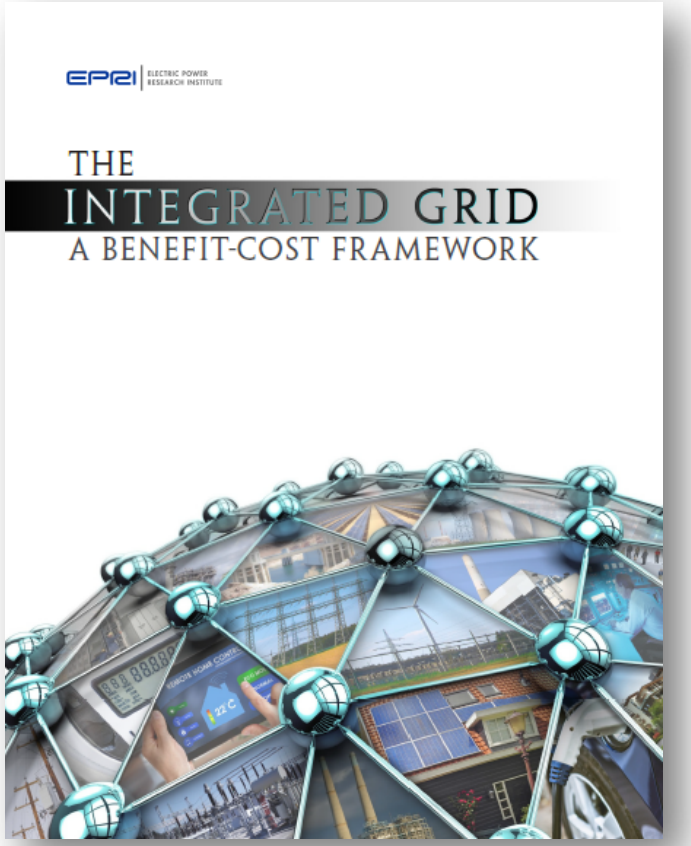
Time and Locational Value of Distributed Energy Resources: Methods & Applications

Jeffrey D. Roark
Technical Executive
Power Delivery & Utilization, EPRI

Energy Policy Roundtable
September 28, 2016

EPRI's Study: "Time and Locational Value of DER: Methods and Applications"

- **Used the EPRI Benefit-Cost Framework**
  - *Objective, reproducible*
  - *Assesses impacts of interconnected DER*
  - *Estimates value/cost to society*
- **Two DER Interconnection Scenarios**
  - *DER only to meet all load growth*
  - *DER at customer discretion*
- **Modeled Actual Systems**
  - *Two systems: Con Edison Mesh and SCE Flexible Radial*
  - *Studied 10-year period to align with distribution planning timeframe*

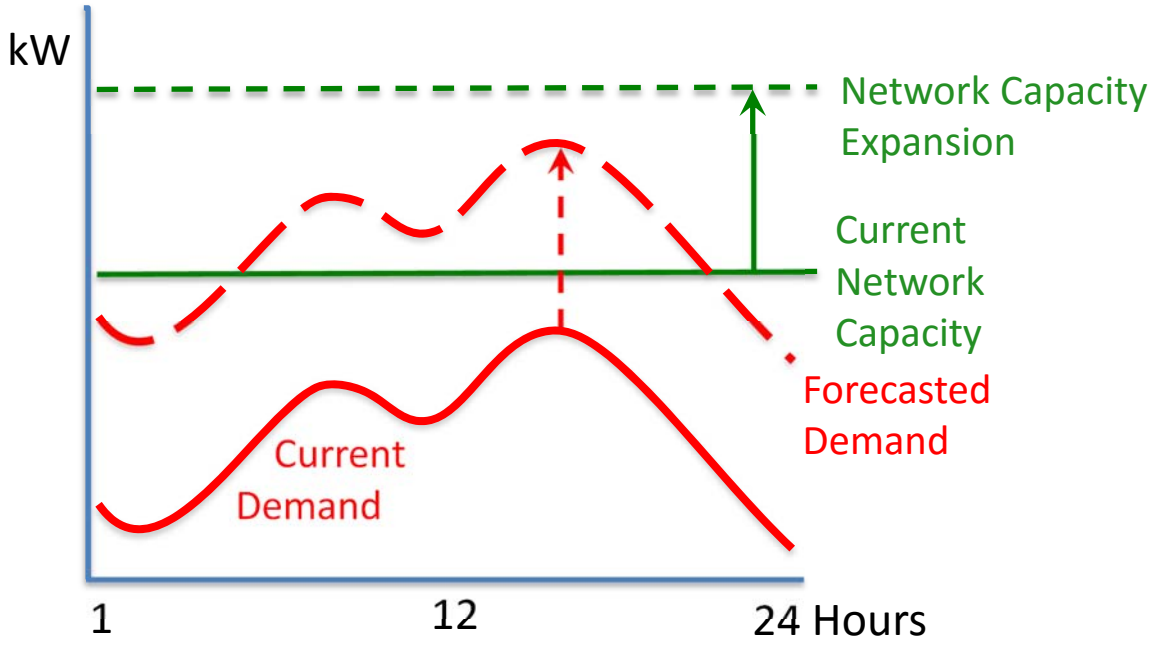


Asks whether DER can economically replace or avoid investments otherwise needed to accommodate growth.

Note: *Companion study conducted by Sue Tierney, The Analysis Group. "The Value of "DER" to "D": The Role of Distributed Energy Resources in Supporting Local Electric Distribution Reliability."*

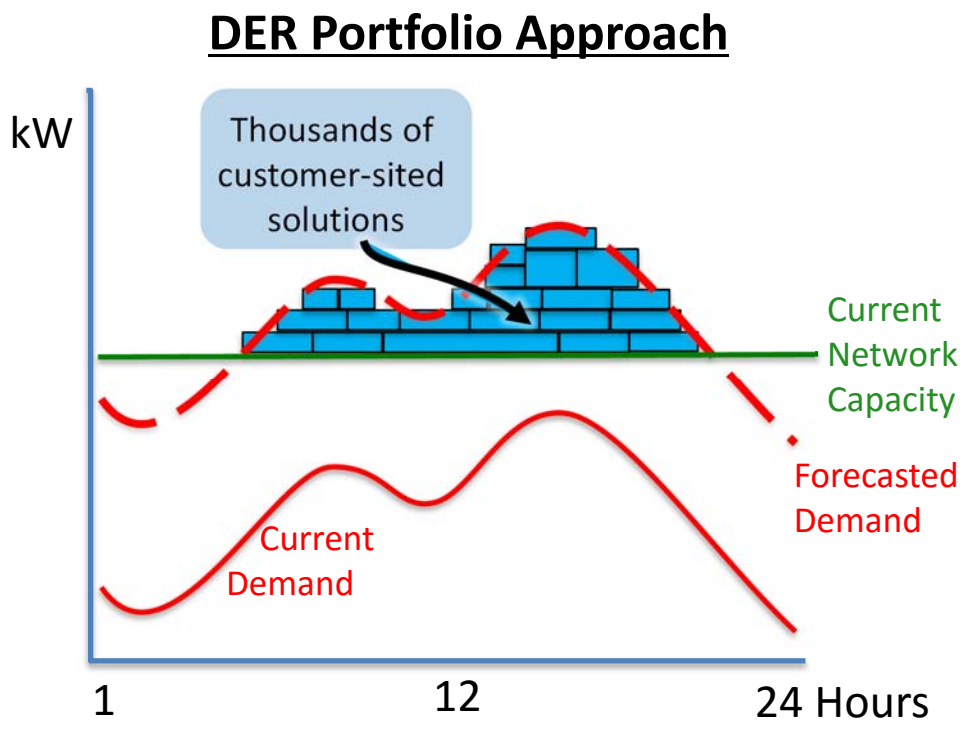
Concept: Deferral of Distribution Upgrades with DER

Traditional Approach



- Expand infrastructure to keep up with load growth

Concept: Deferral of Distribution Upgrades with DER

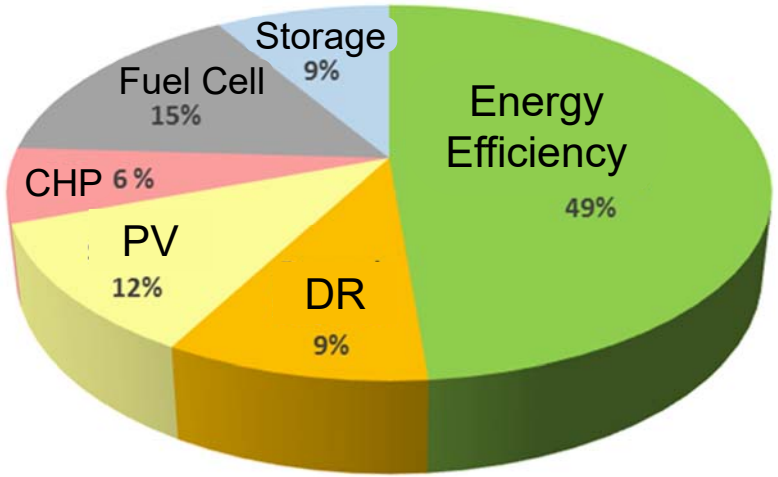


- Assemble a **portfolio** of DER technologies to shave peak.
- Peak load **duration** matters.

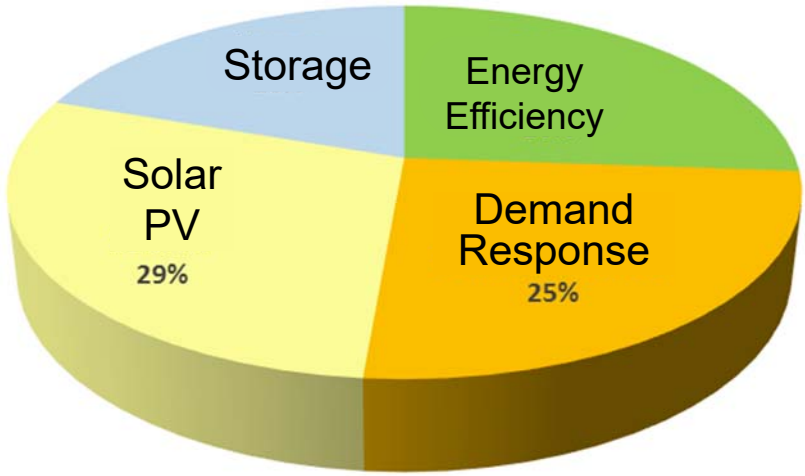
Time

Study assembled DER portfolios based on technology, customer, and system load-curve characteristics for both Con Edison and Southern California Edison

Con Edison Case Study Portfolio

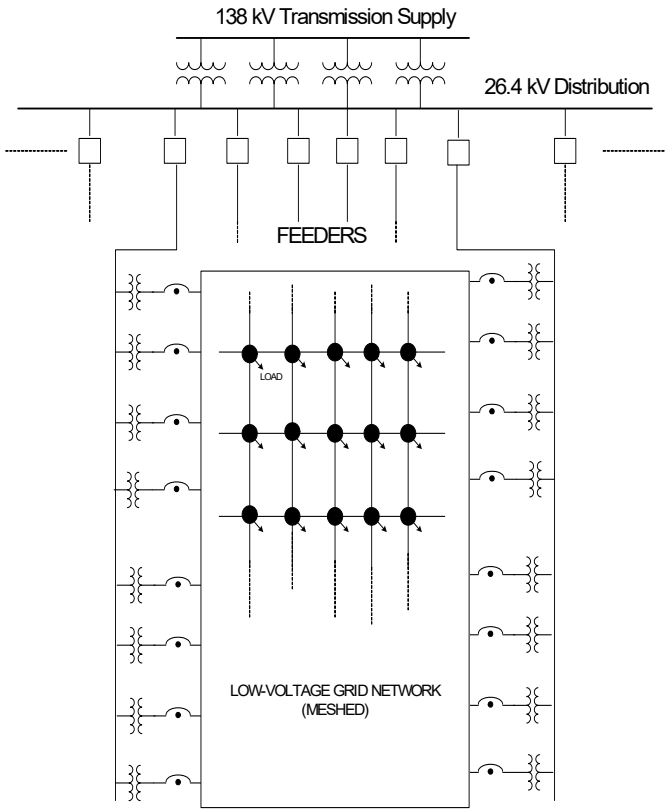


SCE Case Study Portfolio

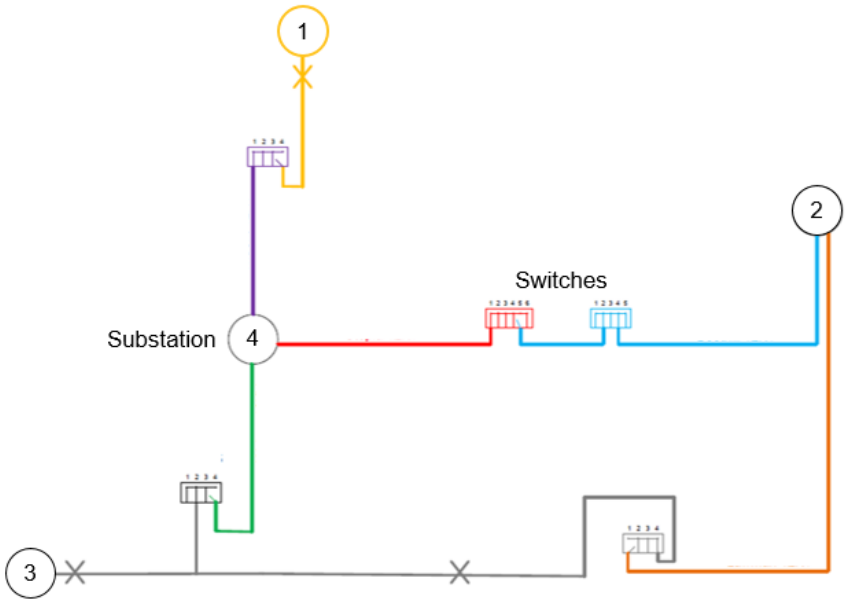


Two very different portfolios demonstrate the methodology.

The Systems:
Mesh Network vs. Flexible Radial Topologies



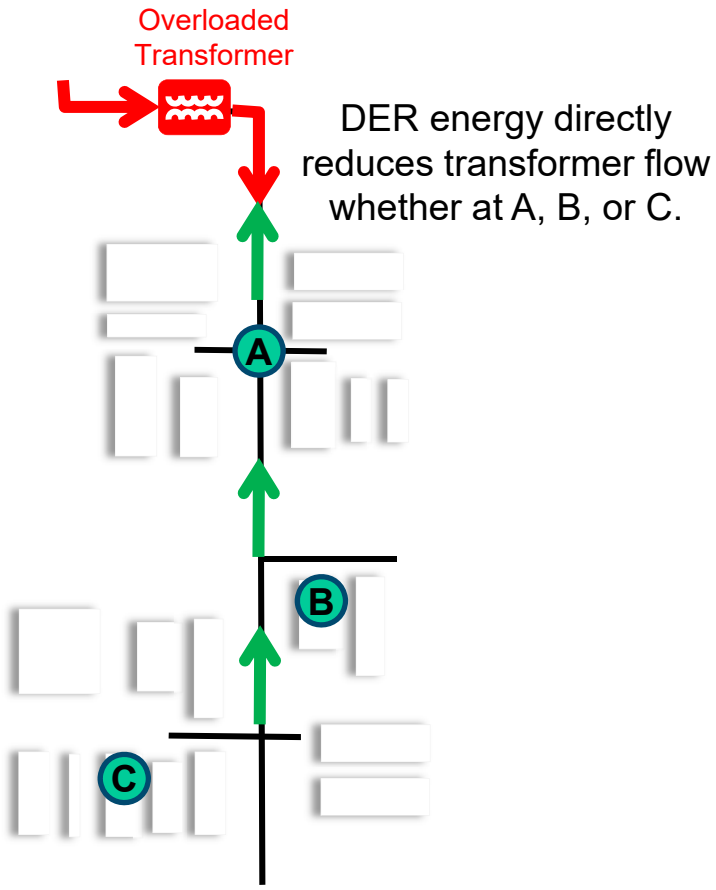
Mesh Network System
(Con Edison)



Flexible Radial System
(SCE)

Two very different systems demonstrate the methodology.

Network systems present challenges when targeting DER to address specific distribution violations

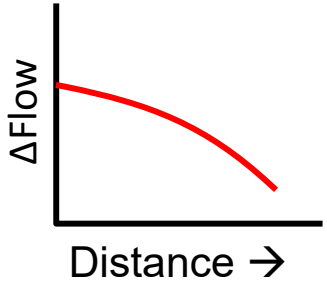


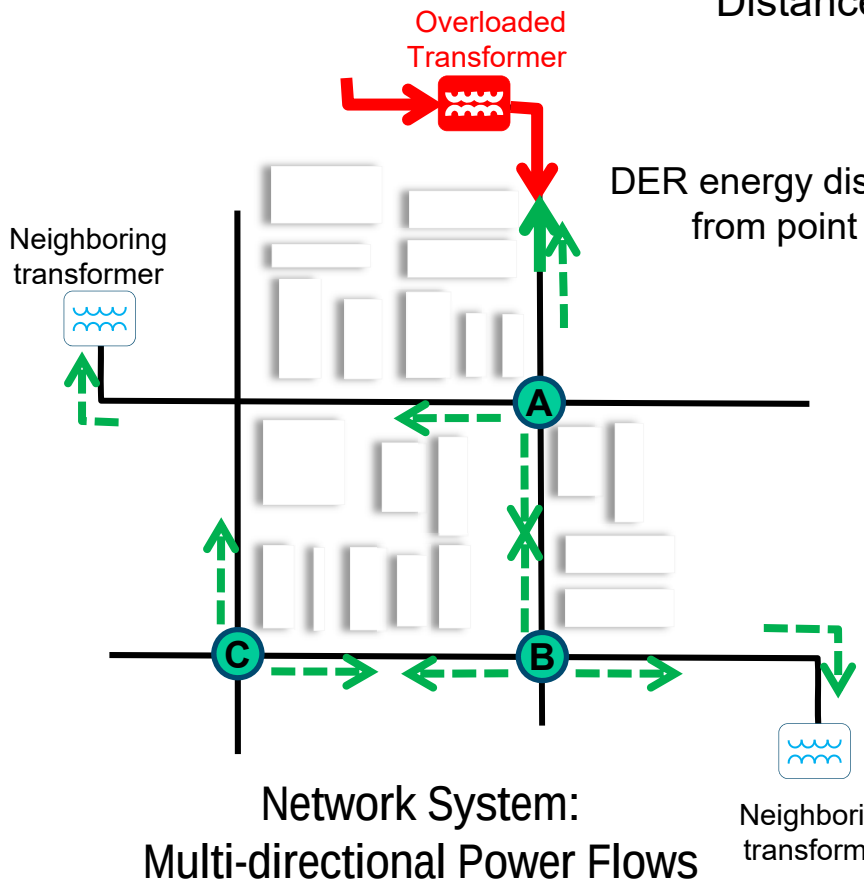
DER energy directly reduces transformer flow whether at A, B, or C.

Simple Radial System:
Unidirectional Power Flows

Locational Sensitivity

Effectiveness degrades with distance.

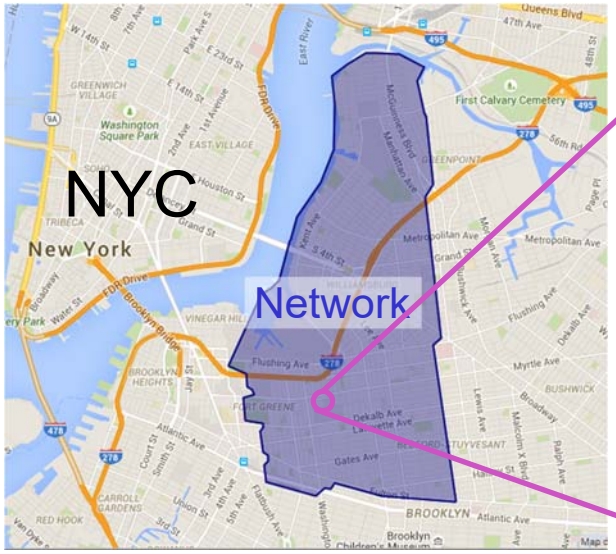


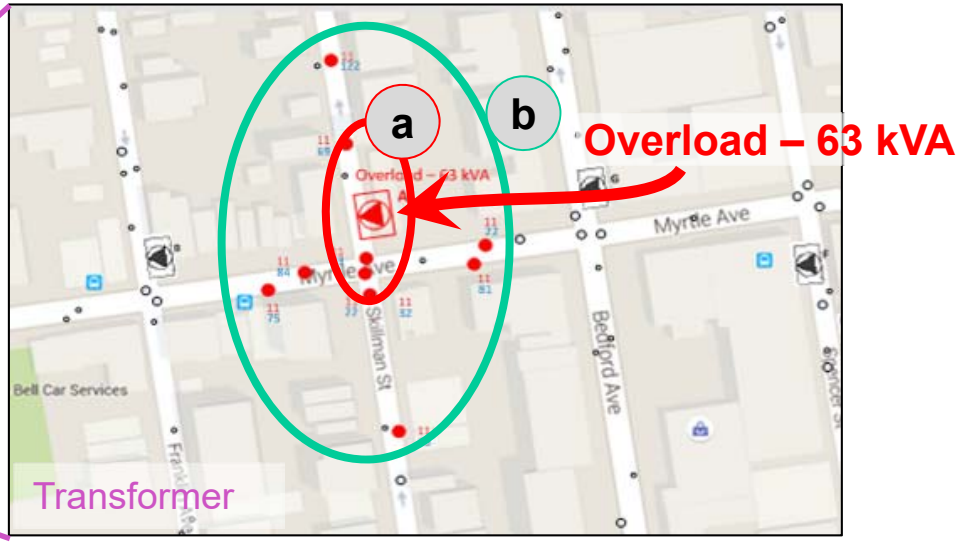


DER energy disperses from point A.

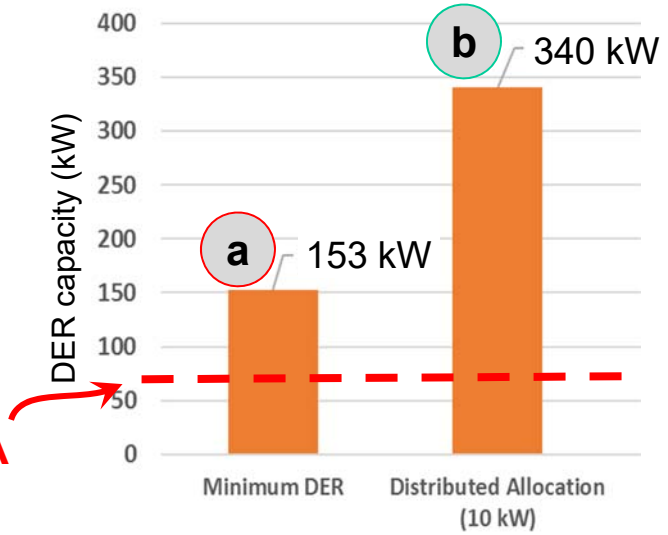
Network System:
Multi-directional Power Flows

EPRI modeling reveals significant locational sensitivity in the local distribution system





In the network, DER portfolios must be tightly situated near the distribution violation to be effective at relieving it.



EPRI ELECTRIC POWER RESEARCH INSTITUTE

Economic Evaluation of Alternative Distribution Plans

Modeling Assumptions and Outputs

Bulk-system characteristics
LMP & Carbon cost rates
Capacity cost rates

Distribution-system/feeder
Energy growth
Load shape

One of:

- 10-year distribution upgrade plans to satisfy voltage, capacity, and protection constraints
- 10-year DER plans to satisfy voltage, capacity, and protection constraints

Economic Analysis Outputs

Cost of serving load growth:

- Energy cost (load and losses)
- Capacity cost
- Carbon cost

Cost of distribution upgrades:

- Asset ownership costs (revenue requirements)
- O&M costs

Cost and value of DER:

- Equipment cost (Utility procurement)
- Net energy value
- Loss-reduction value
- Carbon-reduction value
- Avoided capacity value

Cost Normalized to Load Energy Growth

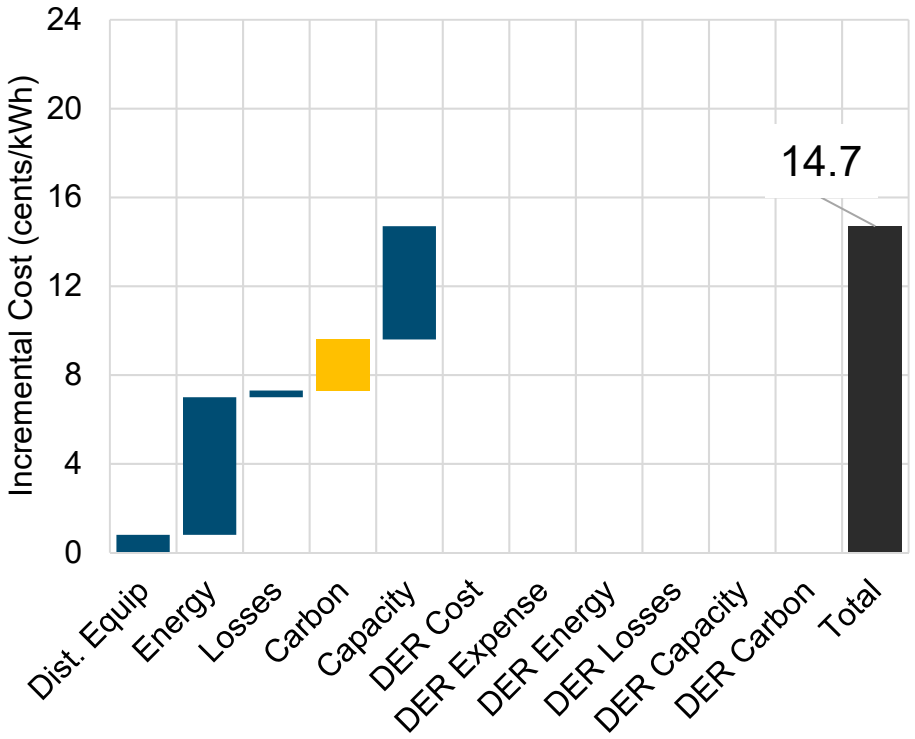
Load Cost ($/kWh$_{grth}$)

Accom-modation ($/kWh$_{grth}$)

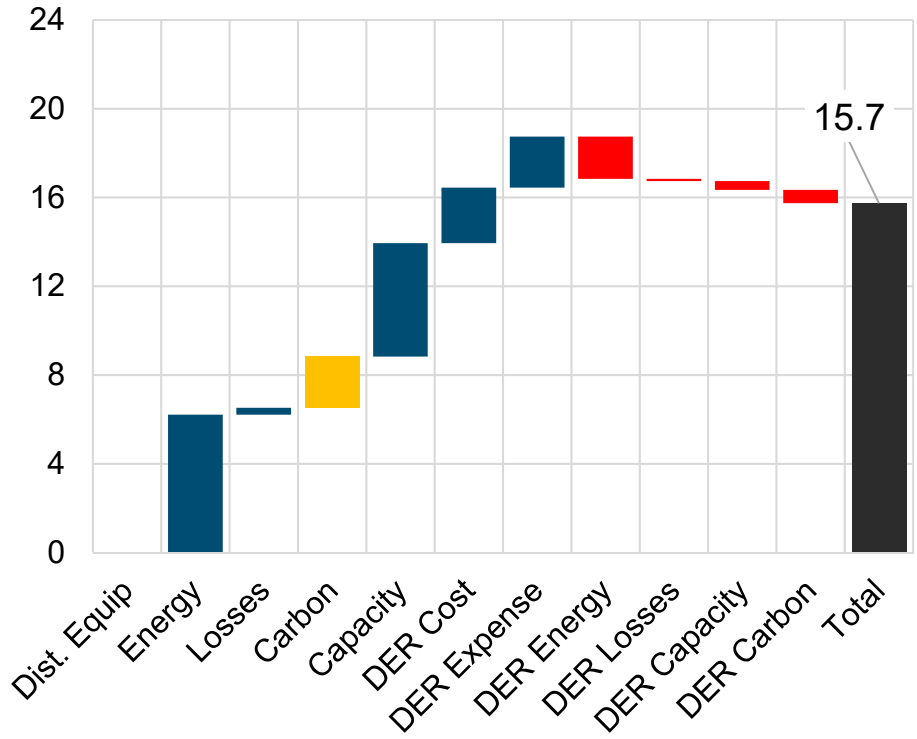
Incremental Cost to Serve Growth in Load ($/kWh$_{grth}$)

In this study we estimated the cost to serve load *growth*.

Comparison of Costs for Con Edison Portfolio and Mesh Distribution Network w/No Headroom



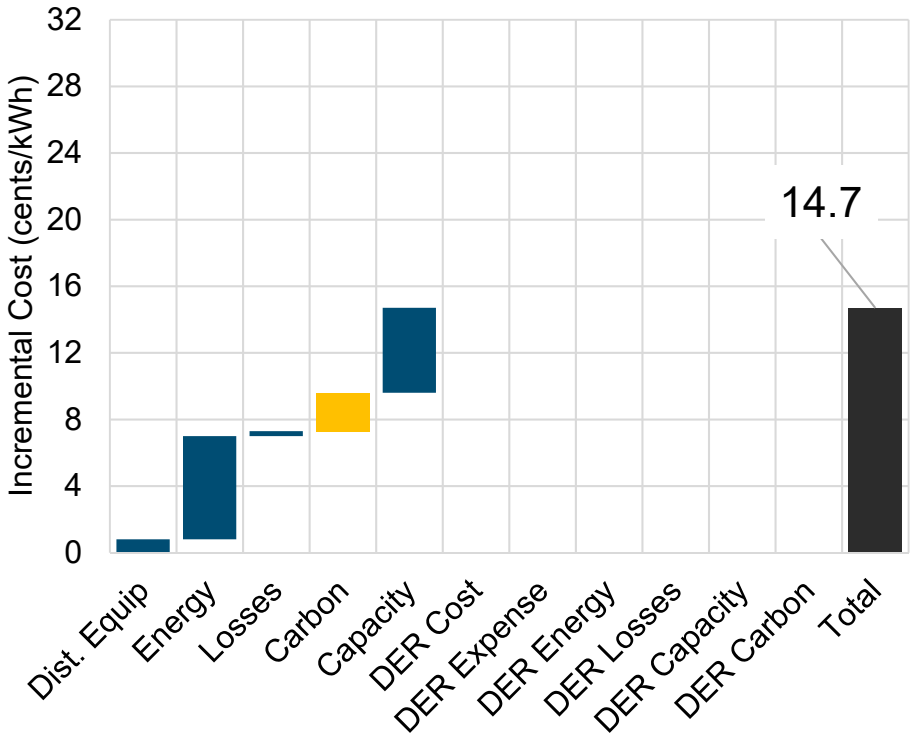
Cost to Meet Load Growth – Traditional Utility Solution



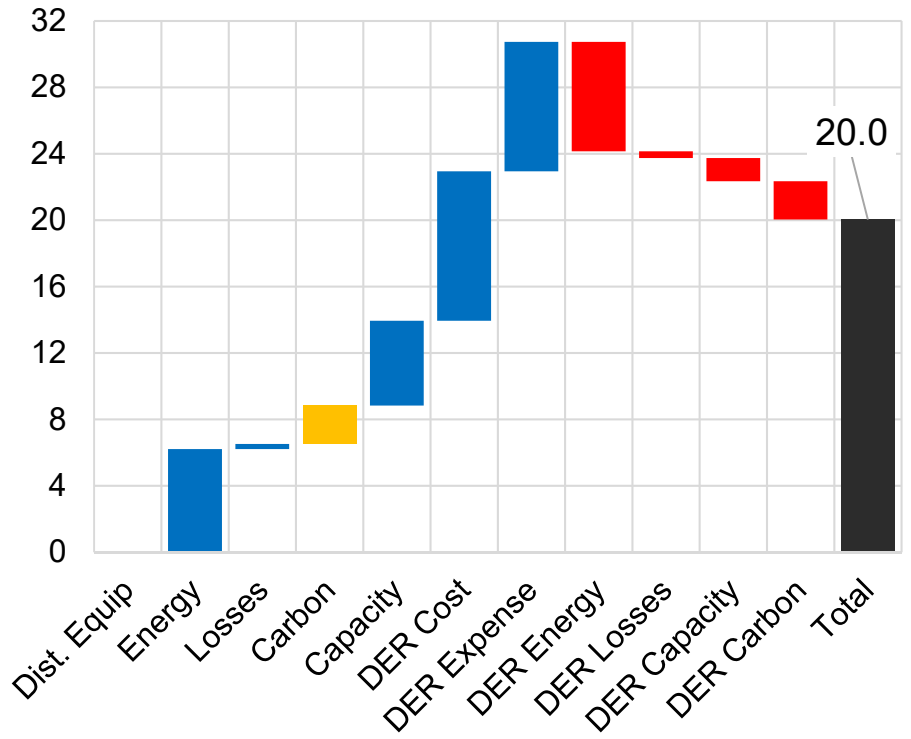
Cost to Meet Load Growth – DER Solution No Headroom

DER solution's net cost is slightly higher than traditional solution, but leaves the circuit with no headroom.

Comparison of Costs for Con Edison Portfolio and Mesh Distribution Network w/10% Headroom



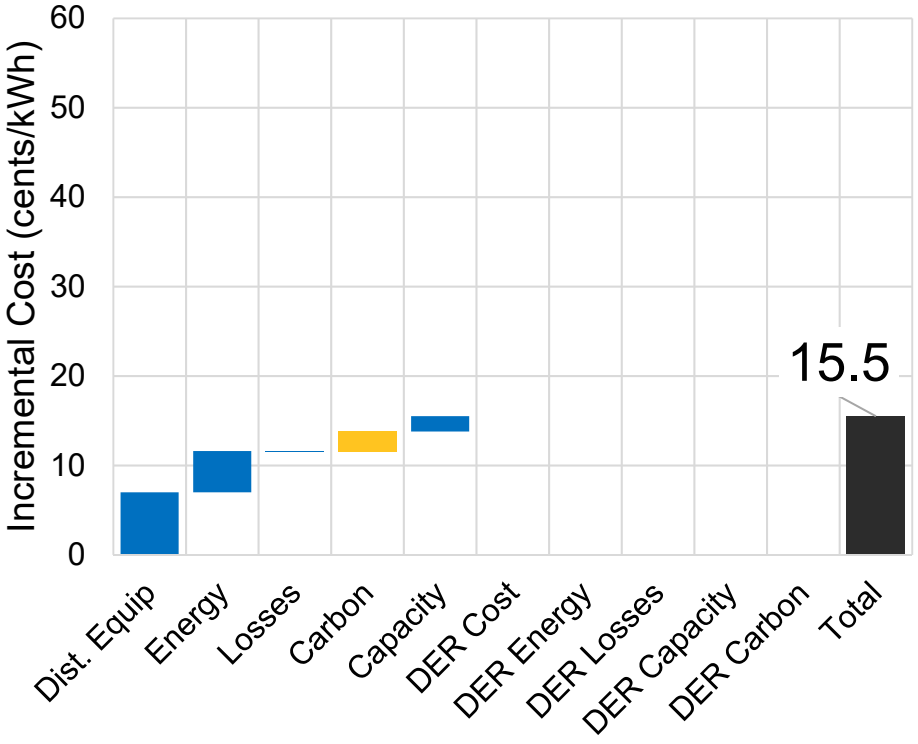
Cost to Meet Load Growth – Traditional Utility Solution



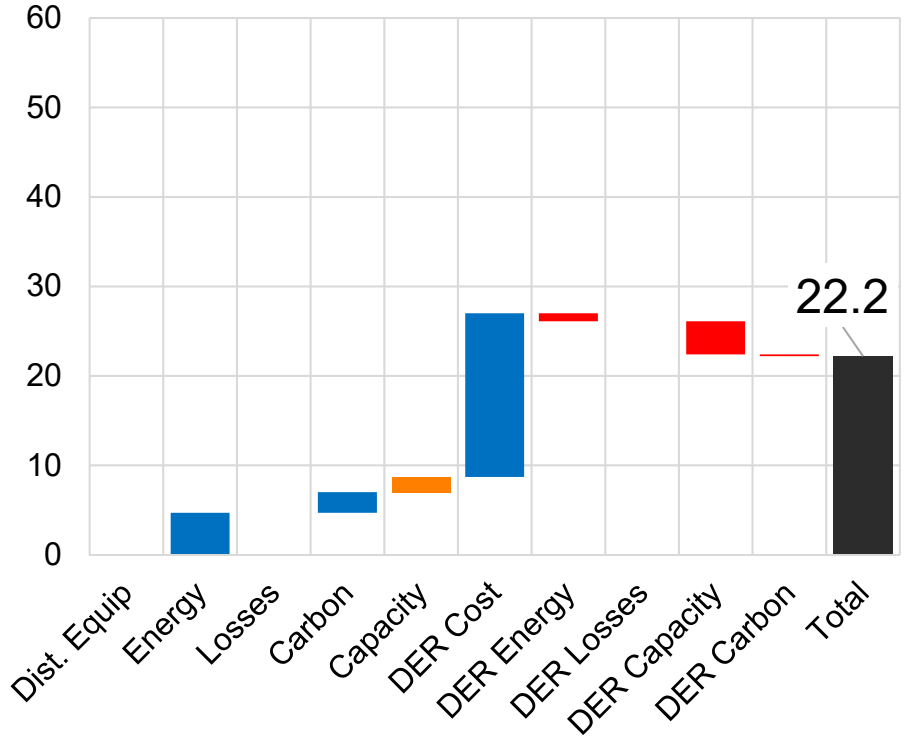
Cost to Meet Load Growth – DER Solution 10% Headroom

Providing similar headroom with DER was more expensive, caused in part by greater dispersion of DER energy.

Comparison of Costs for SoCal Edison Portfolio and Flexible Radial System



Cost to Meet Load Growth – Traditional Utility Solution



Cost to Meet Load Growth – DER Solution Without Preserving Flexibility

The *normalized* cost of the DER portfolio in the SCE case was substantially higher and its energy contribution less.

Time and Location Value of DER: Conclusions from Study

- **Time and location**al impacts are key determinants in valuing DER.
- It is **hard to generalize** the net benefits of DER as an alternative to conventional grid.
- Comprehensive, consistent, and transparent **methods** are required for consistent and sensible results.

Together…Shaping the Future of Electricity

Jeffrey D. Roark
Technical Executive

Electric Power Research Institute
3379 Lakewind Way
Alpharetta, GA 30005
678-325-8971
jroark@epri.com