Mitigating Challenges with Integrating Renewables

2019 USNC Grid of the Future

Beth LaRose, GE Energy Consulting

November 5, 2019

GE Energy Consulting: power system experts for >100 years

~130 power system experts
9 countries
>100 patents

ECONOMIC ANALYSIS

grid value of technology

$$

Renewables planning and strategy
Financial modeling and forecasting

TRANSMISSION STRATEGY

complex plant interconnection

Stability studies

Network risk assessment
Grid reinforcements

GENERATION INTEGRATIO

voltage & frequency performance

Interconnection support

Grid code testing and compliance

Planning years ⟷ **Transients** milliseconds

Models

Capacity GE MARS*

Energy GE MAPS*

Power flow GE PSLF*

Software

GE technology
1/3 earth's power | #1 clean energy fleet

*Trademark of General Electric

Powerful trends shaping the nature of electricity

DECARBONIZATION

By 2026, **RENEWABLES will represent 40%** of global **installed generation capacity***

IMPACT

- Growing share of renewables an increasing challenge to the traditional power system model

DIGITIZATION

EXPONENTIAL GROWTH of **connected devices** & **smart sensors**

IMPACT

- Real time decision making becomes possible … new software solutions open breakthrough optimization

DECENTRALIZATION

GROWING PENETRATION of **Distributed Energy Resources**

IMPACT

- End users become active actors of the power system ('pro-sumer') … growing grid complexity

ELECTRIFICATION 2.0

ELECTRIFICATION OF ENERGY-INTENSIVE USES

IMPACT

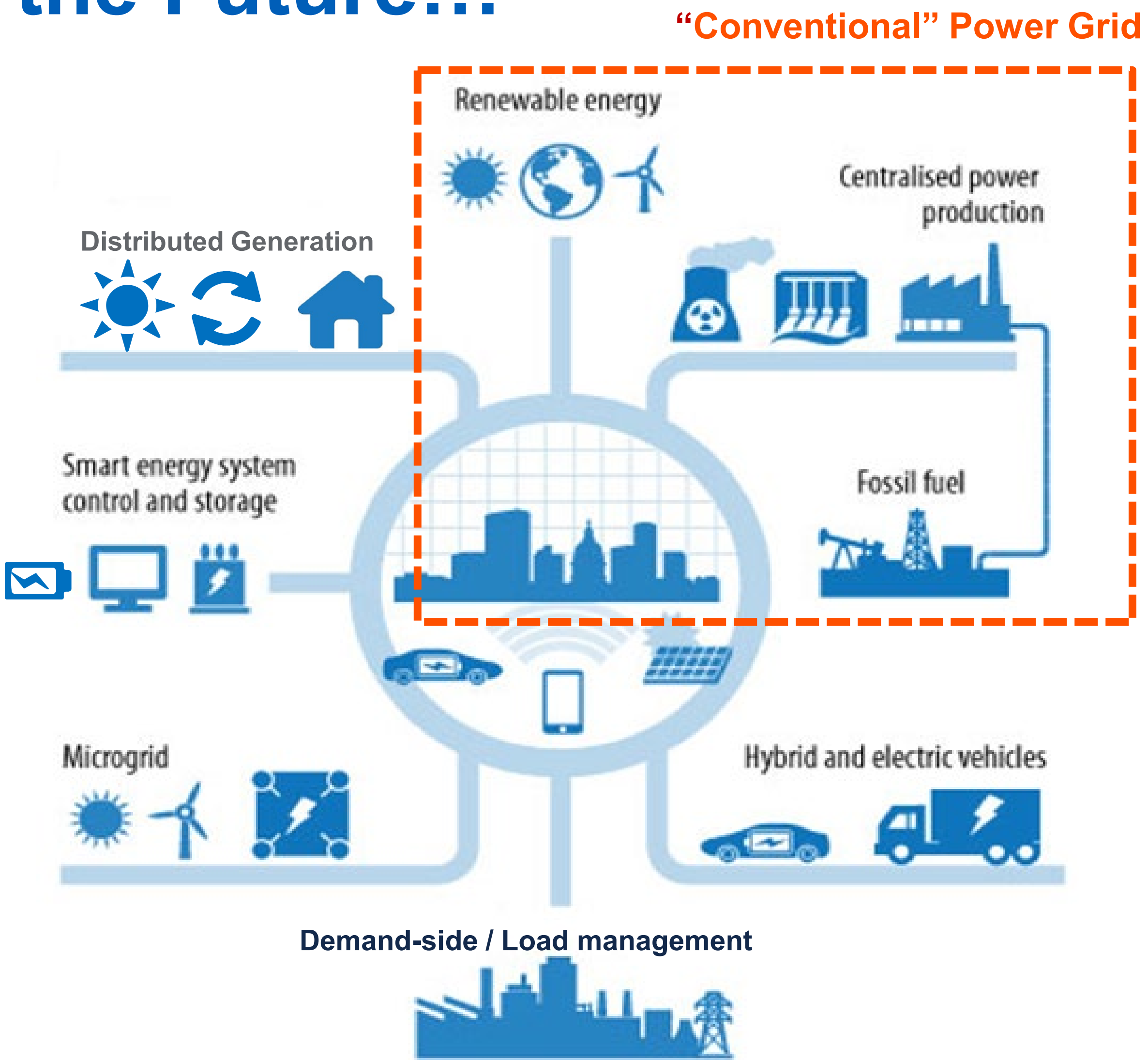
- Step increase in electricity consumption … accelerating Decentralization

Renewables and the Grid of the Future…

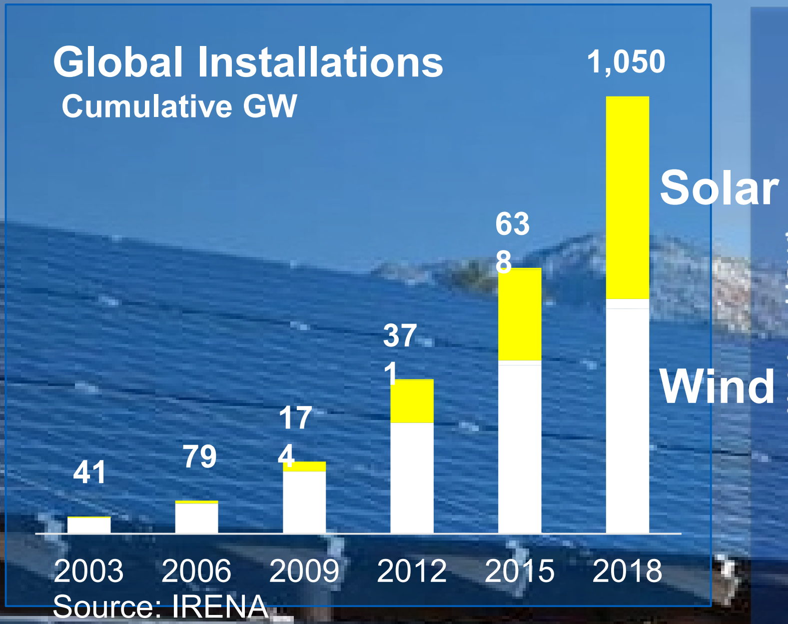
Towards a low carbon future

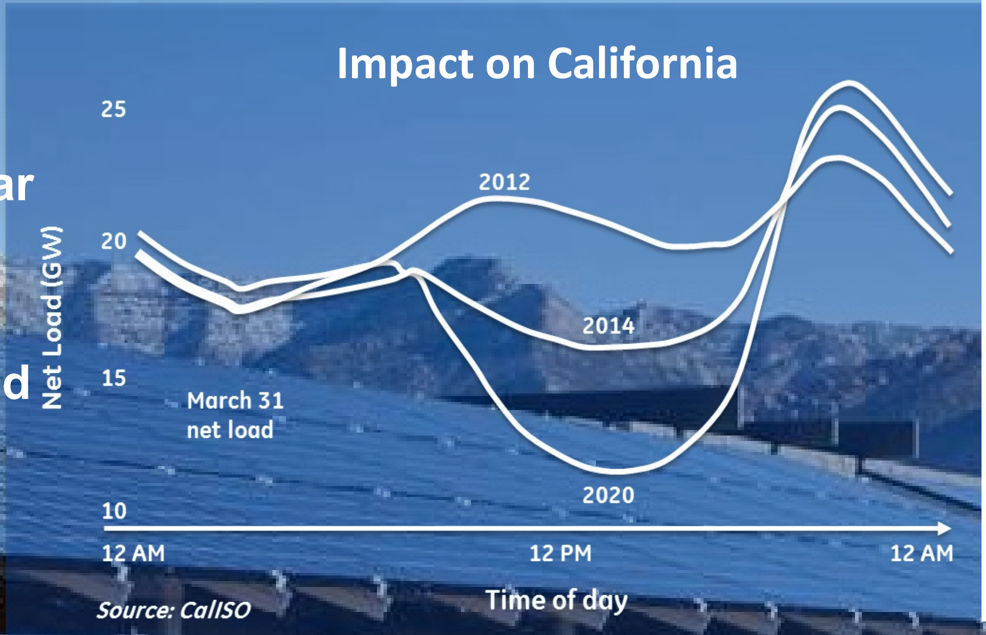
Addressing challenges of weak grid operation, resource variability, uncertainty and providing cost-efficient reliable operation

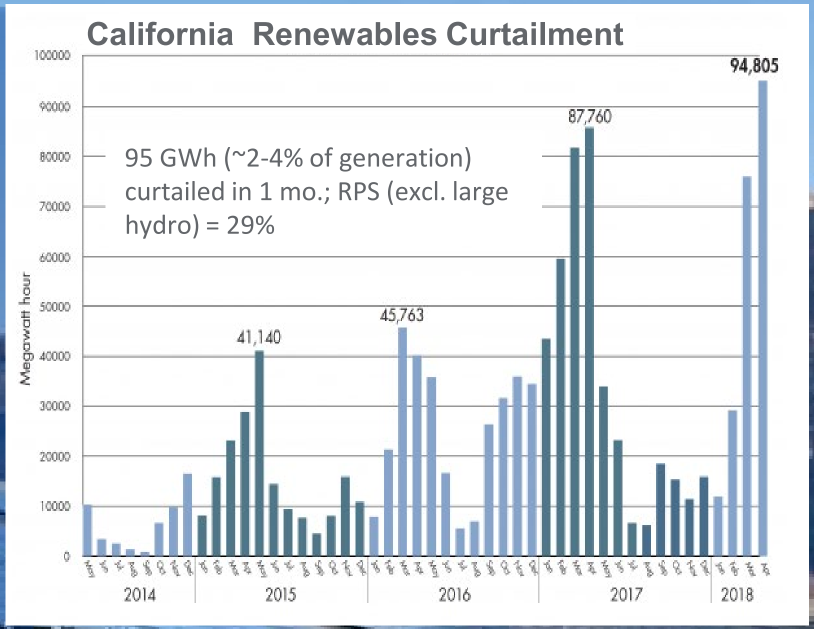
The technology exists TODAY to get there…



Transformation…at incredible speed

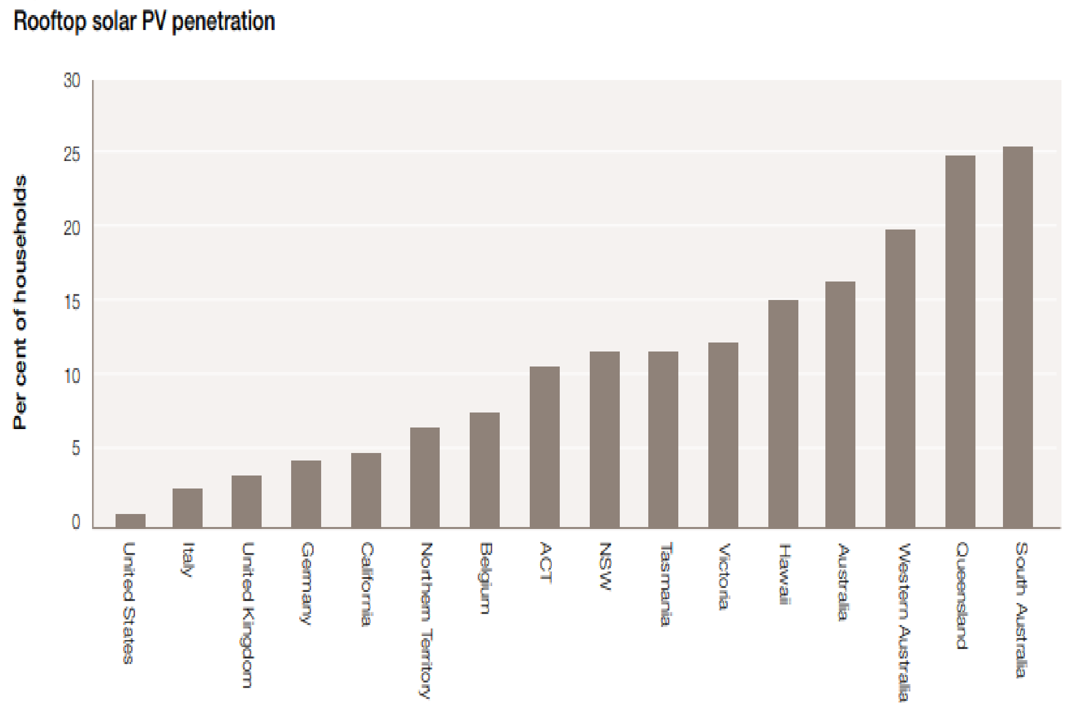




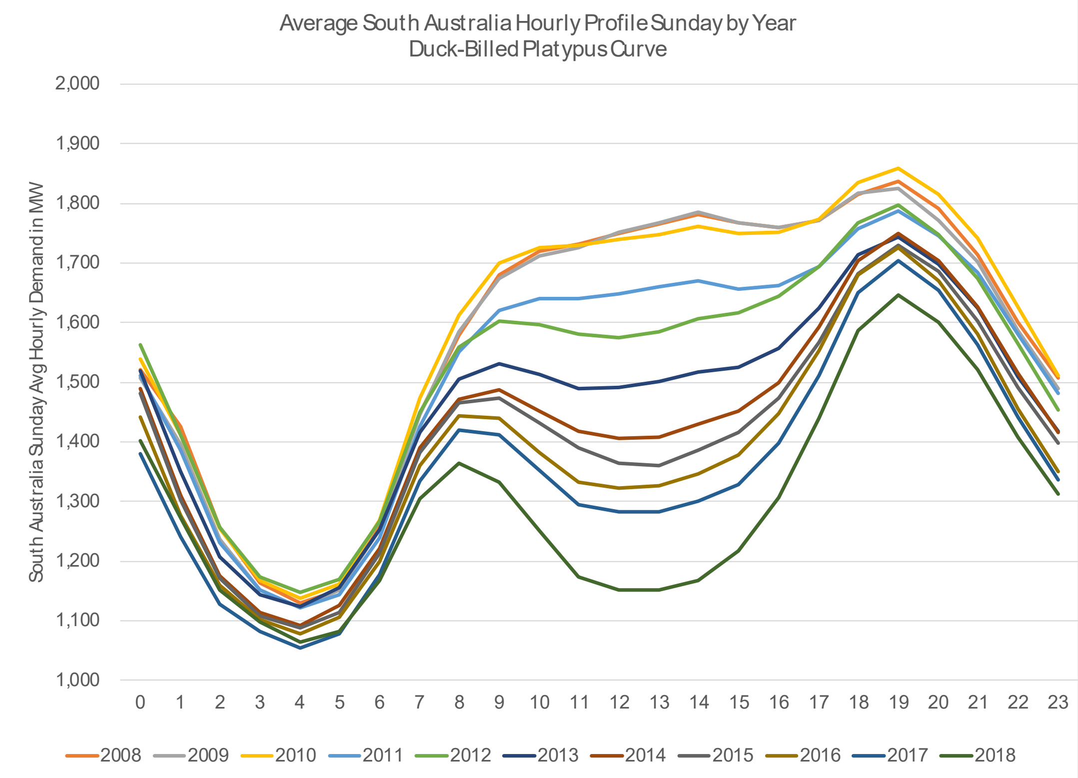


Growing need for flexibility

South Australia Rooftop Solar PV and "Duck-billed" Platypus Curve



Source: International Energy Agency, *Renewable energy medium-term market report 2016*, p. 144; and reproduced in Expert Panel (Dr Alan Finkel, Chair), *Independent Review into the Future Security of the National Electricity Market, preliminary report*, December 2016.



- Total installed capacity of rooftop solar systems in the NEM >5 MW in 2016, ~ 9% of total installed generation capacity, in 2019 rooftop solar is ~15%
- South Australia increasing solar rooftop generation changing the daily hourly profile between 2008 and 2018

Source: GE Energy Consulting and AEMO South Australia half hourly load data. [1] Estimated as of September 12, 2018

Back to fundamentals

SYSTEM SECURITY

Stability with high penetrations of inverter-based resources (IBRs)

- Inertia
- Frequency
- Protection

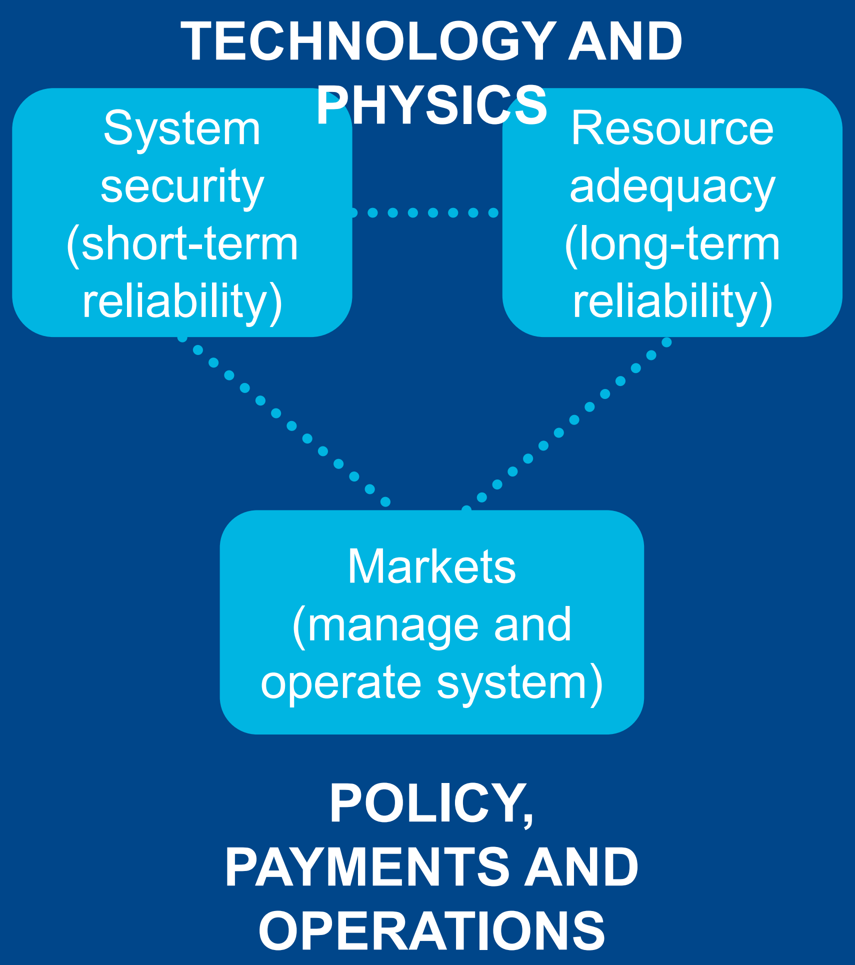
RESOURCE ADEQUACY

Resource mix and balancing load

- Capacity expansion
- System balancing
- Loss of load expectation (1 day in 10 years)
- Power to "X"
- Energy systems integration

MARKETS

- Capacity, energy, ancillary and support services
- Re-regulation?
- Transactive, grid architecture, DERs



Load profiles/shapes are important

Conventional generation provides known capability at all times

- Traditional resource adequacy determined at time-of-peak demand

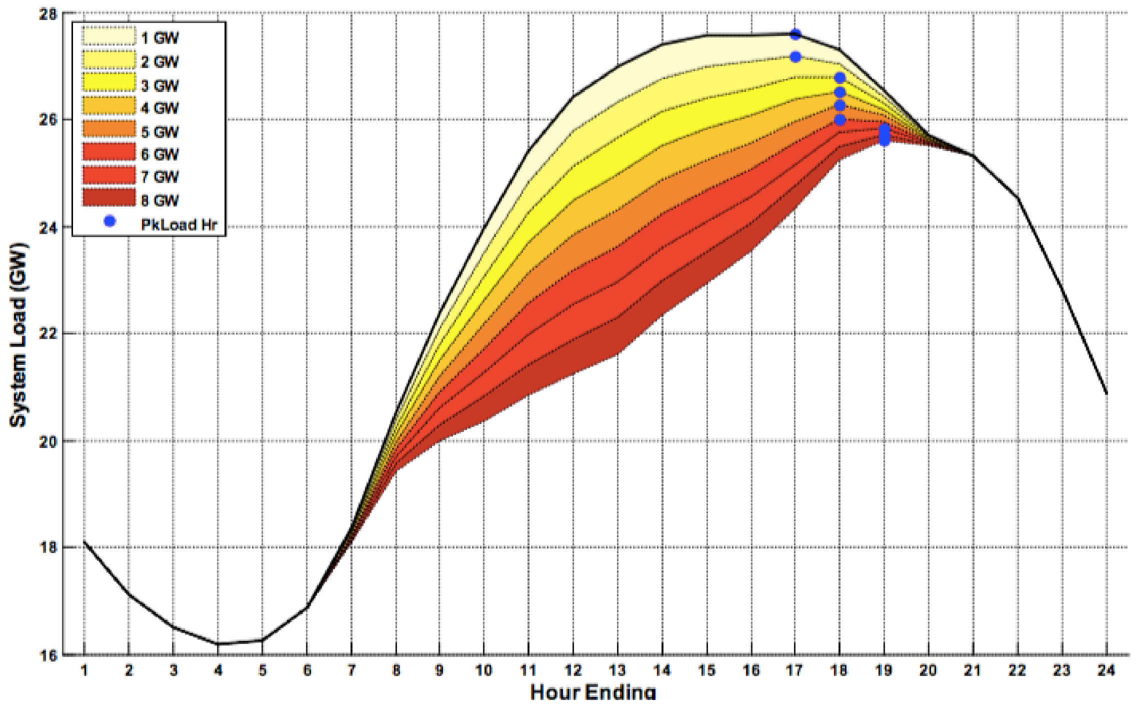
DERs may provide variable output

- Resource adequacy now needs to be based on hourly resources and load profiles for days that of potential adequacy impact (may not be traditional peak days!)

"Peak" is moving because of a changing grid

- As we move to time-varying rates, as solar penetrations increase, as EVs proliferate, it becomes harder to predict the time of peak

System peak is different from circuit peak



Source: ISONE, 2016

Challenges and Consequences of Passive DER Planning

Autonomous DER deployment with little information/guidance

- Passive DER planning leads to uncontrolled resource deployment that could have technical and economic consequences for the utility, developers and customers
- Customer decides what kind of DER to install, how big, where, and how/when to operate it
- If the next DER requires upgrade/mitigation, that next customer is responsible, even though it might enable many more customers to install DERs
- Utility compensates customers (e.g., net metering, fixed tariff)

Proactive DER planning

Give customers information about where the grid needs help and incentivize them

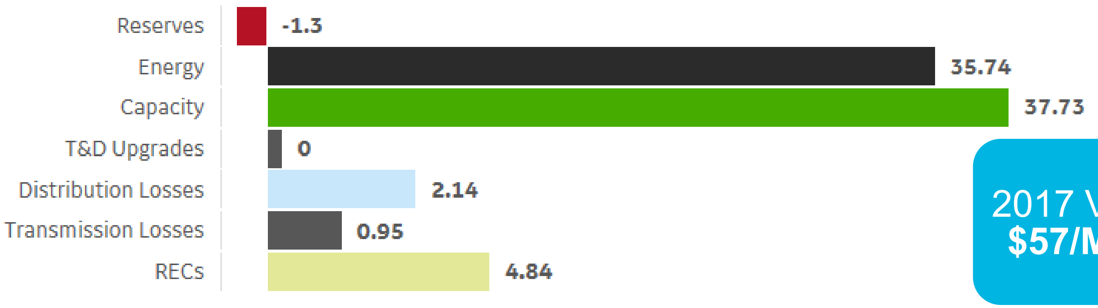
- Hosting capacity shows how much more DER can be managed on a given feeder easily, or where interconnection costs will be low/high
- Locational net benefits analysis helps determine the specific benefits of specific services at a specific location to guide developers
- Proactive upgrades of circuits that are likely to see DER growth
- Defer traditional infrastructure investments through non-wires alternatives that provide specific services at specific locations
- Assess true value of DER to inform rate- and tariff-making decisions
- Help prioritize DER and non-wires alternative solicitations
- Leverage third-party capital investments

Colorado Springs utility solar program design study

Problem: What **rate & structure** should CSU charge customers with PV?

Step 1: GE calculated the "Value of Solar" (VoS)

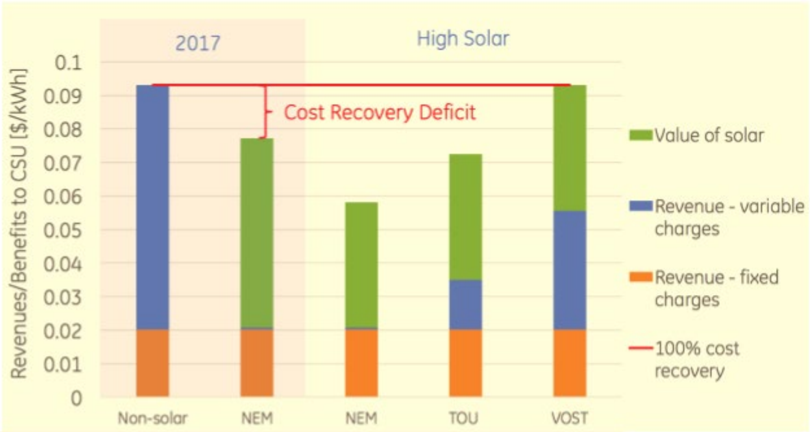
VoS = rate CSU pays for surplus PV power
= total value PV delivers CSU



2017 VoS = **$57/MWh**

Step 2: GE evaluated rate structure alternatives

Examples: time-of-use charge, demand charge, VoS tariff



	Non-solar	NEM	NEM	TOU	VOST
First year CSU deficit	0	$0.2M	$7M	$4M	0
25-year NPV of CSU deficit	0	$3M	$127M	$70M	0

NEM → VoS tariff
100% cost recovery

DER location, size, time of use determine value

Battery integration example

Integrating wind, solar and storage in India

FUNDED BY USTDA & IL&FS DEVELOPMENT

25MW + 16MW + 10MW/ 15MWh

Problem: Does co-located wind, solar + storage have development value?

GE Energy Consulting led analyses …

- Technical design
- Cost-benefit analysis
- Financing plan
- Environmental and social impact plan
- Policy recommendati

… to identify benefits:

- Costs: co-location synergies
- Energy: energy shifting/congestion mgt
- Reliability: fault recovery, frequency response, black start, voltage regulation
- Transmission: lower limits

Techno-economic modeling to quantify value of combining renewables with batteries

https://www.geenergyconsulting.com/insights/hybrid-wind-solar-storage-powerplant

Mitigating Challenges with Integrating Renewables

- Trends of **decarbonization, digitization, decentralization, and electrification**
- Integrating renewables technologies, especially DERs, introduce new challenges that require a **back to fundamentals** approach with an emphasis on **locational and sequential time analysis**
- Traditional supply and demand planning for those few peak load hours of the year does not adequately address resource adequacy
- **Visibility and control** are needed to appropriately recognize the value of DERs