

Planning and Operating an Integrated Grid

Harvard Electricity Policy Group
March 2015

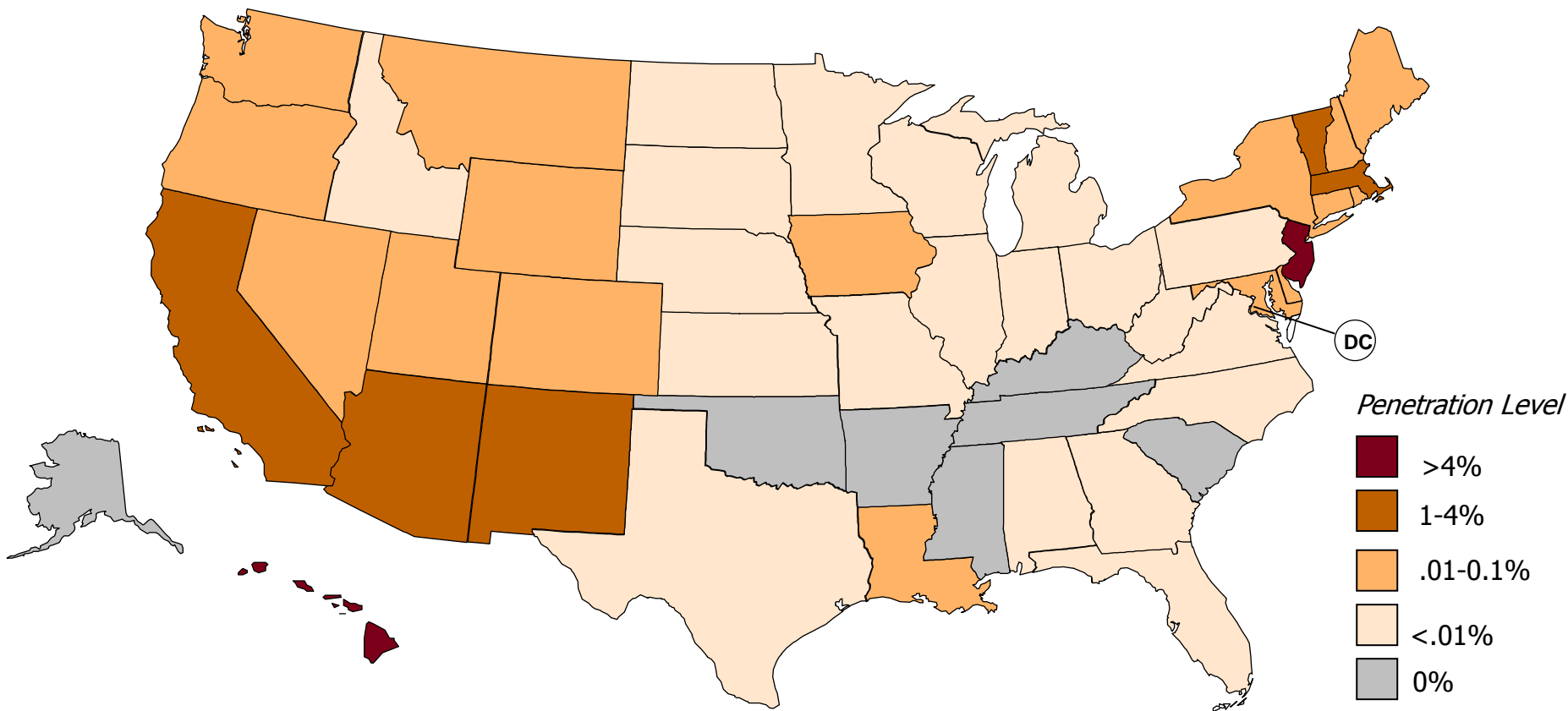
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EPRI



Distributed Energy Resources and Distribution Systems

- Do we need an Independent Distribution System Operator (DSO)
- Should LMP pricing be employed?
- Should Smart Inverters be Required?
- **What Planning and Operational Processes are Needed**

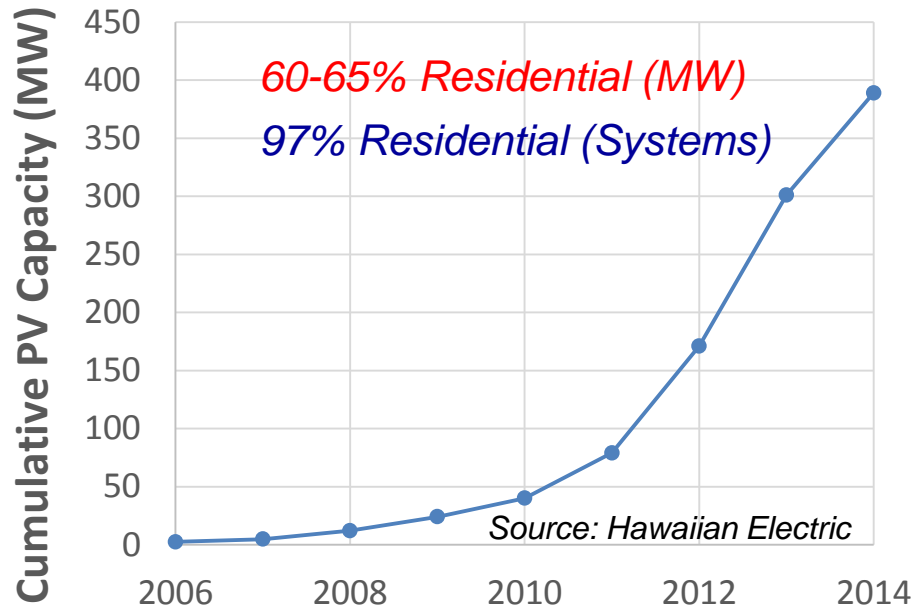
Distributed Solar Penetration by State



- Aggregate U.S. PV Penetration: ~1%...
- ... But PV growth occurring in nearly all states
 - Key Drivers: 1) economics, 2) policy mandates, 3) financing options

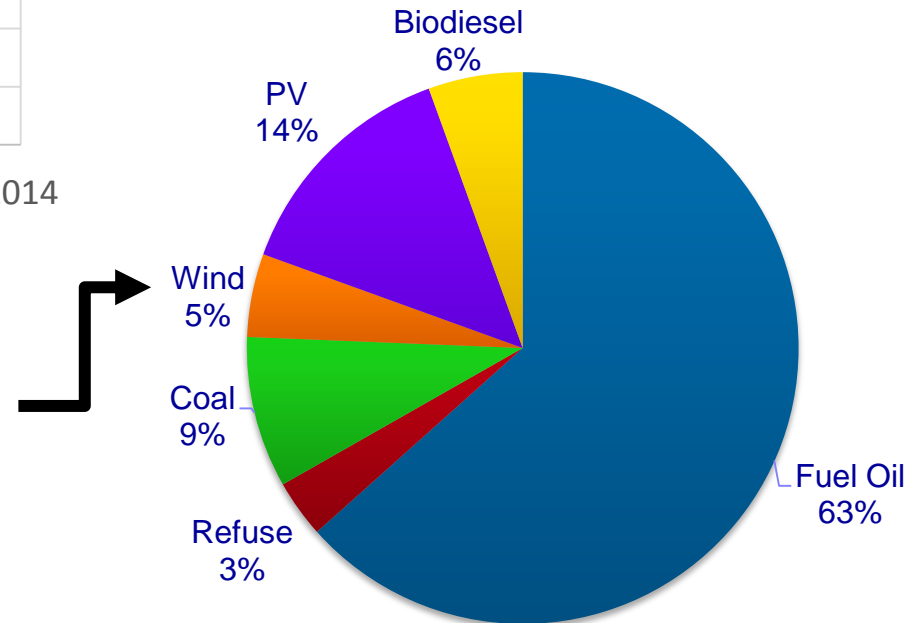
Sources: Bloomberg New Energy Finance, EIA

Recent PV Growth in Hawaii



Rapid growth of residential PV over the last 3-4 years

Hawaiian Electric Generation Capacity by Fuel Type

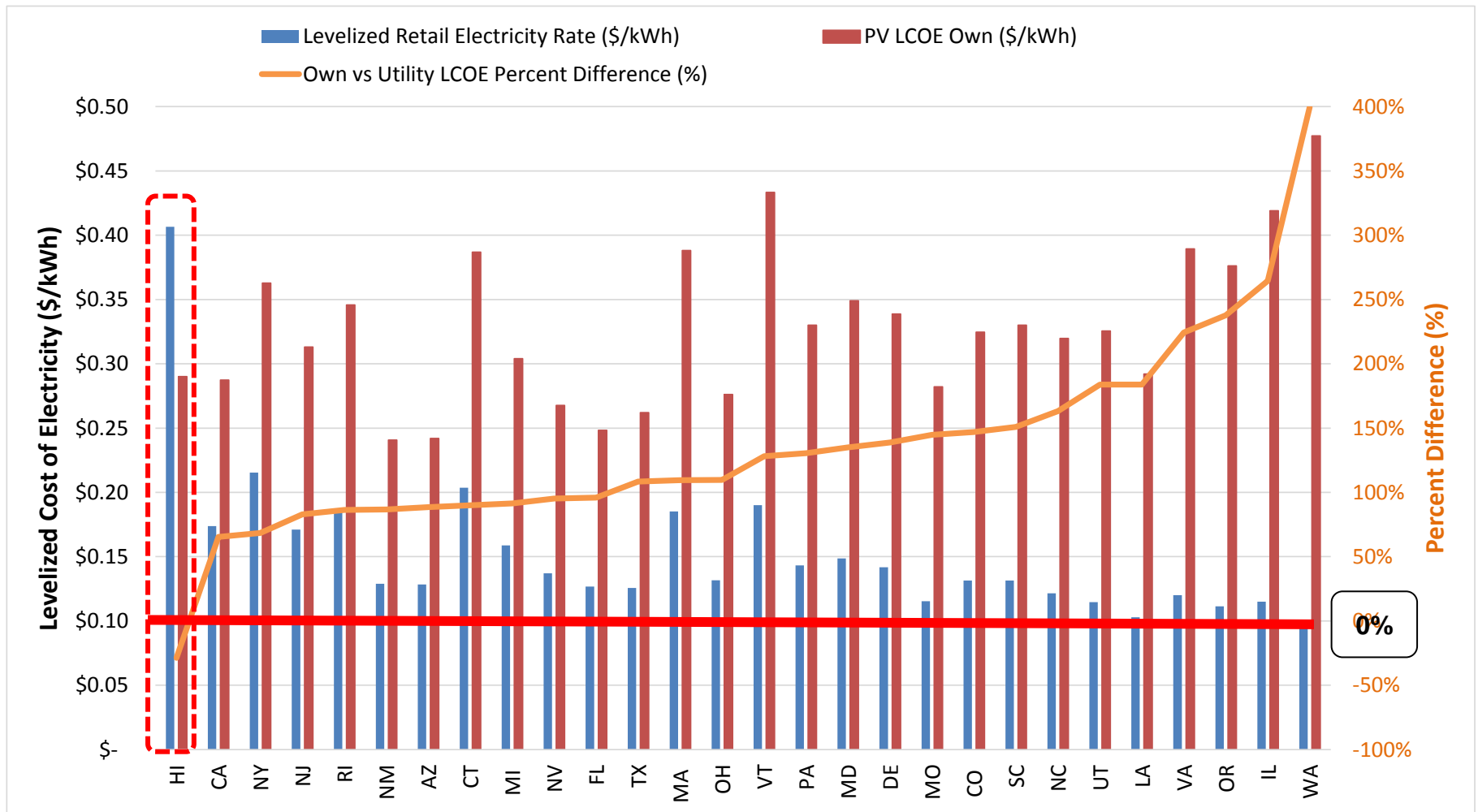


During the daytime, PV could be supplying 25-30% of demand

Source: Hawaiian Electric PSIP

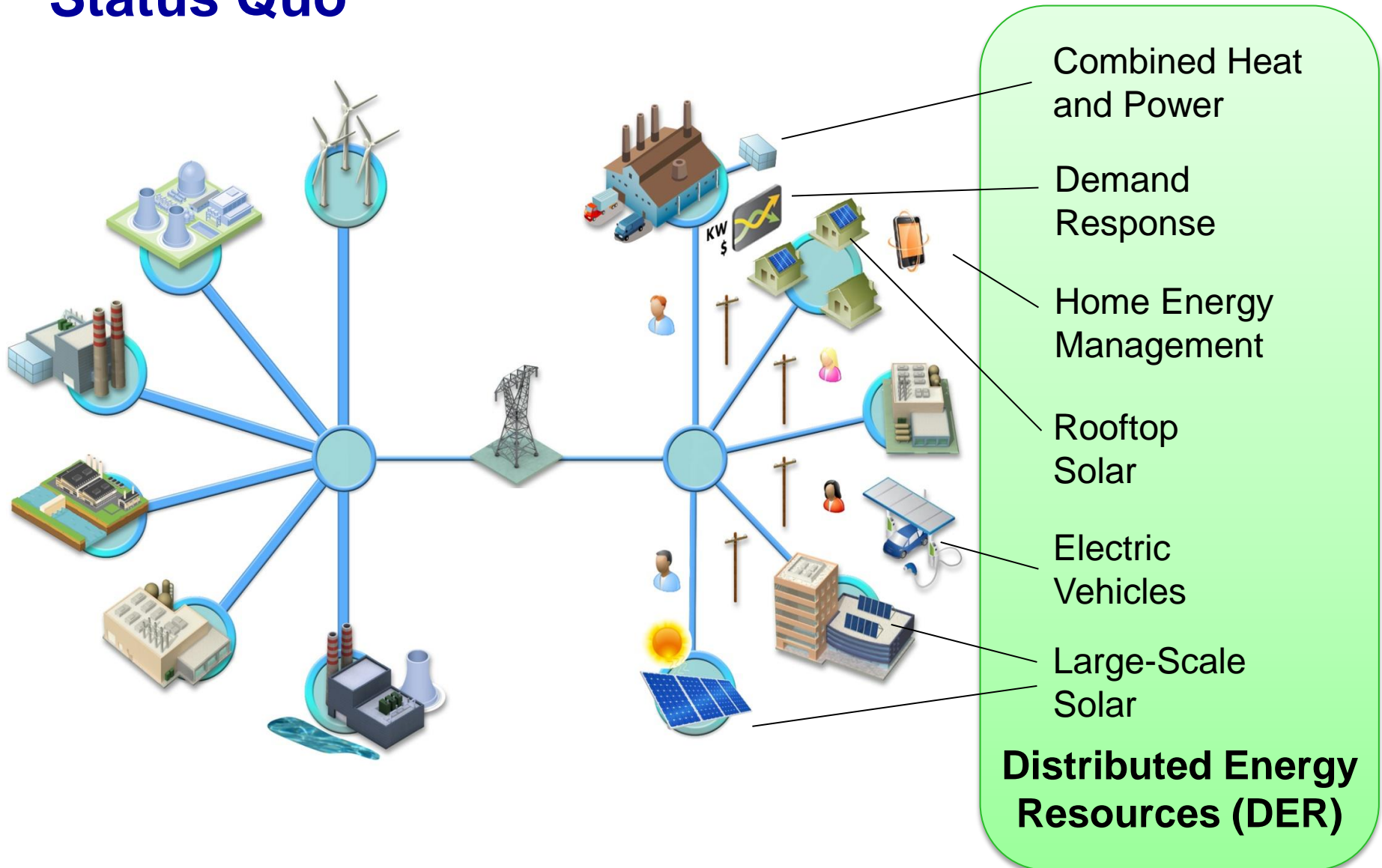
Assessing PV Retail Rate Parity Across U.S. States

PV LCOE (Own) vs. Retail LCOE



Notes: Data from 3rd party installers of avg. all-in install price to end customers for systems 1-10kW. Prices are averages over past 6 mos. (Mar-Aug, 2014). Different samples sizes per state. No rebates or incentives included in price points. Lease data is derived from a variety of structures (e.g., fixed, % escalation, etc.). Avg. capacity factors used for individual states.

Its Not Just Solar That is Disrupting the Sector Status Quo



Strategic Planning with DER

Research Questions

Net Benefits of (DER)?

Storage Deployment?

Community Solar?

Smart Inverter?

Proactively Upgrade?

Core Assumptions

Study Timeframe

Regulatory Framework

Resource Mix

Expected DER Growth

Environmental Impact

Principles

Bottom-up Impact Analyses

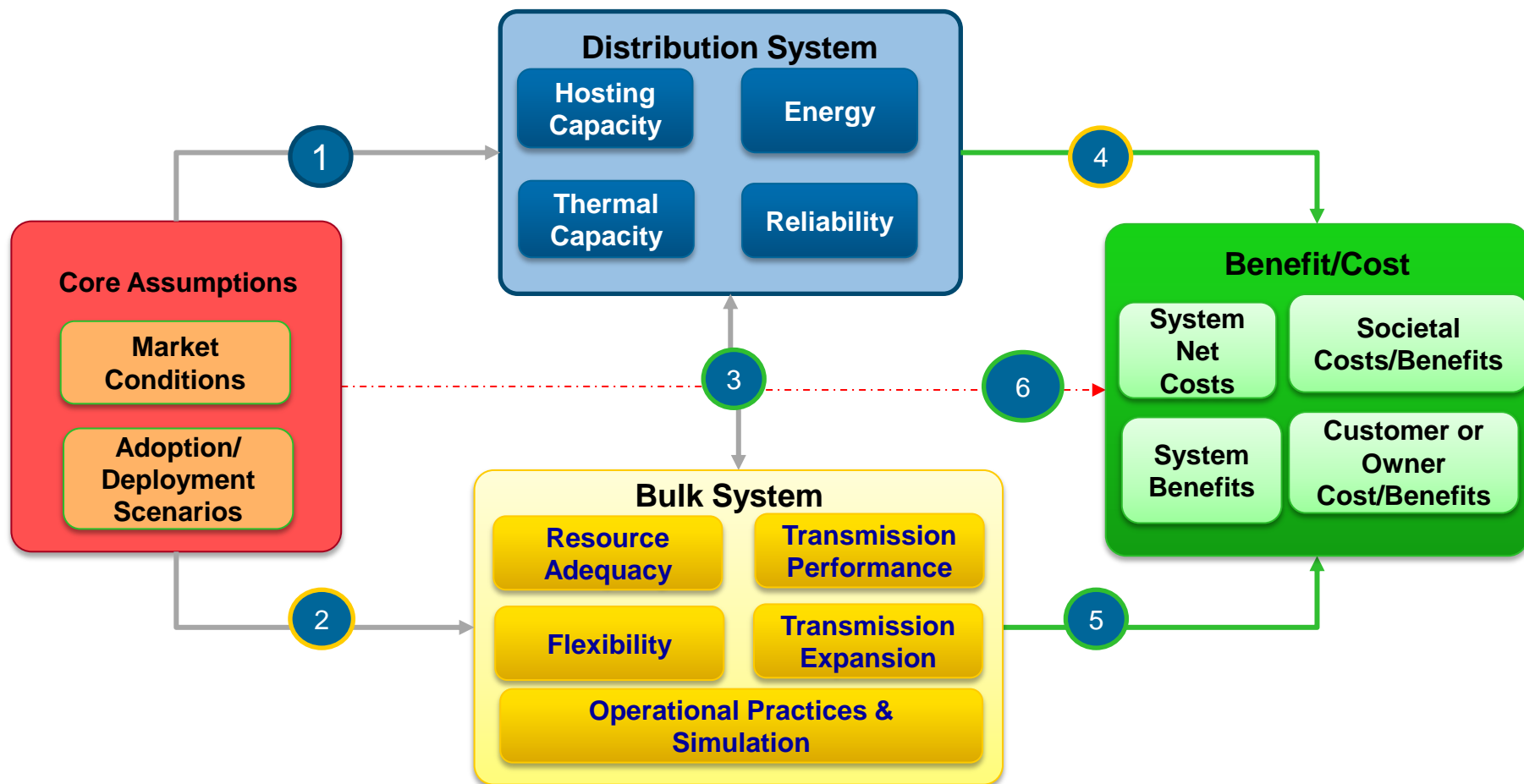
Accommodation at all Levels

Count all Benefits/ Cost, but Only Once

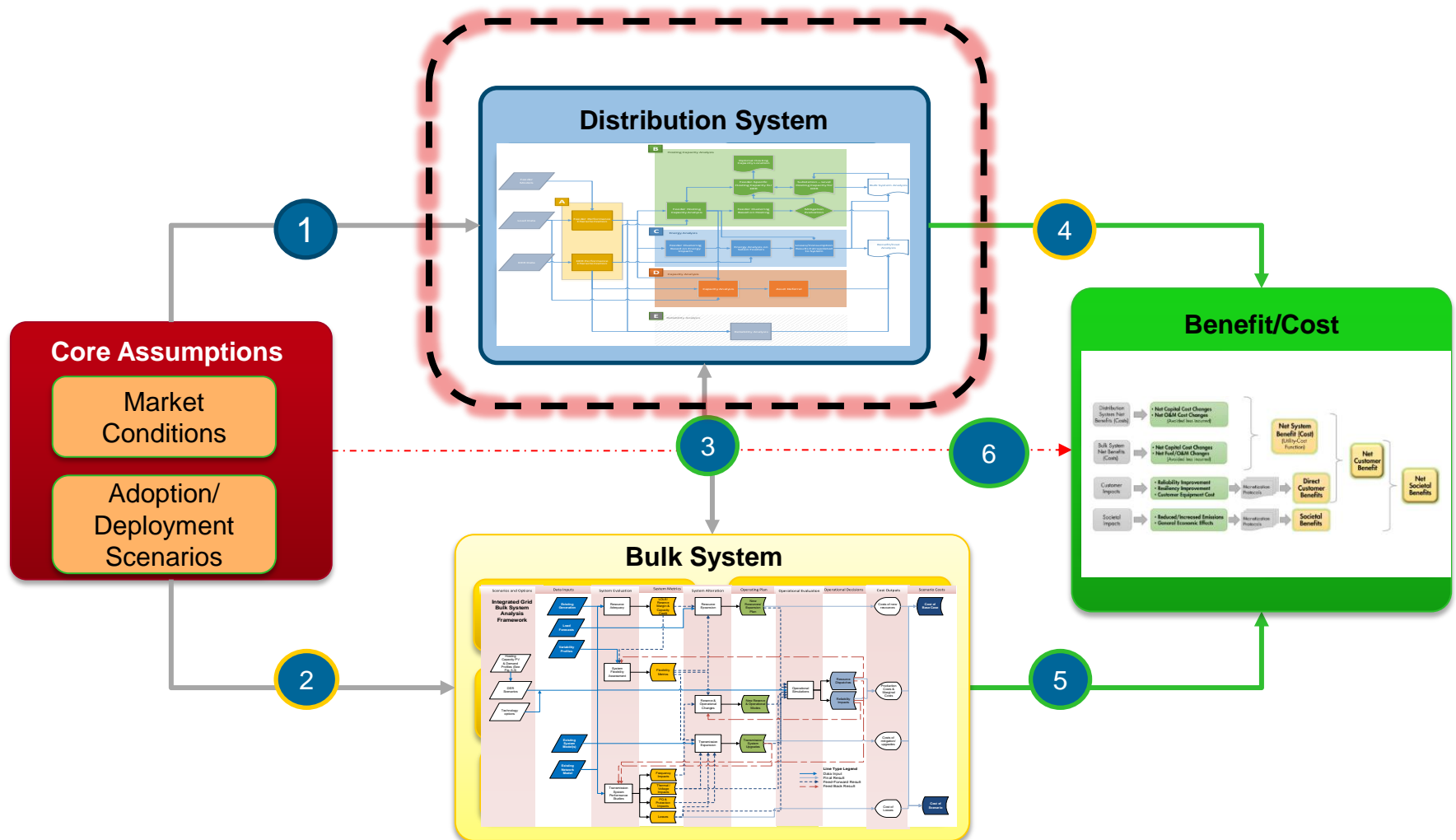
Multiple Perspectives on Net Benefits

Analytical process must be consistent, repeatable, and transparent

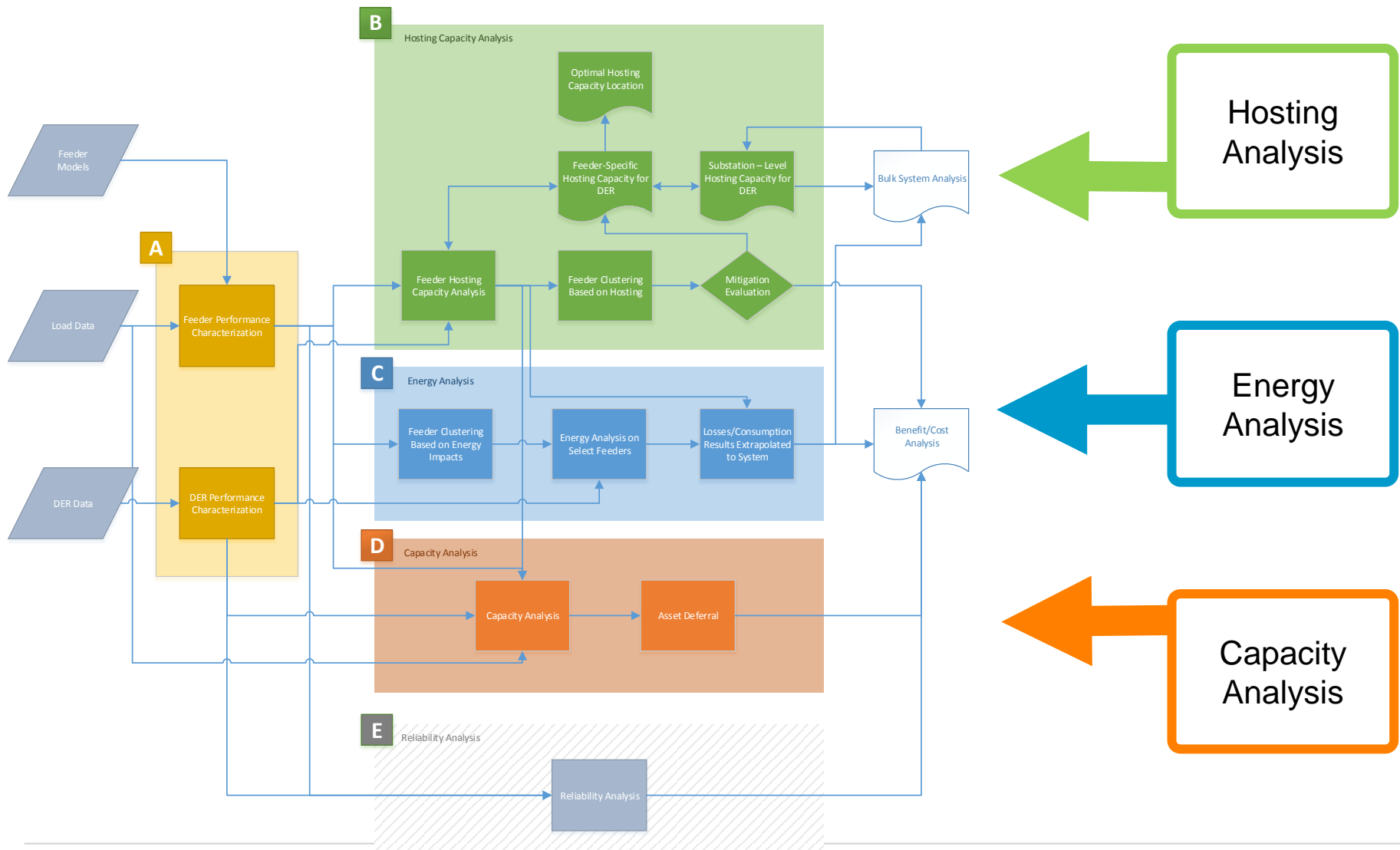
EPRI's Integrated Grid Benefit-Cost Framework



Integrated Grid Benefit Cost Framework

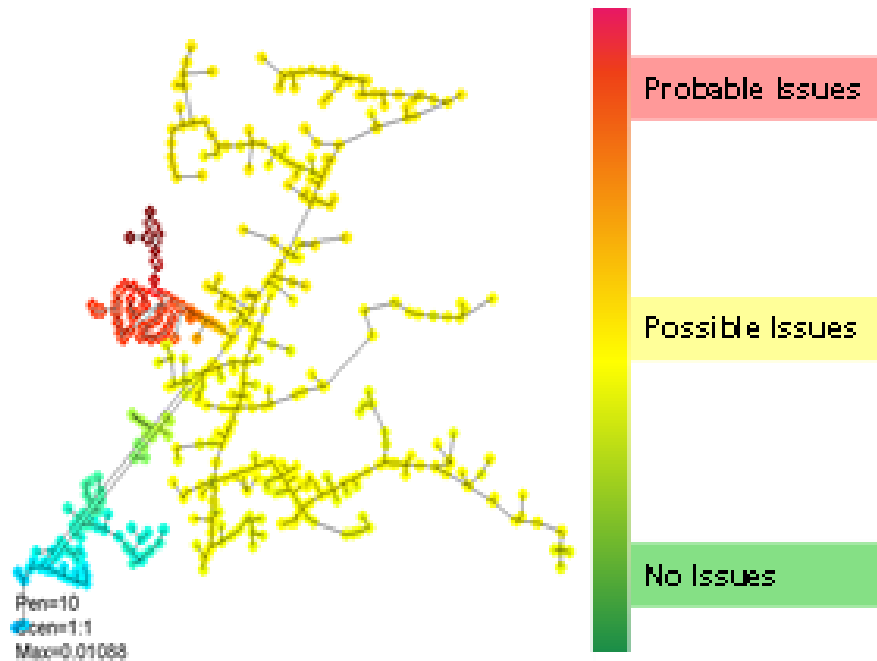


Distribution Framework Flowchart



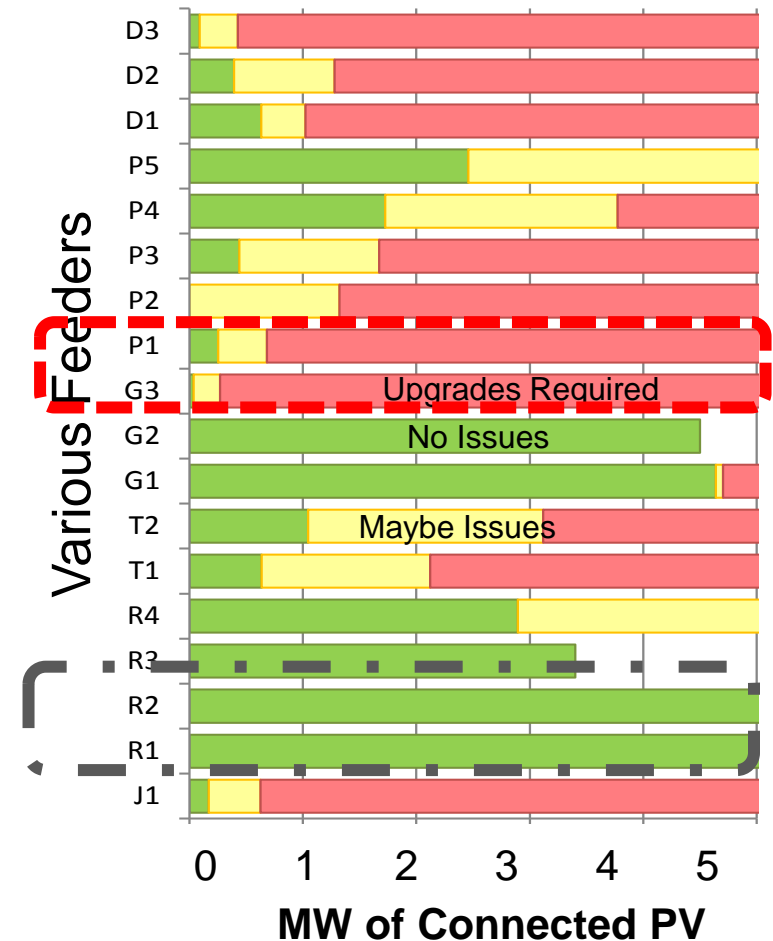
Hosting Capacity: How much PV can a feeder accommodate before needing upgrades?

Location may be the driver

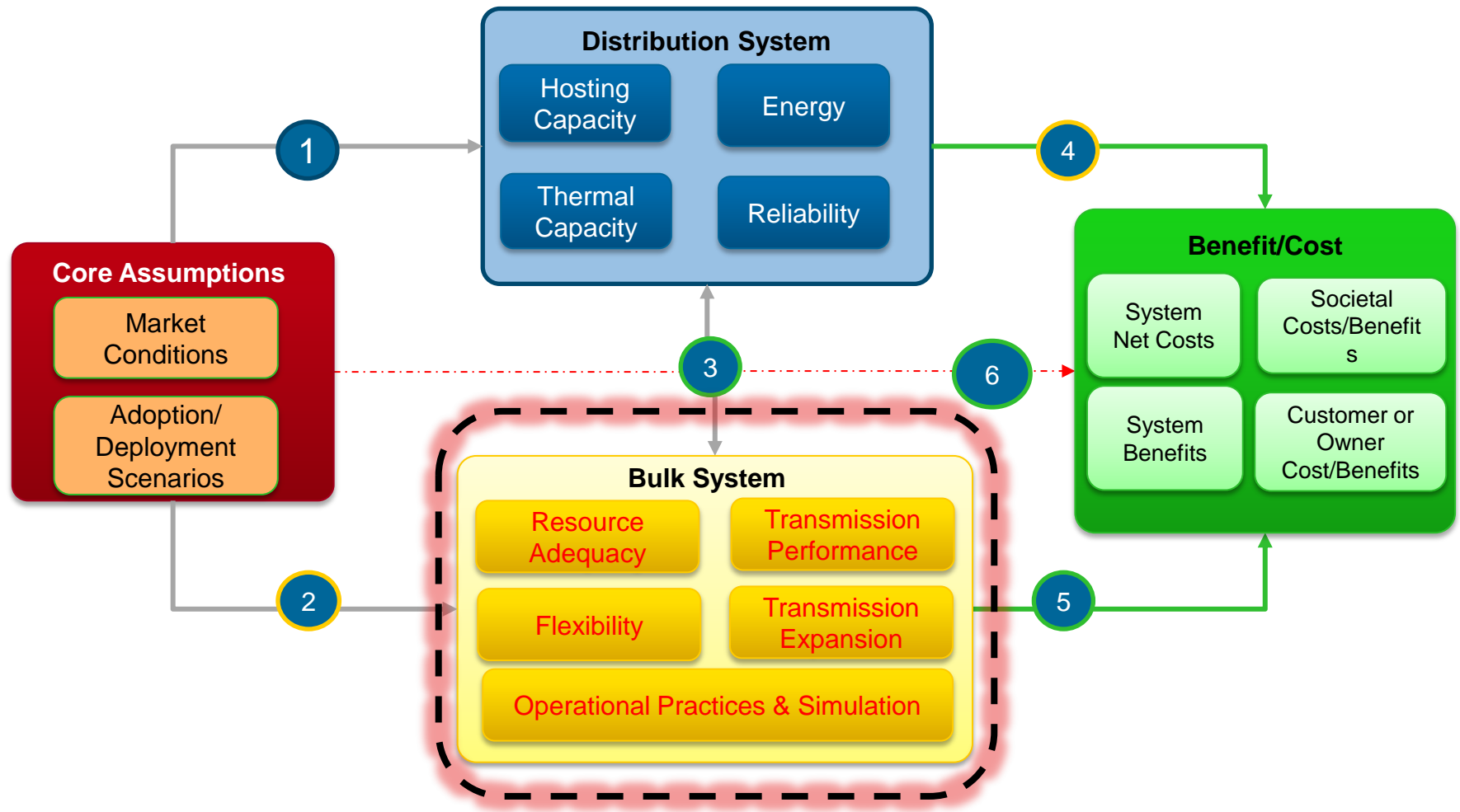


* Streamlined Methods for Determining Feeder Hosting Capacity for PV, EPRI, Palo Alto, CA: 2014. 3002003278

Accommodation can be load dependent



Integrated Grid Benefit Cost Framework



Integrated Grid: Bulk System Analysis

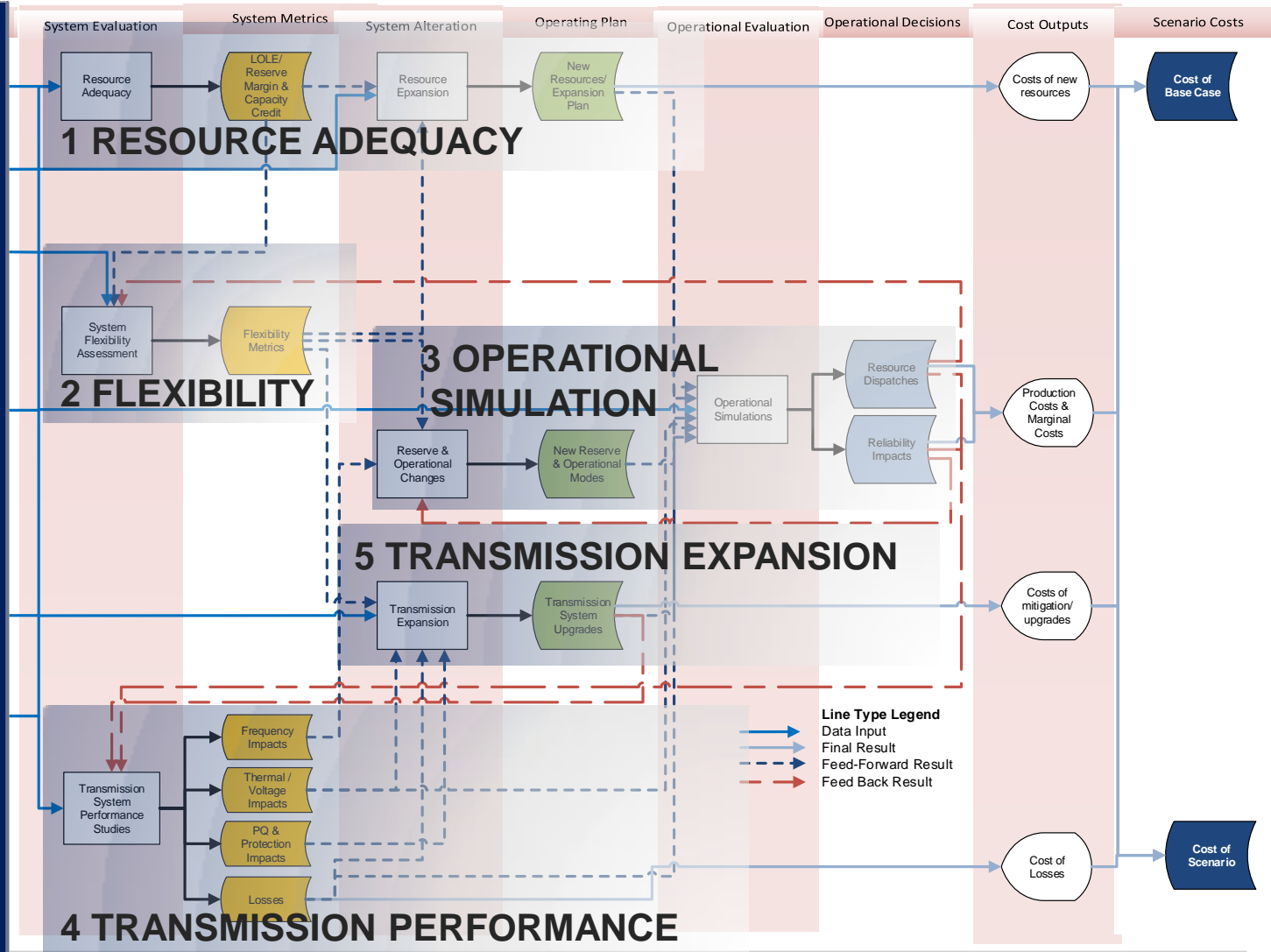
5 TRANSMISSION EXPANSION

Value:

Evaluates potential Trans expansion options to ensure performance levels

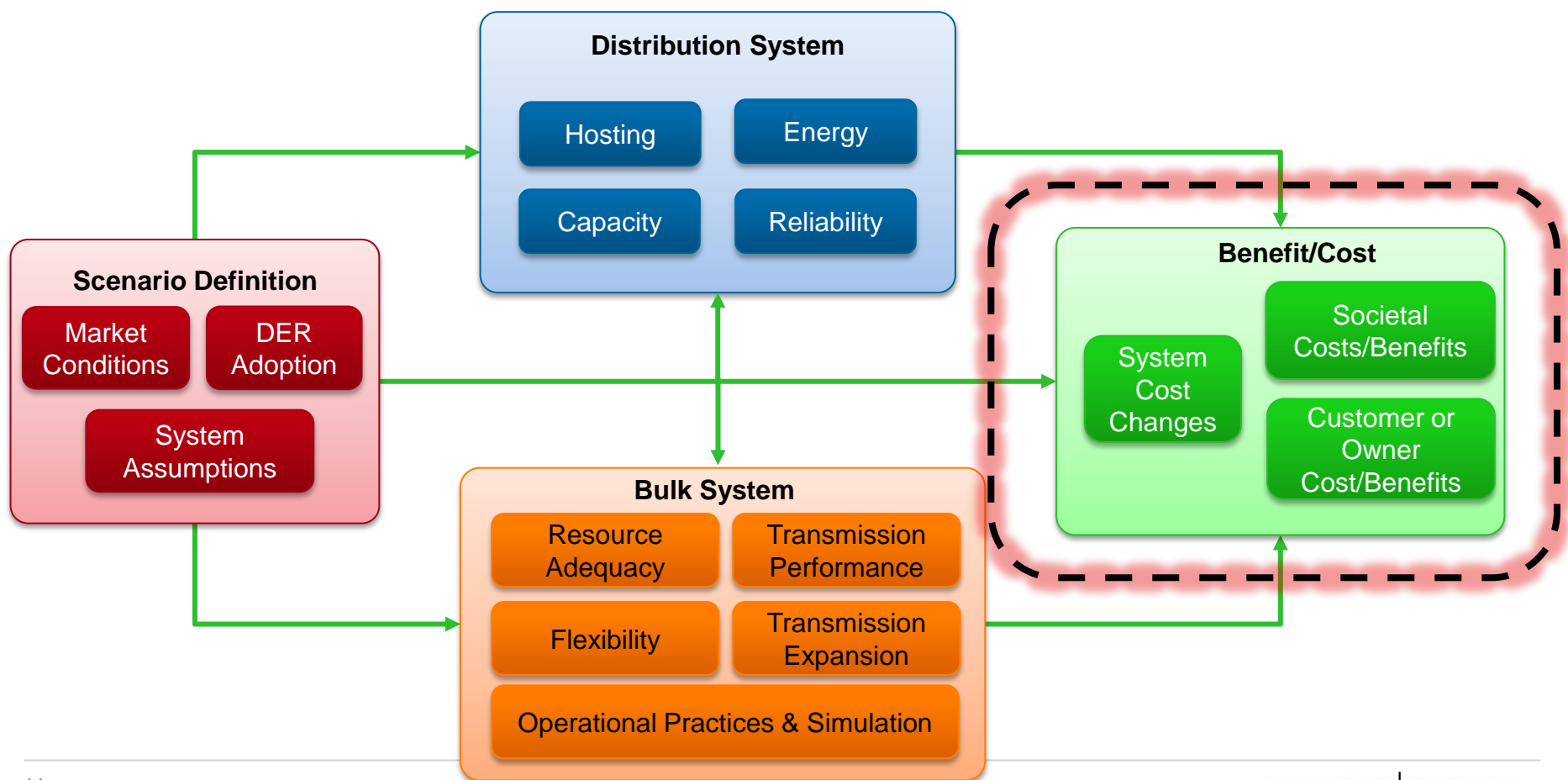
Determines min. Trans Performance mitigation cost for selected scenario

Provides input into operational simulation process



Integrated Grid Methodology

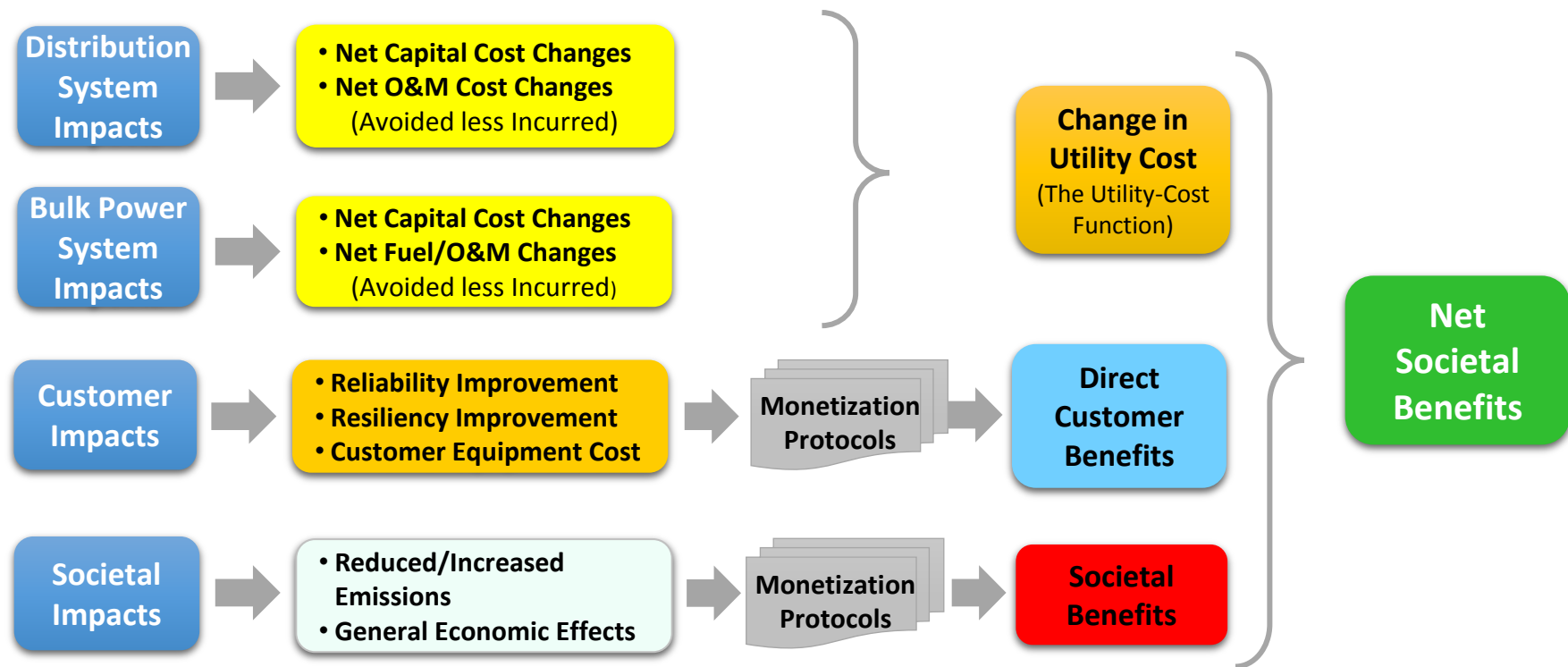
The Integrated Grid's benefit-cost framework contains both bulk system and distribution system elements.



DER Impacts → Benefits and Costs

Element	Impacts	Benefit	Cost
Distribution	Loss Reduction	●	
	Capacity Upgrade Deferral	●	
	Reconductoring		●
	Line Regulators/STATCOMS		●
	Relaying /Protection		●
	LTC accelerated wear		●
	Voltage upgrade		●
	Smart Inverters	●	●
	O&M		●
Bulk Power System	Generation Mix/Requirement Changes	●	●
	Deferral of Transmission Upgrades	●	
	Transmission losses	●	
	O&M	●	●
	Fuel Savings	●	
	Congestion	●	
	System Operations/Uncertainty		●
Customer	DER Investments		●
Societal	Emissions - CO2/GHG, Hg, SOx, NOx	●	
	Cyber Security	●	
	Health	●	
	Macroeconomic effects	●	

EPRI's Benefit-Cost Framework





THE INTEGRATED GRID

A BENEFIT-COST FRAMEWORK

3002004878

Final Report, February 2015

IG Final report:

<http://www.epri.com/abstracts/Pages/ProductAbstract.aspx?ProductId=000000003002004878>

IG Executive Summary:

<http://www.epri.com/abstracts/Pages/ProductAbstract.aspx?ProductId=000000003002005177>



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