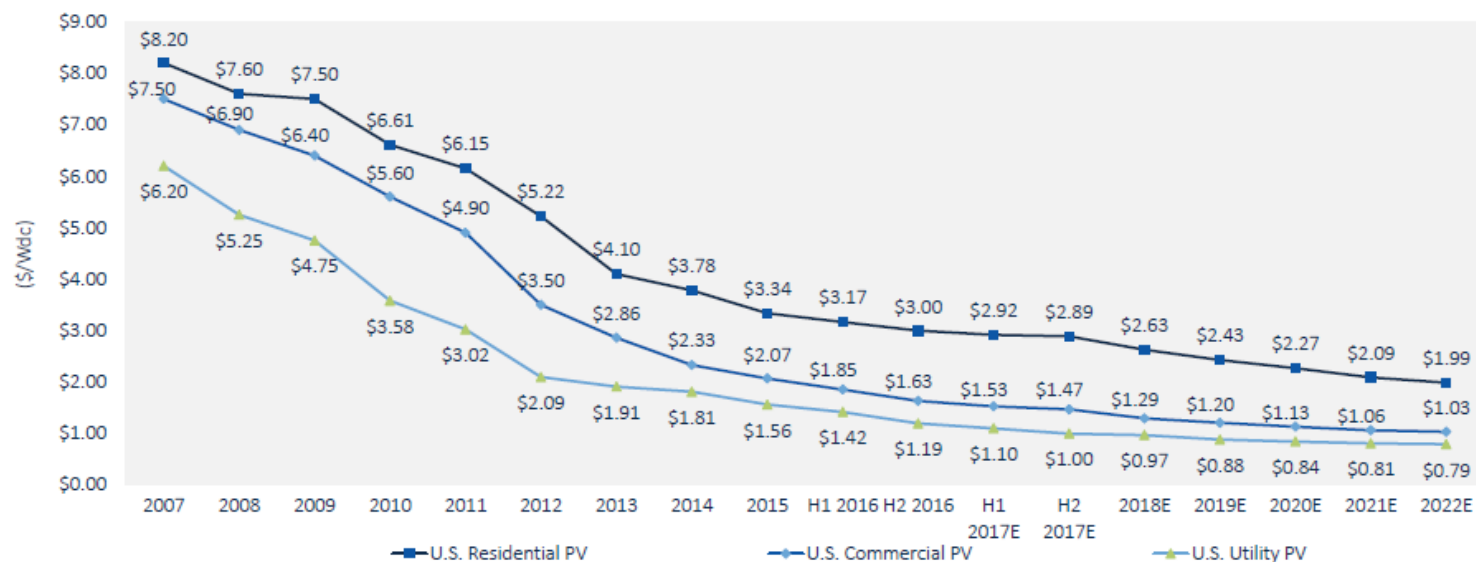


Source: Energy Information Administration's (EIA) Annual Energy Outlook released in 2015

# Key Driver: Economics

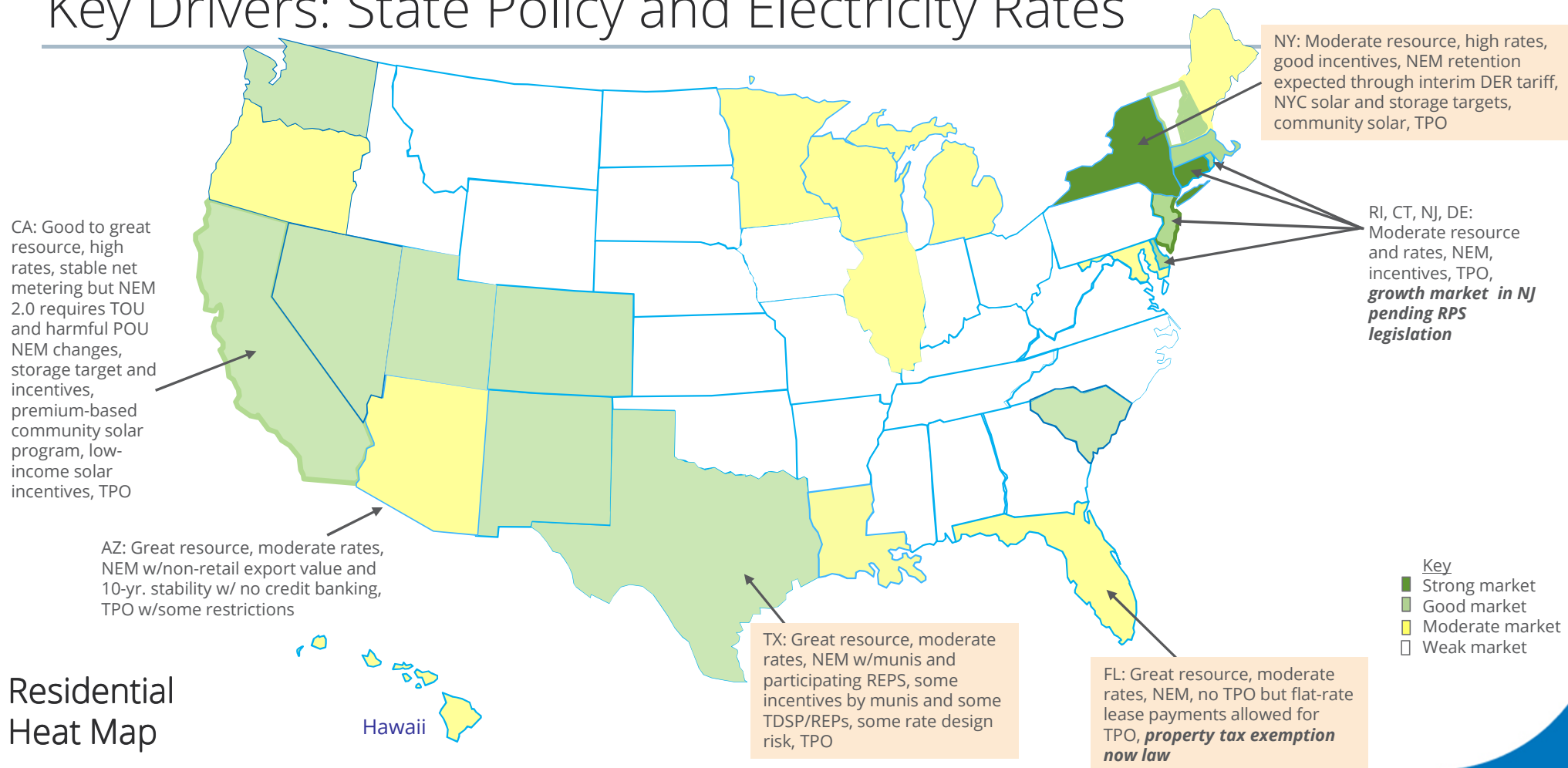
From H1 2017 to 2022, Average U.S. PV System Pricing Will Fall By 31%

Historical and Forecasted U.S. PV System Pricing by Market Segment, 2007-2022E (\$/Wdc)



Source: GTM Research

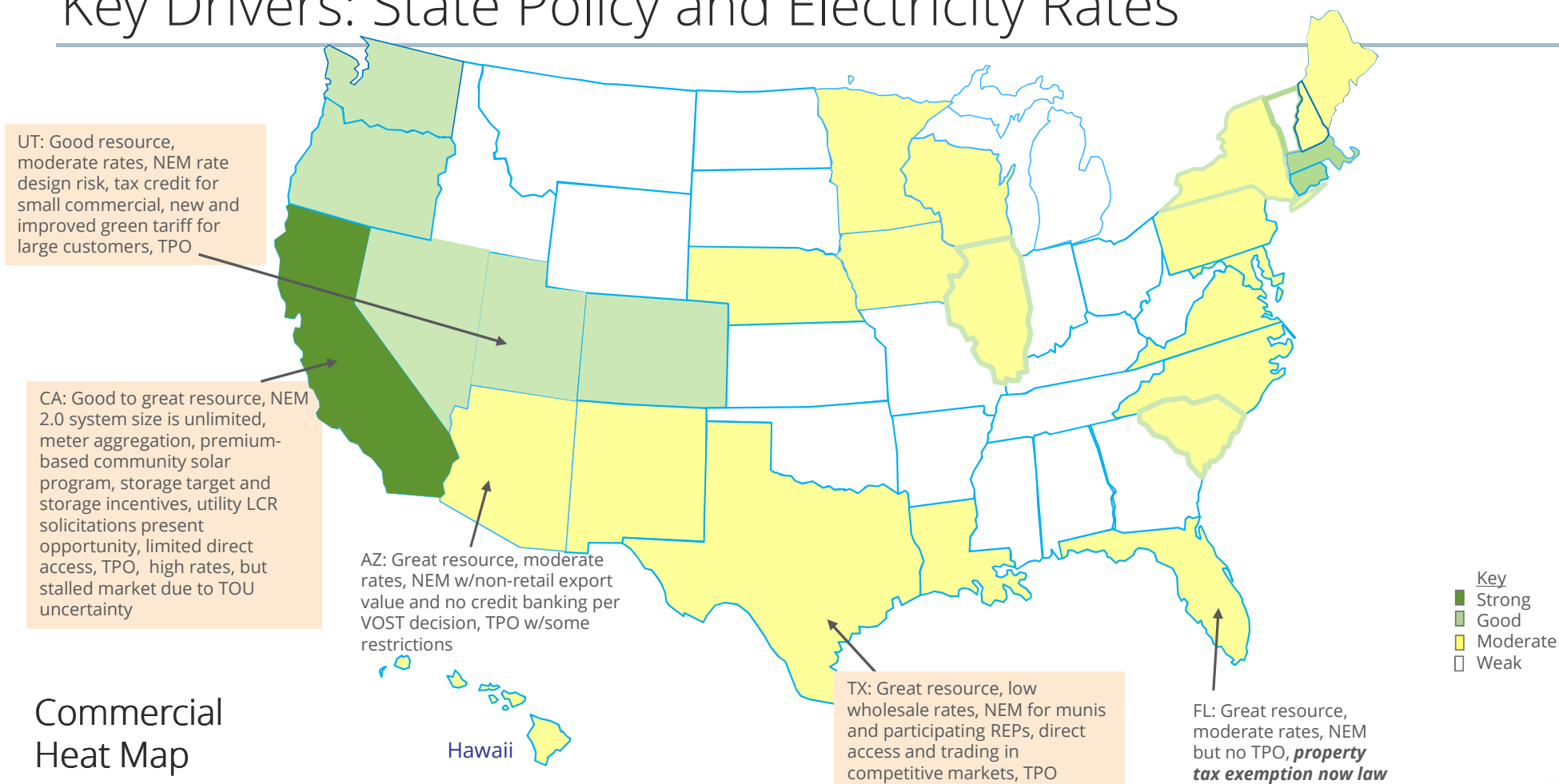
# Key Drivers: State Policy and Electricity Rates



Residential  
Heat Map



# Key Drivers: State Policy and Electricity Rates



Commercial  
Heat Map

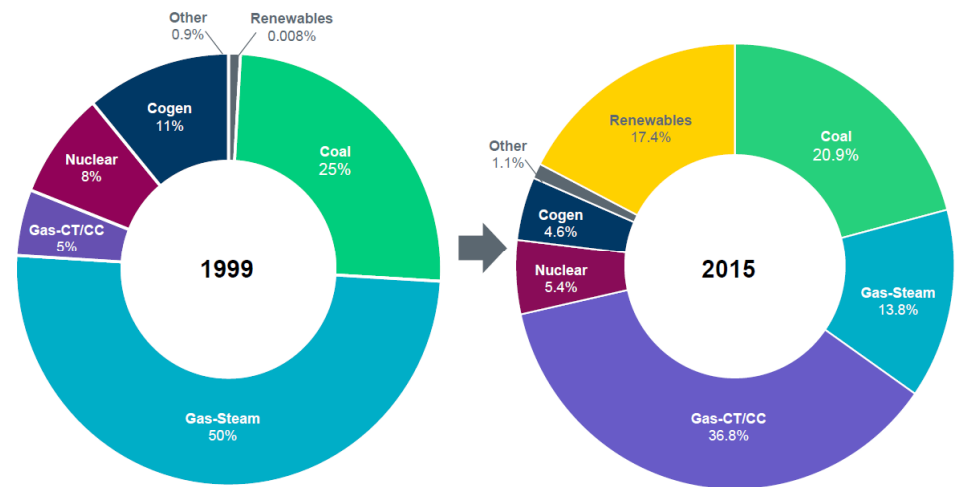
# ERCOT Influence...

## Milestone 10: The future



- **Distributed Energy Resources move to the mainstream**
  - ERCOT now has ~ 1,100 MW of generation connected at distribution voltage
  - >80% of that is diesel, natural gas or landfill gas
    - Much of it is backup generation on critical infrastructure vulnerable to weather (i.e., hurricanes)
    - Some of it is price-responsive
  - ERCOT is now working with T&D utilities to:
    - Establish better reporting of DG
    - Create a framework for DG to participate directly in the ERCOT markets

## Changing Resource Mix



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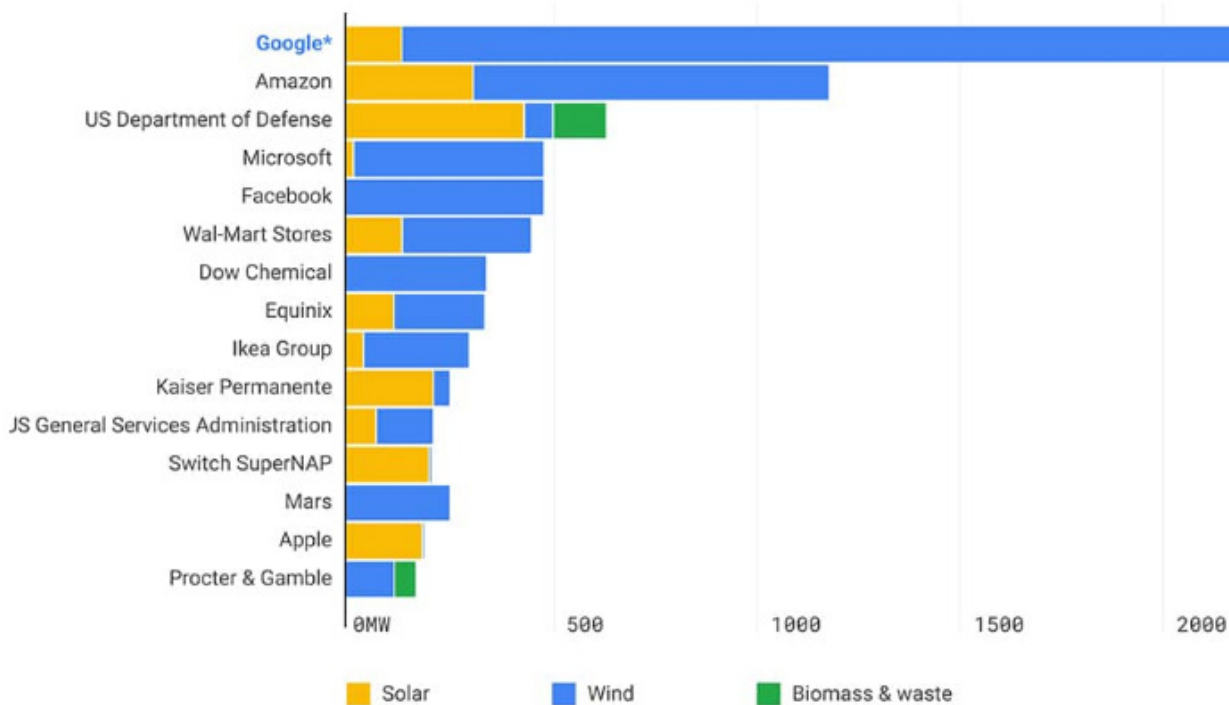
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# Key Driver: Customer Values

CUMULATIVE CORPORATE RENEWABLE ENERGY PURCHASING  
IN THE UNITED STATES, EUROPE, AND MEXICO—NOVEMBER 2016



Source: Bloomberg New Energy Finance

\*Google total also includes one 80 MW project in Chile

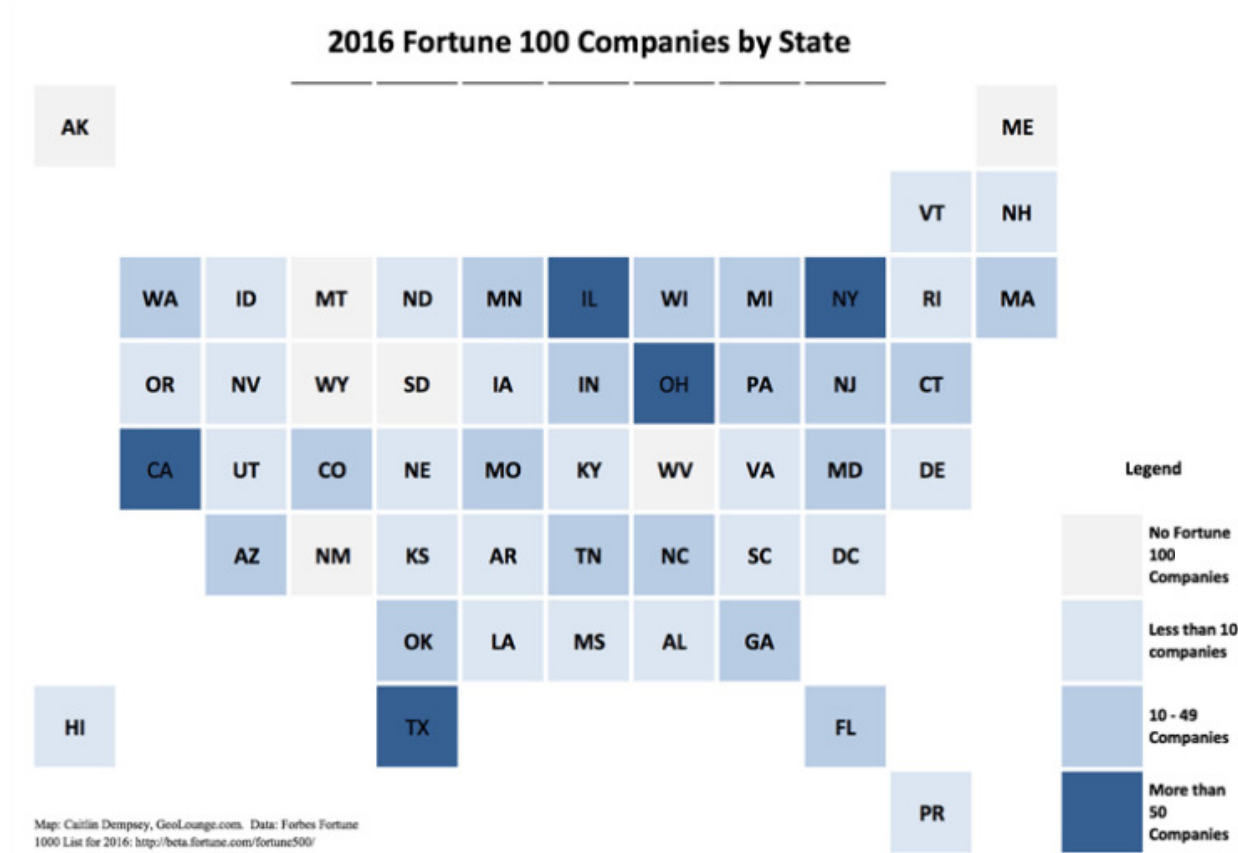
## Google, Apple, Facebook race towards 100% renewable energy target

A global campaign to promote 100% renewable energy use in the business world means more Silicon Valley giants are now investing in solar and wind electricity



Businesses, like homeowners, have historically relied on their local utilities for power. Now, tech companies like Google and Facebook are racing to reach a 100% renewable energy target. Photograph: Lucy Nicholson/Reuters

# Key Driver: Customer Values



Stemming from the [Paris Pledge for Action 2015](#), recent initiatives including [RE100](#), [WeMeanBusiness](#) and [Science Based Targets](#) are working with leading corporations to set sustainability targets, such as a commitment to source 100 percent of electricity demand from renewable sources (RE100). With corporate energy consumers accounting for about 50 percent of global electricity demand, these initiatives aim at spearheading a major shift in the global renewable energy market.

# Other Drivers...

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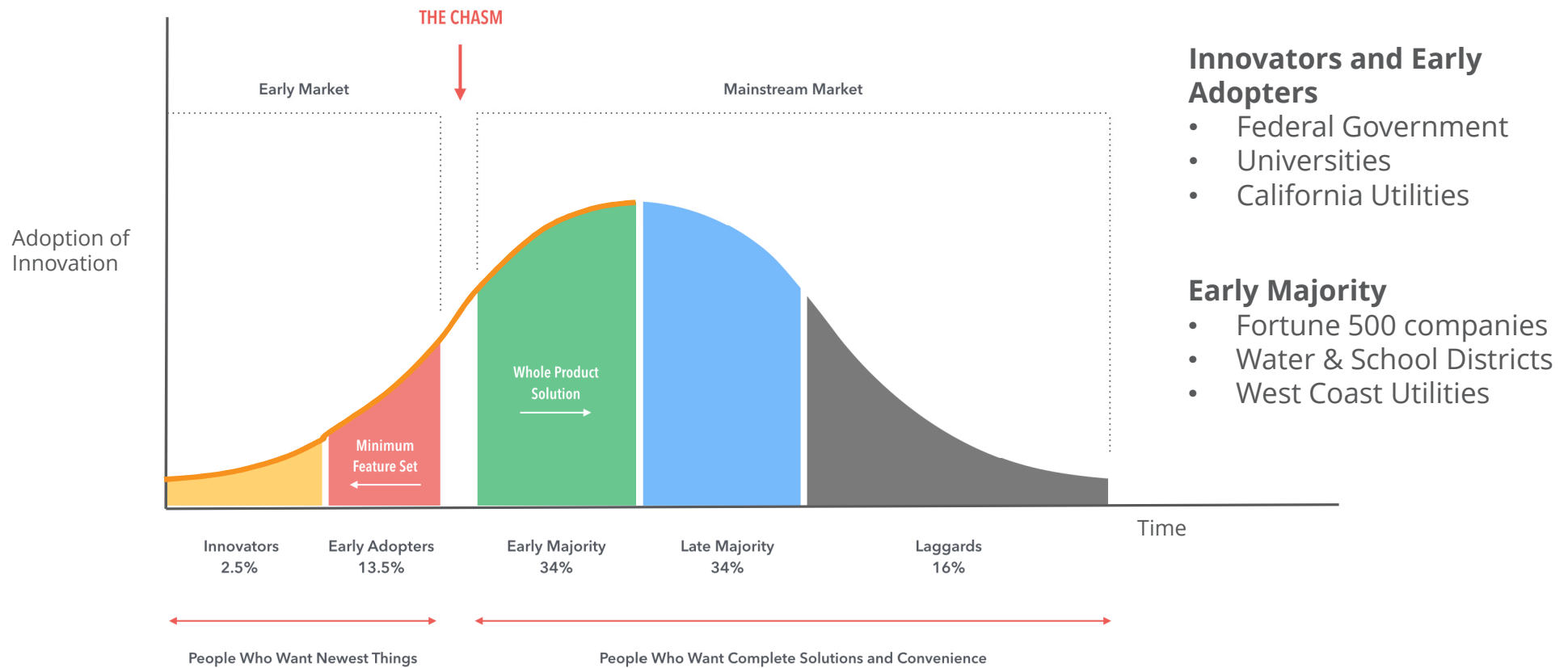
- Project Finance
  - Partnership Flips
  - Sale Leaseback
  - Inverted Lease
- Technology Enhancements
  - Energy Storage
  - Module Efficiency
- Sharing Models
  - Community Solar
  - Energy Districts
  - Microgrids



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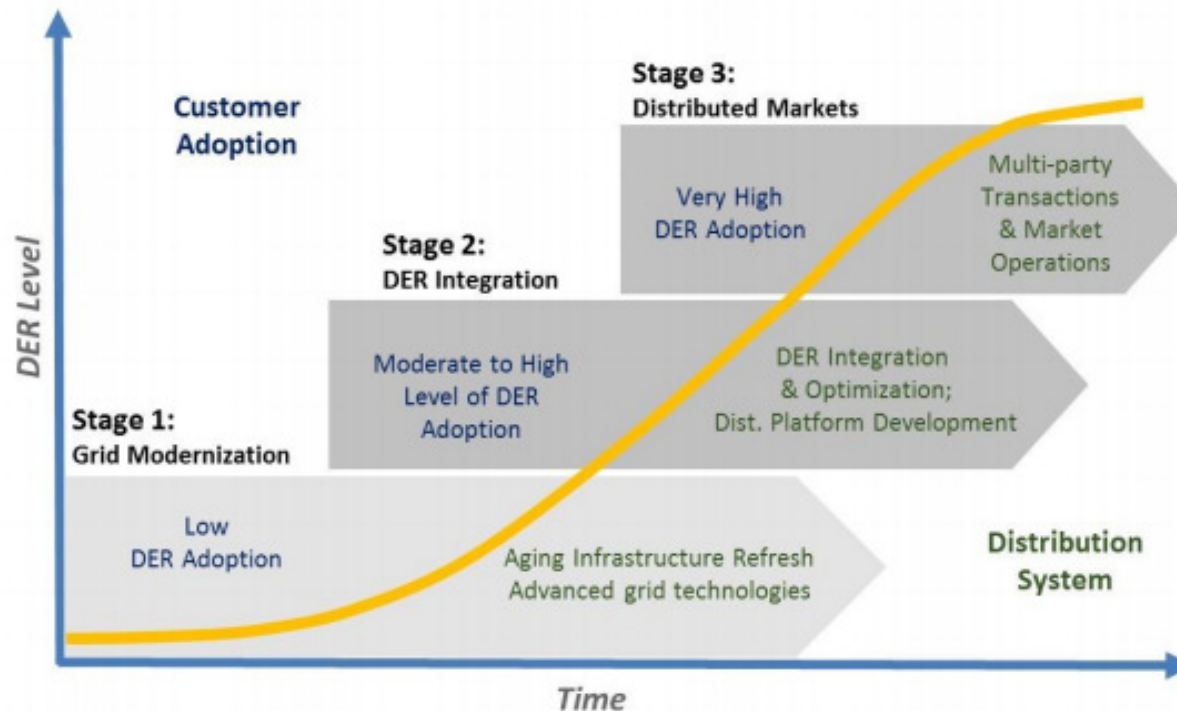
# The Challenge of Distributed Energy Resources

# Technology Adoption S-Curve...



# DER Technology Adoption vs. Utility Readiness...

Figure 3. Distribution System Evolution



Source: ICF International, Integrated Distribution Planning Presentation

## Stage 1

- Most States
- Low DER Adoption
- Focus: Grid Modernization

## Stage 2

- Few States (i.e. California)
- Moderate to High DER Adoption
- Focus: Grid Optimization

## Stage 3

- No States
- High Adoption
- Focus: Retail Energy Transactions

## ICF International recommendations...

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- **Stage 1:** States in Stage 1 should also proactively plan for an intelligent, flexible, efficient, open, and secure distribution system that can integrate new distributed energy technologies and the complexity of many actors on the system. Consider performing locational value assessments, to identify areas of the distribution system where the addition of DERs would benefit the system
- **Stage 2:** Changes to grid planning and operations are required. To address, bi-directional power flows and/or voltage variations on high DER circuits, advanced protection and control technologies and operational capabilities to manage a distribution grid safely and reliably will be needed.
- **Stage 3:** It is unlikely that Stage 3 markets will develop until the next decade after DER rate reform and current incentives expire. Also, this will require regulators in most states to institute changes to allow retail energy transactions across the distribution system.

## Best Practices...

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- California Rule 21 Fast Track
  - ❖ Non-Export: DER < 50% of min base campus load and/or Reverse Power Protection
- Congestion Maps – locational focus DERs
- Pre-application reports (quick check to see if equipment ratings will be exceeded)
- Advanced Inverters – extended voltage-frequency protection and ride-through



## Take Aways...

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- Distributed Resources, more specifically Solar is here to stay
- Growth of this resource is inevitable
- High DER Penetration is a risk, but we can mitigate by being proactive
- Partner with customers and DER developers for mutual success



# Thank You

Let's change the way our world is powered.

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