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Integrated Resource Planning in an Evolving Technology and Policy Landscape

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IRP Emerging Requirements and Best Practices
Workshop for South Carolina PSC

U.S. DEPARTMENT OF ENERGY BATTELLE

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Agenda

- Traditional Planning Practices
- Technology Pressures on Resource Planning
- Policy Pressures on Resource Planning
- Emerging Modeling Practices

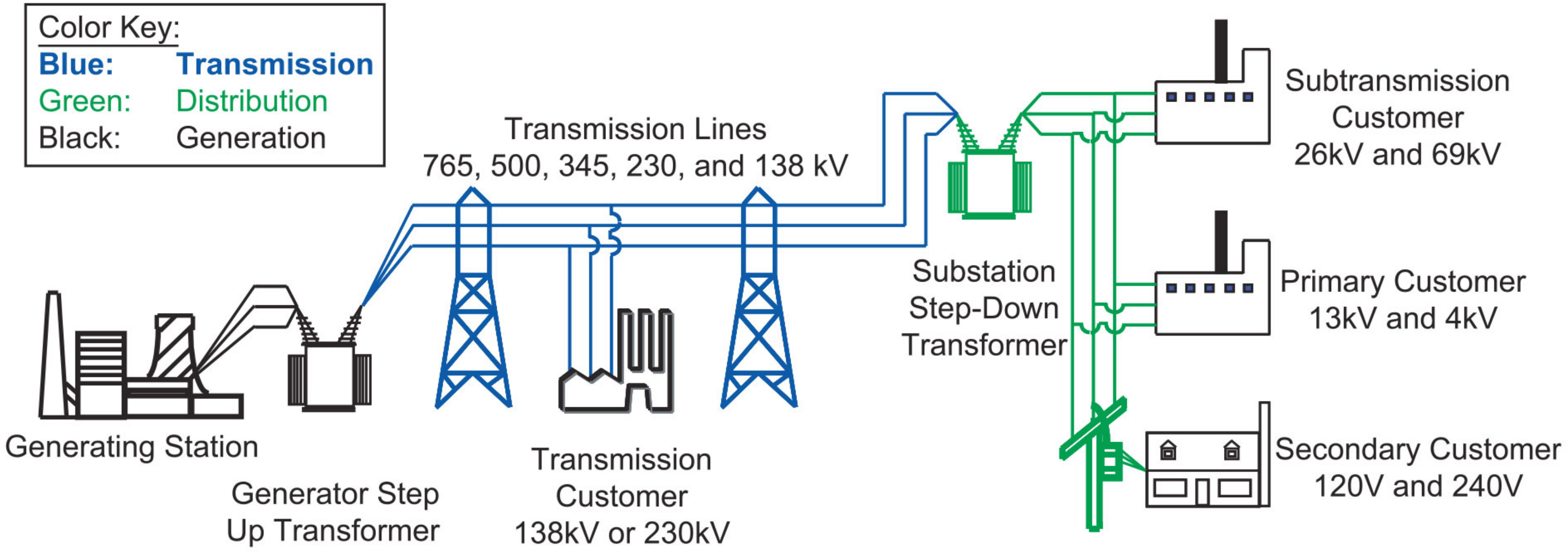
Traditional Planning Practices

Key Assumptions Facilitate IRPs

- Resource planning is an incredibly complex exercise
  - Load and generation must be kept in constant balance
  - Dozens of generators, market interfaces, fuel costs, changing load patterns (DG, EVs, etc.)
  - For each interval, solving the load/generation equation requires consideration of many complex variables
  - A 15-year plan looking at hourly intervals must solve for 131,400 data points

- As a result, resource plans make three simplifying planning assumptions
  - Hourly planning resolution
  - Substitution of robust reserve margins for ancillary services
  - Focus on generation only (no distribution planning, limited transmission planning)

Grid Planning has been a Fragmented Process



Generation Planning
- Capacity
- Energy
- Ancillary services
  - Regulation
  - Frequency response
  - Spin/non-spin reserve
  - Etc. …

➢ Generation resources

Transmission Planning
- Thermal management
- Congestion relief
- Contingency analysis
- Policy-driven needs

➢ Infrastructure needs and non-wire alternatives

Distribution Planning
- Voltage support
- Conservation voltage reduction
- DG integration/hosting capacity
- Flow management

➢ Infrastructure needs and non-wires alternatives

The Planning Landscape

- IRPs
  - Function
    - What they do: Identify energy and capacity needs
    - What they *kind of* do: Identify ancillary service needs (based on standards, not optimization)
    - What they don't do: Transmission optimization, distribution system modeling
  - Prepared by utilities for review by state/provincial regulators
    - May be formally approved, acknowledged, or treated as information-only
    - Traditionally associated with vertically integrated states, but some market-facing states have started re-introducing them (California, Michigan)

- Regional Transmission Plans
  - Function
    - What they do: Identify transmission infrastructure needs based reliability standards, economic optimization, and policy directives
    - What they *kind of* do: Identify non-wires alternatives
  - Prepared at a regional level by system operators or utility coalitions
    - Generally not subject to regulatory review or approval
    - Active research project at PNNL: Storage as a transmission asset

The Planning Landscape

- Distribution Plans
  - Historically, have not been required for regulatory review/approval
  - Where required, some functions are:
    - DER forecasting
    - DER integration (hosting capacity analysis)
    - DER optimization (controls/leveraging for grid needs)
    - Non-wires analysis
  - Required by a growing number of states/many more developing requirements
    - Report: Distribution System Planning – State Examples by Topic

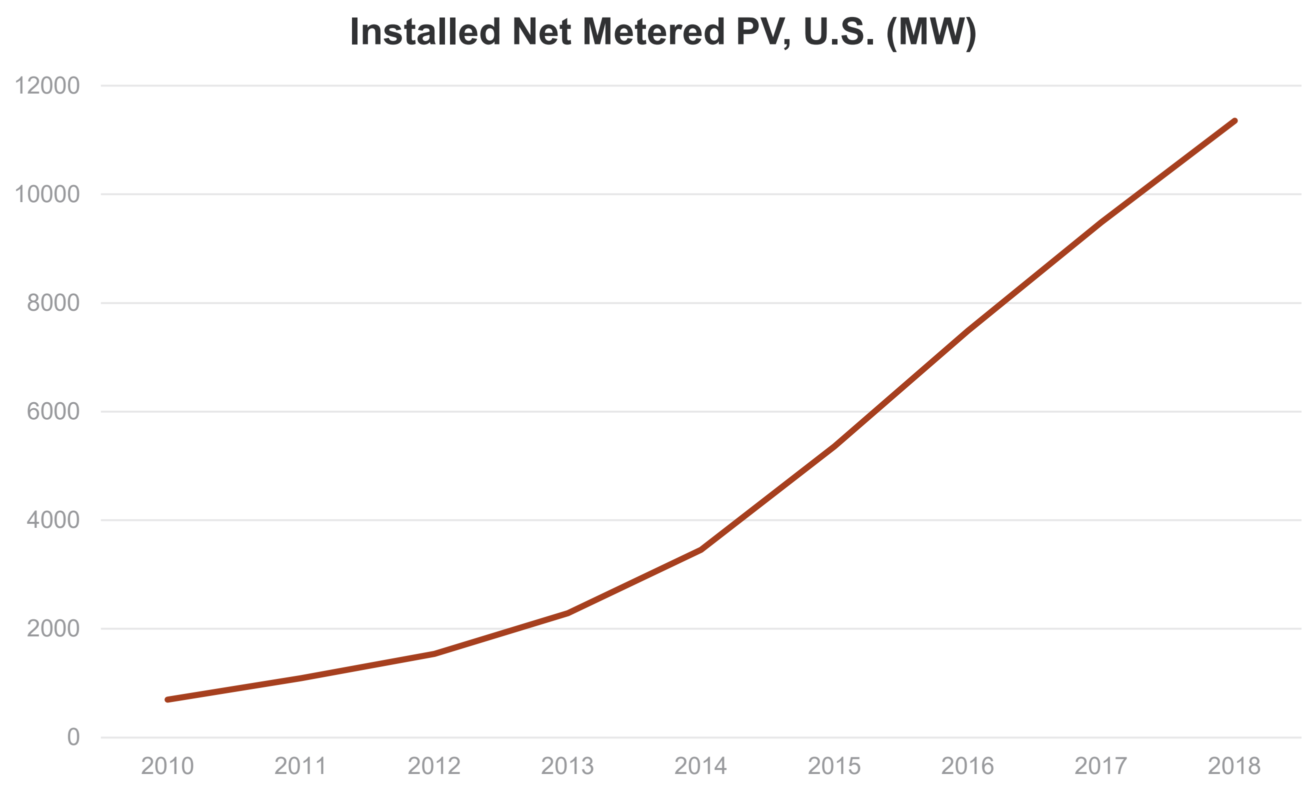
Technology Pressures on Resource Planning

- Distributed Generation
- Electric Vehicles
- Energy Storage
- Smart Grid
- Evolving Markets

Distributed Generation

Planning Implications:

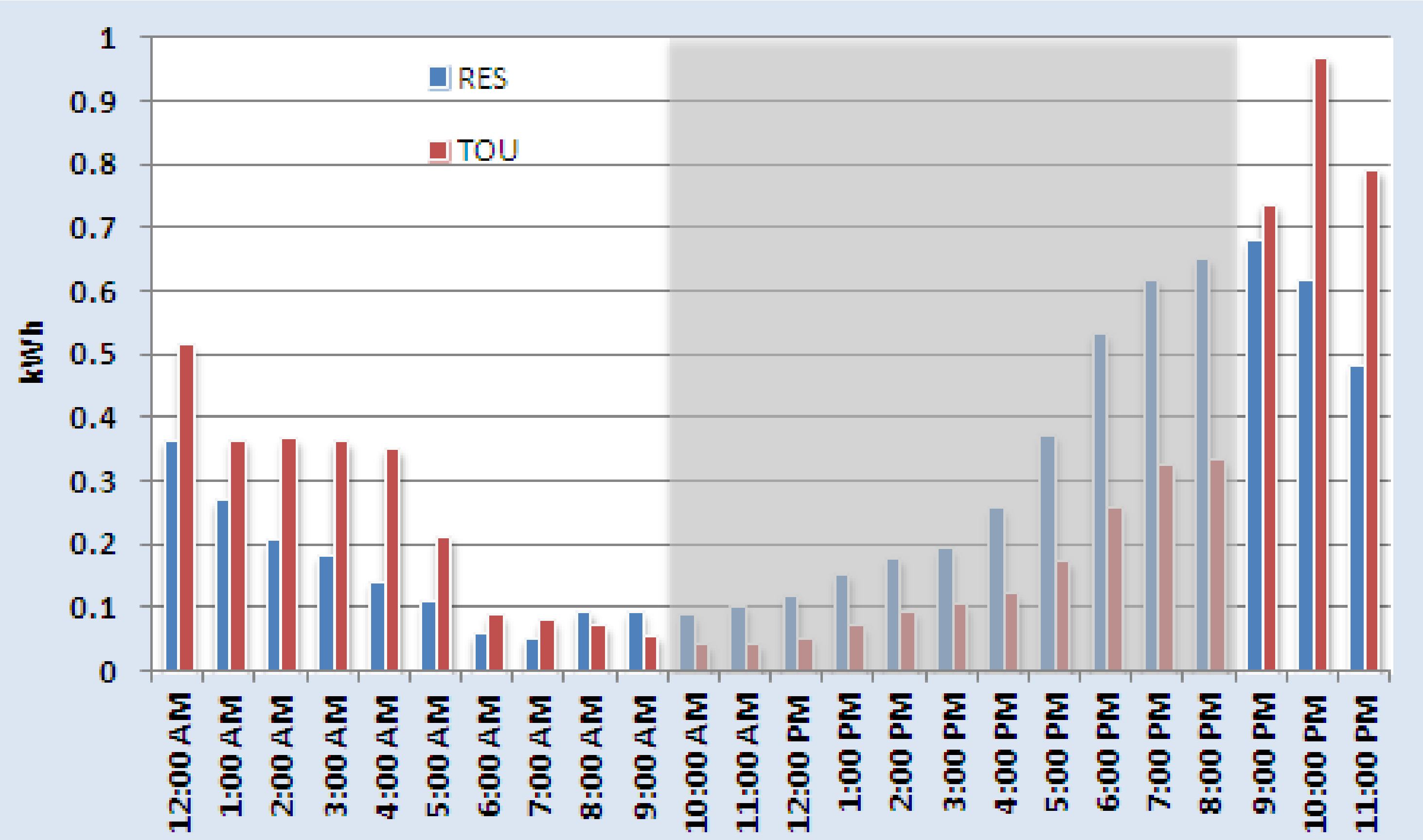
- Changing load patterns
- Reduced/altered generation needs
- Power flows



U.S. Energy Information Administration

Electric Vehicles

Residential EV Charging Behavior, with Time-of-use Rates and Without

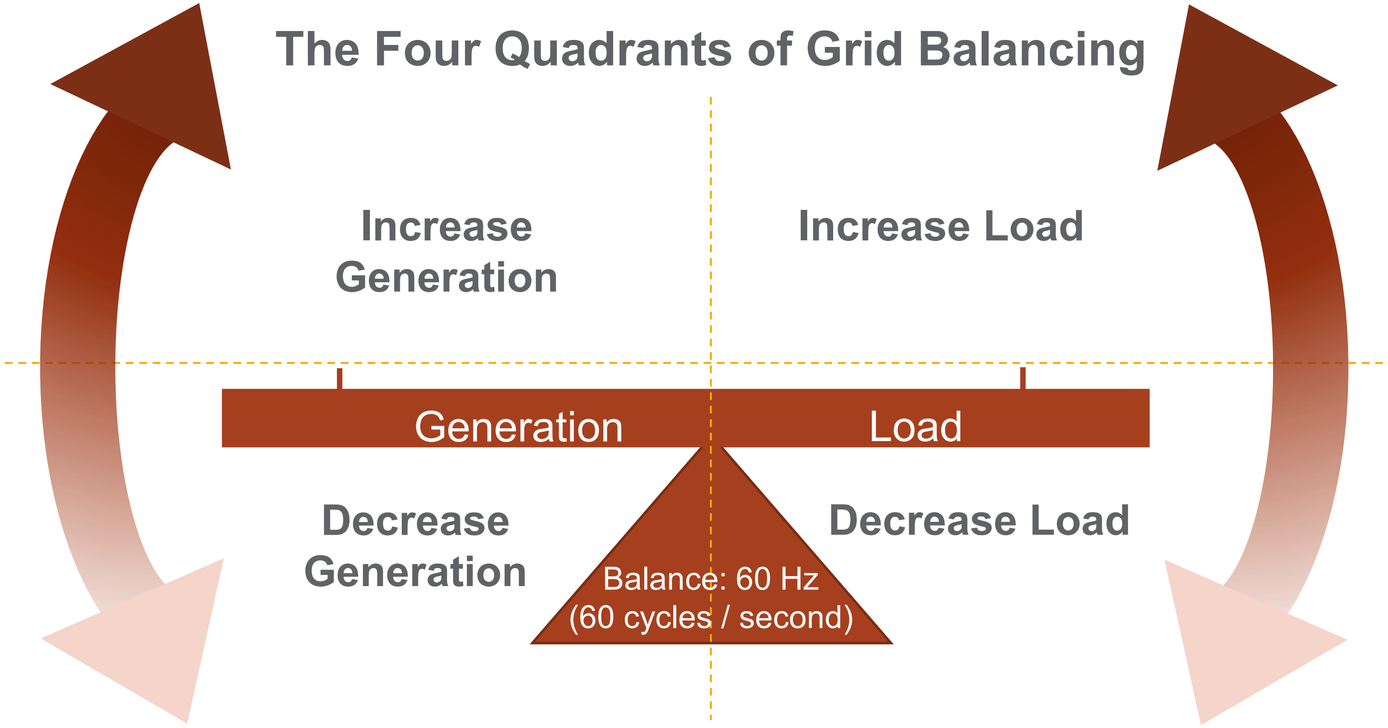


U.S. Department of Energy

Planning Implications:

- Changing load patterns
- Peak load growth
- Distribution system power flows

Energy Storage



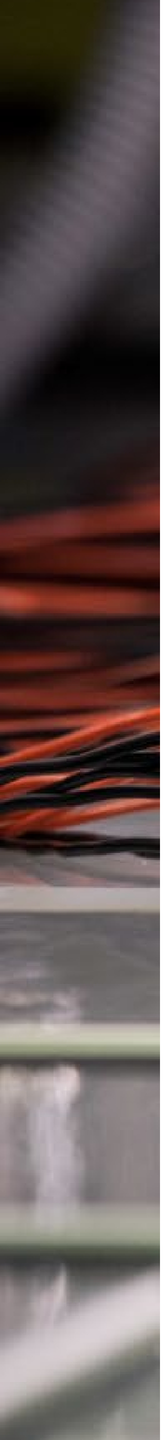
Because it can be a generator or a load and rapidly alter its input or output, energy storage can be a valuable asset for supporting the grid.

Report: [Energy Storage in Integrated Resource Plans]

Energy storage has two unique characteristics: flexibility and scalability, meaning that it can be deployed by multiple actors for multiple uses.

Planning Implications:

- Modeling challenges
  - Granularity
  - Value stacking
- Cross-functional benefits
- Changing load patterns
- Non-wires analysis



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Smart Grid

"Smart Grid" technologies are those that improve grid communication, monitoring and control. Examples include:

- Phasor measurement units (PMUs)
- Advanced metering infrastructure (AMI)
- Distributed Energy Resource Management Systems (DERMS)

Benefits include:

- Increased system reliability
- Reduced O&M costs
- Increased integration & control of distributed energy resources

Planning implications:

- Transmission system planning
- Distribution system planning

Research Area: Grid Architecture

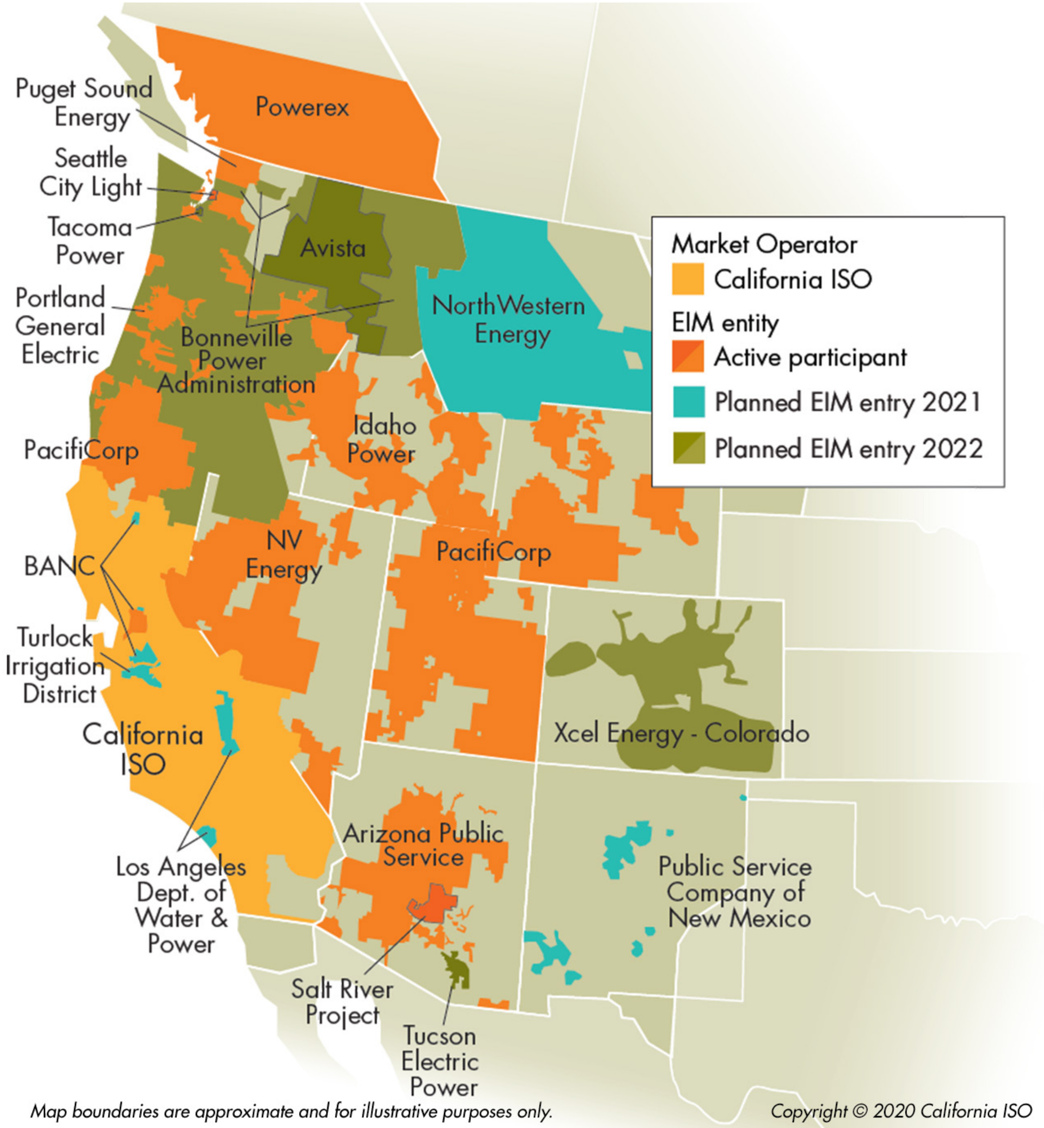
Evolving Markets: Western EIM

The Western Energy Imbalance Market (EIM) allows market participants to trade resources at the margin at 5- and 15-minute intervals to reduce the costs of balancing their systems.

- $1.18 billion in benefits since 2014 launch

Planning implications:

- Increased granularity in modeling
- Integrated generation and transmission modeling



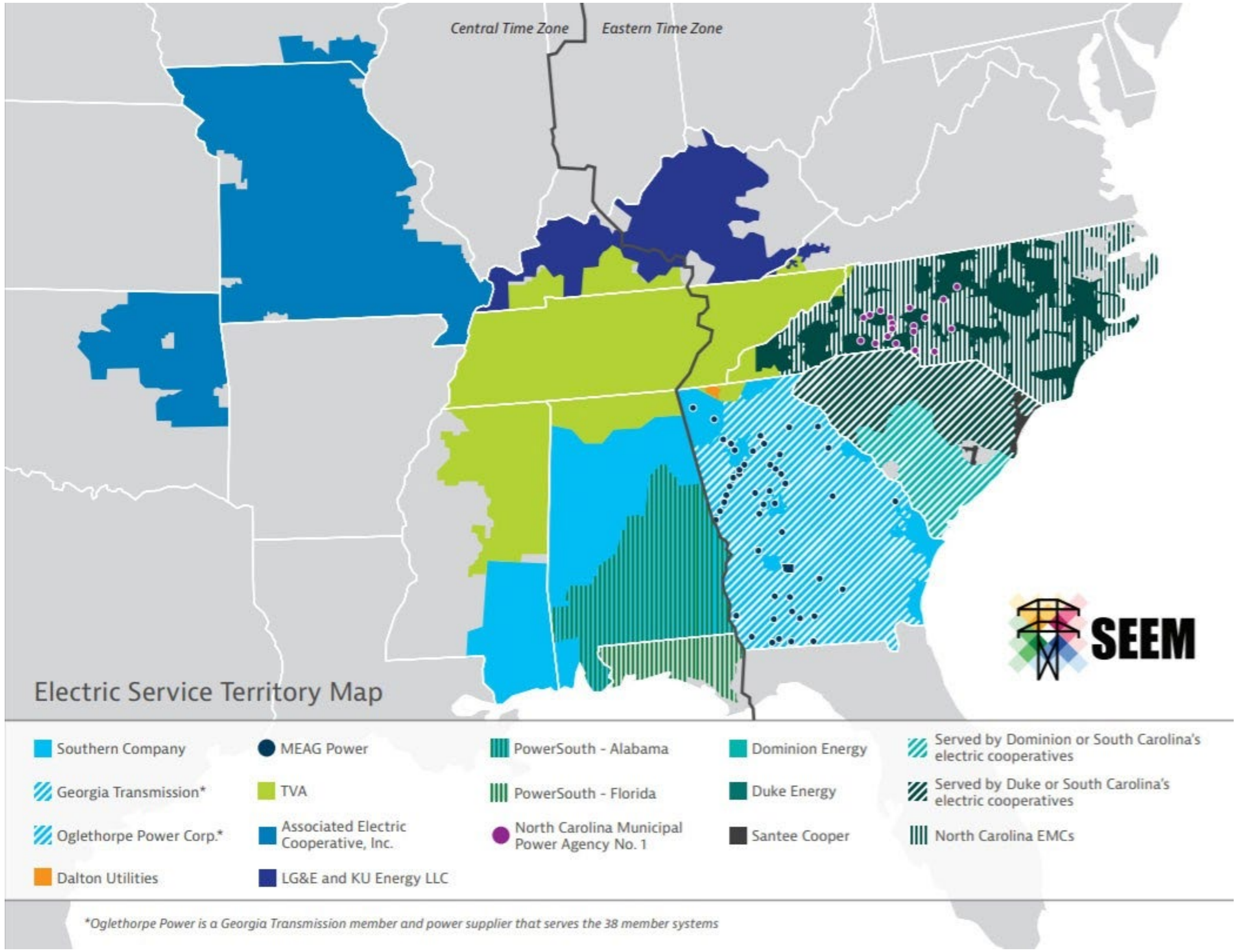
Evolving Markets: Southeast Energy Exchange Market (SEEM)

The proposed Southeast Energy Exchange Market (SEEM) would create a voluntary, 15-minute, energy-only market.

- Virtual market hub for more efficient execution of bilateral agreements
- Based on a technology platform – no centralized market
- Non-firm, as-available – no transmission charges

Duke's FERC docket: ER21-1115-000

Dominion's FERC docket: ER21-1112-000



Southern Company

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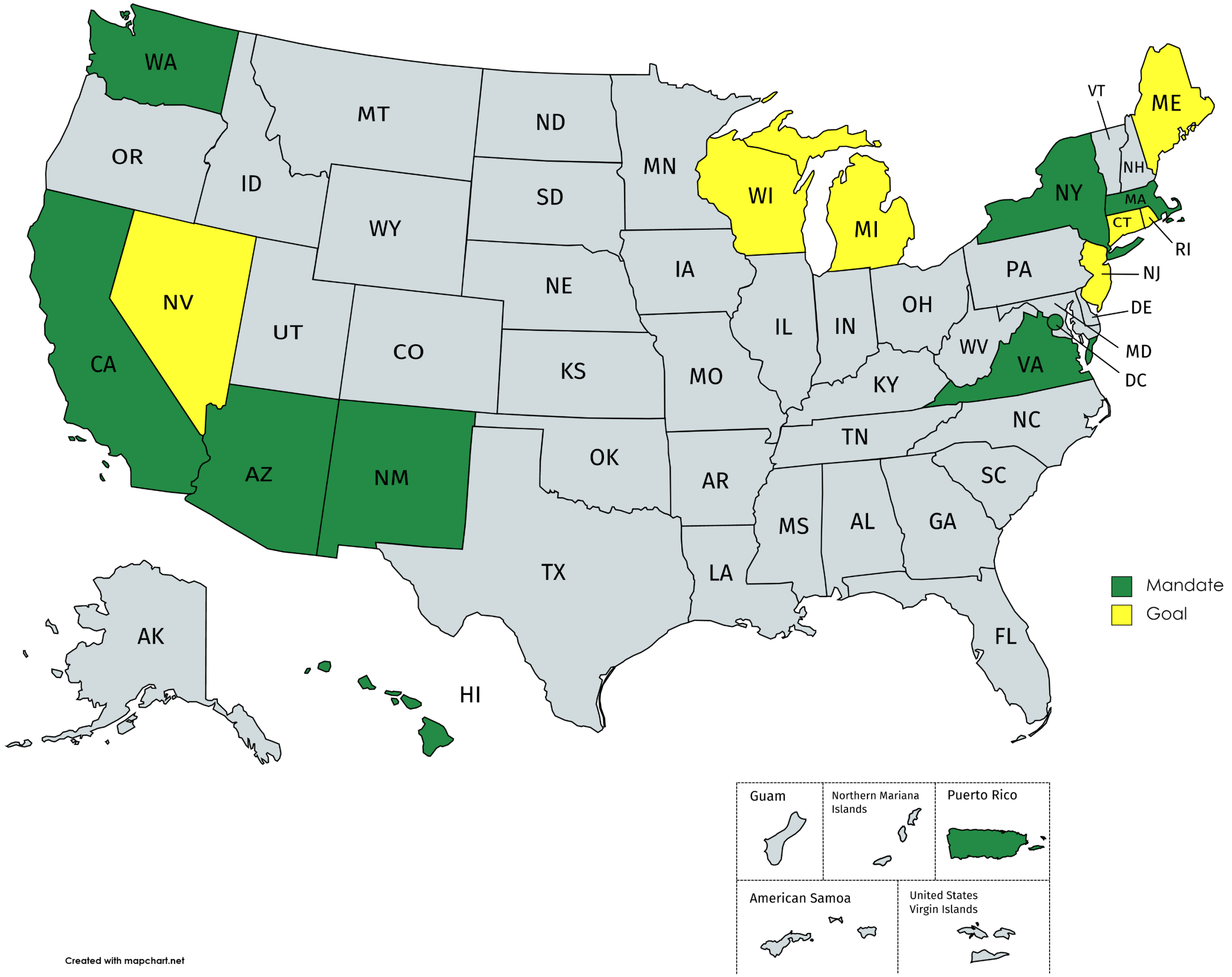
Policy Pressures on Resource Planning

- Decarbonization
- Changing Customer Preferences
- Grid Modernization

Decarbonization



Nine U.S. states and territories have 100 percent clean energy **requirements** (green), while seven states have 100 percent clean energy **goals** (yellow).

Clean Energy States Alliance

Decarbonization in the Southeast

In place of state-level action, utilities and municipalities are setting decarbonization policy in the Southeast:

- Dominion: Net Zero Emissions by 2050
  - Particular focus on methane: 80% reduction by 2040; methane capture for RNG
  - More detailed study of energy storage, hydrogen, advanced nuclear, carbon capture
  - Transportation: EV charging infrastructure investments; electric buses, LNG & CNG
- Southern Company: Net Zero Emissions by 2050
  - Intermediate goal: 50% reduction in emissions by 2030
  - Energy efficiency, carbon capture, afforestation are key focal points
  - Regular progress reporting
- Columbia, SC: Municipal clean energy and climate resilience
  - Prompted by severe flooding in 2015
  - Powering municipal facilities with clean energy
  - Investments in wastewater facility resilience, flood management
  - Efforts underway to tap additional resources for efficiency, distributed generation

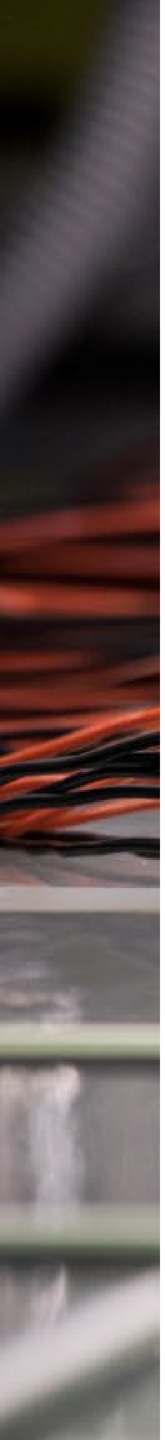
Changing Customer Preferences

Renewable Energy Buyers' Alliance (REBA)

- Corporate sustainability goals are beginning to place significant pressure on utilities to increase clean energy investments
- REBA is a trade association for corporations to lower costs, develop best practices for clean energy procurement
  - Amazon, Google, Facebook, Walmart, McDonald's, etc.

Customer Choice

- Community Choice Aggregation: Allows communities to forego utility supply and procure their own energy (Authorized in 7 states, but most prevalent in California)



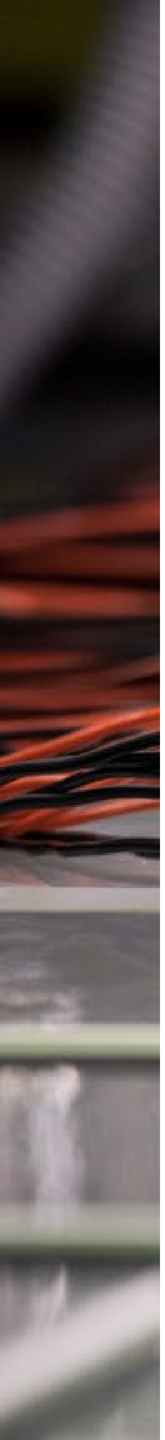
Grid Modernization

New York's Reforming the Energy Vision (REV)

- Multi-year effort to fundamentally restructure the state's energy infrastructure
- Core goal: redefine utilities as Distribution System Platform Providers (DSPP), whose job is to provide a platform for customers to bring whatever distributed technology they want (DG, storage, smart thermostats, grid-connected appliances, EVs, etc.) and be able to "plug and play" with the grid
    - Significant implications for system planning, rate design

Maine's Nonwires Coordinator

- In 2019, the Maine Legislature created the Nonwires Coordinator, who is tasked with reviewing utility transmission and distribution system plans, identifying potential non-wires alternatives, performing cost-benefit analyses, and making recommendations
    - Contracted with the state's Public Advocate, which represents residential customers in utility rate proceedings



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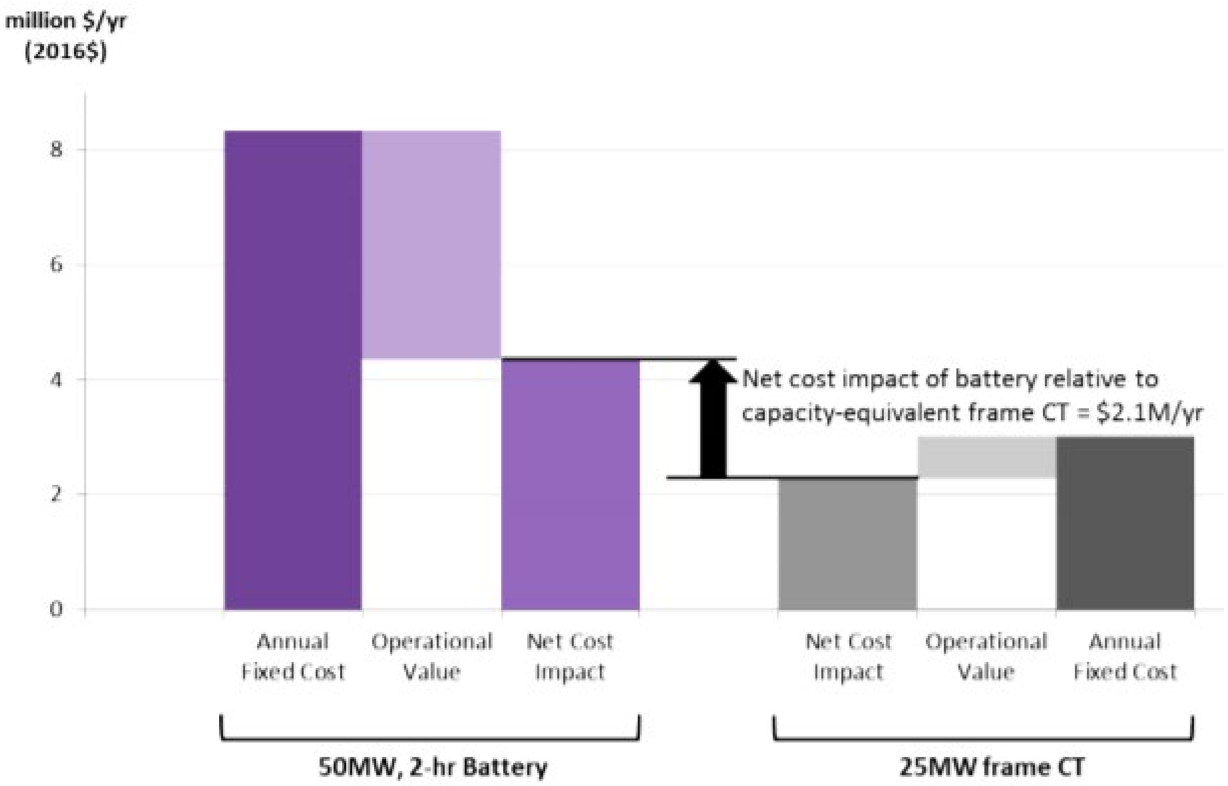
Emerging Planning Models

- Net Cost
- Sub-Hourly Models
- Integrated Distribution System Planning

Net Cost Approach

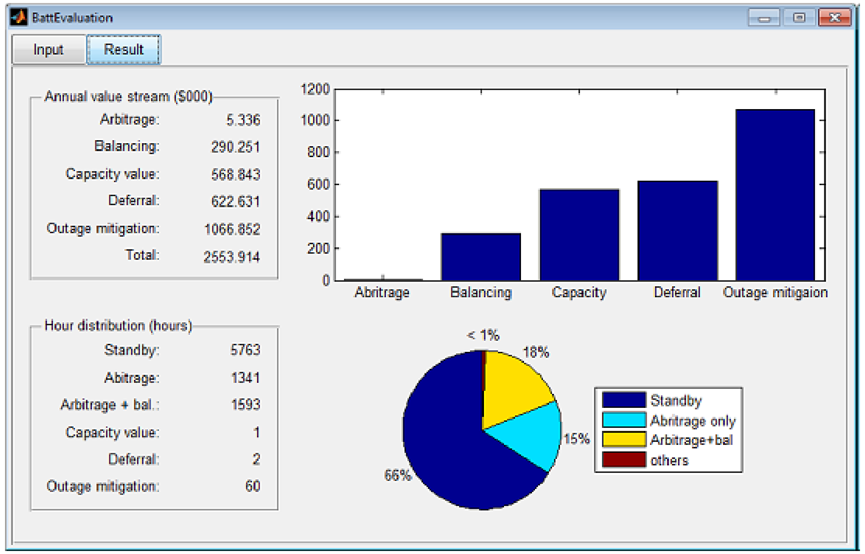
- An IRP model compares resources in terms of capital cost and hourly capacity and energy value
  - For flexible resource options such as energy storage or demand response, that's an apples-to-oranges comparison
  - Net cost uses an external model to capture non-IRP values of storage
  - Deducting those operational values from modeled storage cost → apples-to-apples

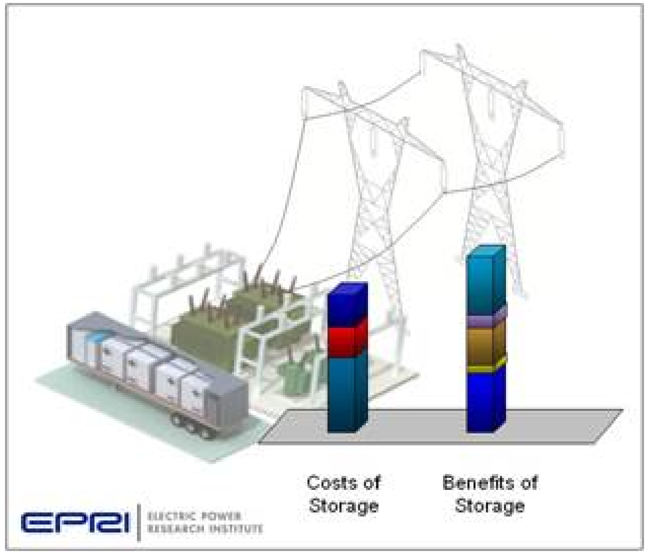


Portland General Electric 2016 IRP, p. 239

Net Cost Approach – Available Models

- [Energy Storage Evaluation Tool](#) (PNNL)
  - Free, web-based evaluation tool
  - Conducts sub-hourly storage system optimization using user-input service values
  - Can be used to optimally size and site storage projects





- [StorageVET](#) (Electric Power Research Institute)
  - Free, open source software
  - Web-based interface
  - Flexible granularity and time horizons
  - Can directly compare storage to other resource options (i.e. combustion turbine)

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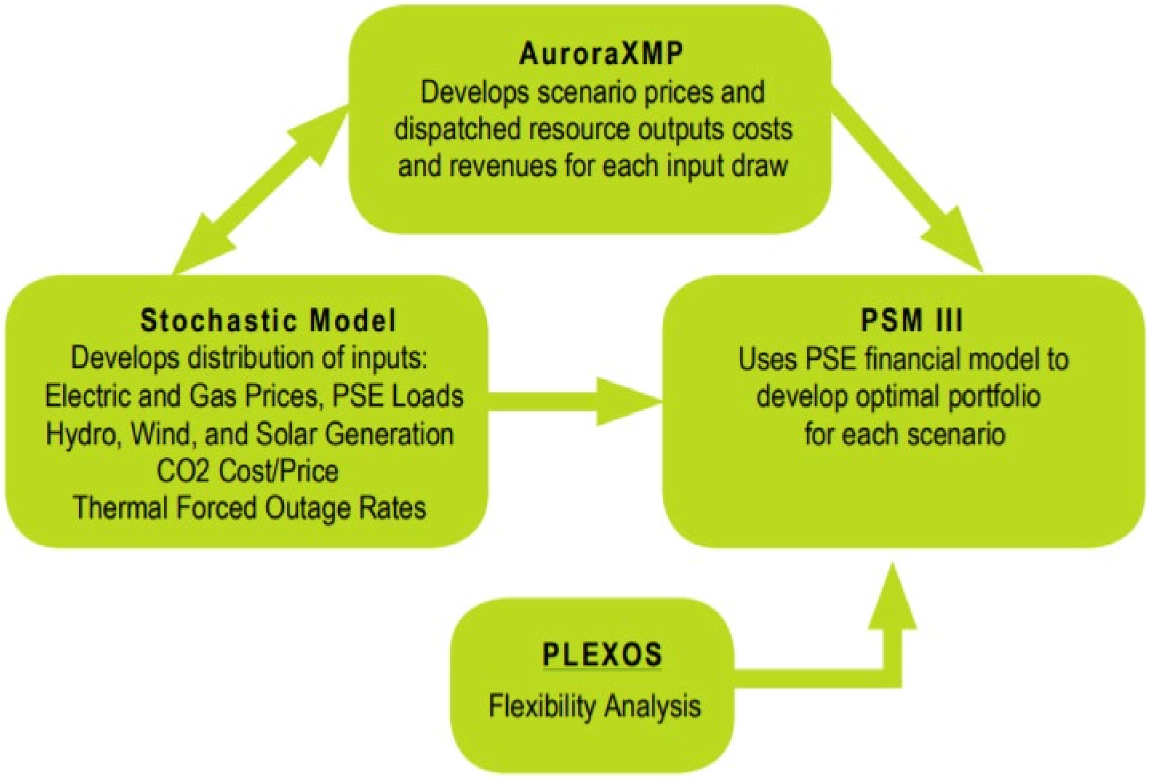
Sub-hourly Planning

- At hourly granularity, many flexible and ancillary services are omitted
  - Frequency response is one of most universally valuable services, but it's measured in seconds
  - Under high DG penetration, load following may be measured in minutes as solar comes on and off with passing clouds
- Market operations moving toward sub-hourly transactions
  - FERC Order 825 requires regional market operators to clear markets at the same interval at which they are dispatched
  - Regional markets moving to 5- and 15-markets at varying paces
  - Granular system design/optimization of resources increasingly necessary to maximize revenue
- Moving to sub-hourly models is an expensive and complicated process
  - Multiple software licenses for a large utility likely to cost several hundred thousand dollars
  - Training staff on new software takes significant time
  - Both pressures must be managed within existing cyclical planning requirements

Sub-hourly Planning Models: Puget Sound Energy

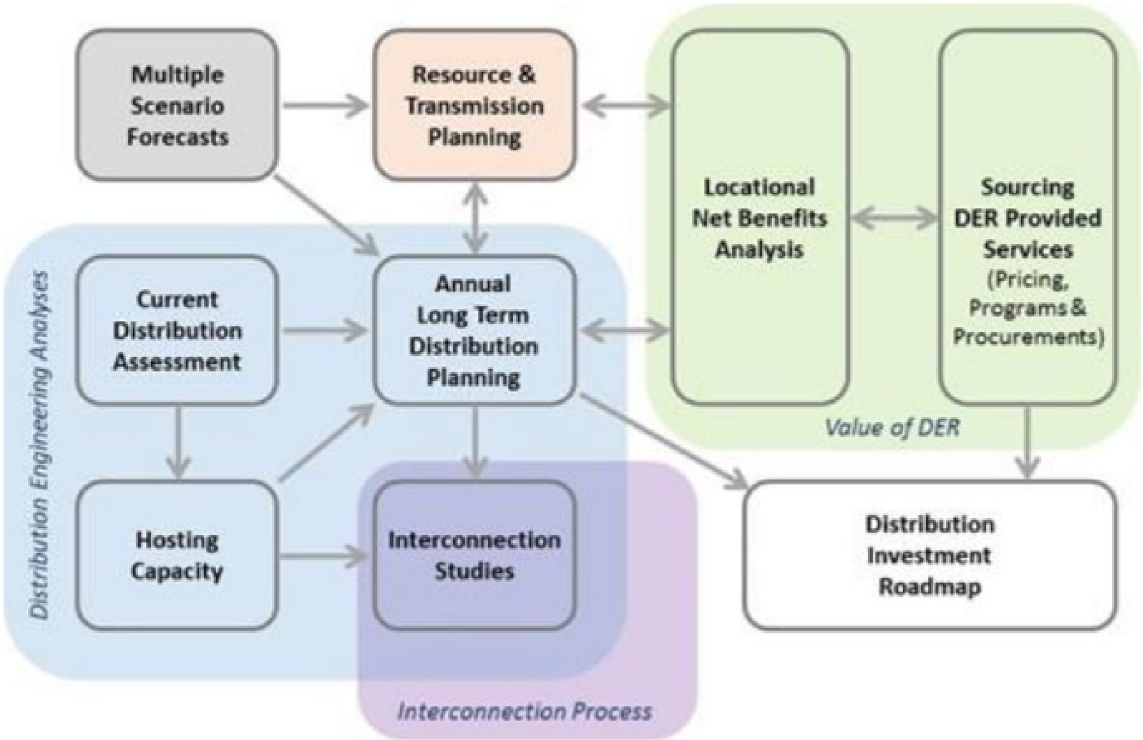
- Puget Sound Energy developed a gradual transition for its 2017 IRP
  - Traditional (hourly) planning tools used to identify model inputs and portfolio selection
  - Once resource portfolio was selected, PSE used PLEXOS to compare it to a portfolio with storage at 5-min granularity
  - Result: 50 MW of storage by 2035 became 75 MW by 2024



Puget Sound Energy, 2017 IRP, pg. N-4.

Integrated Distribution System Planning

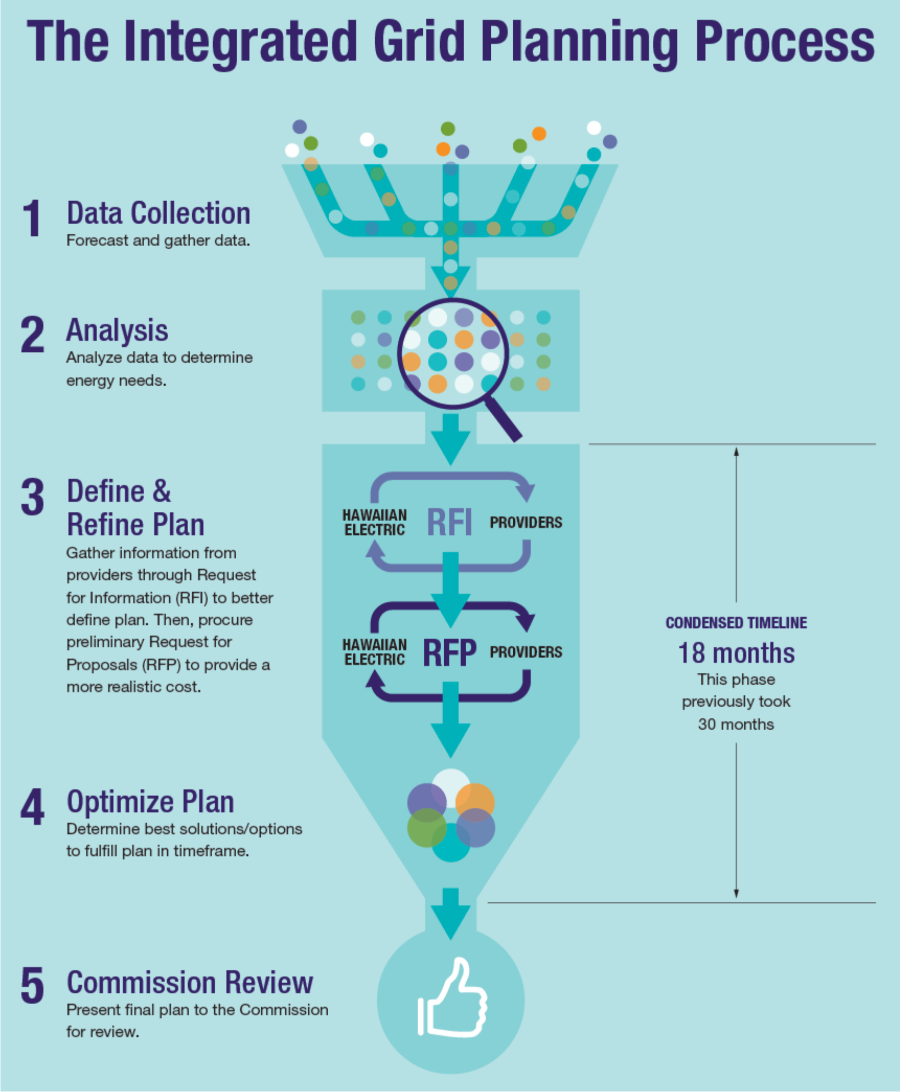
- Under the right circumstances, non-wires alternatives such as storage and demand response can cost-effectively defer or displace a transmission or distribution system upgrade. But system-level IRP tool can't identify those constraints and those opportunities.
  - Punkin Center (Arizona Public Service)
  - Nantucket Island (Massachusetts)
  - Brooklyn-Queens Demand Management Project (ConEd in NY)
- Additional values (volt/var optimization, resilience, outage mitigation, etc.) also best measured on a locational basis
- Potential for local and system co-optimization
  - If local/system peaks align, resource may provide T&D deferral and capacity benefits
  - When resource not serving local need, can be dispatched for system benefits
  - IRP may identify need for storage/DR, but can't identify optimal location



Integrated Distribution Planning, by Paul De Martini, ICF, for Minnesota Public Utilities Commission, August 2016

Integrated Grid Planning: Hawaiian Electric

- Driven by the first-in-the-US 100 percent clean energy policy, Hawaiian Electric redesigned its IRP process in 2016 to develop a Power Supply Improvement Plan
- The objective of Integrated Grid Planning is to identify not just clean energy generation resources, but:
  - Transmission and distribution system improvements necessary to incorporate those resources (including non-wires alternatives)
  - Develop fair compensation mechanisms for distributed energy resources (not just generation)
  - Identify/optimize demand response opportunities
  - Develop the system flexibility needed to support a 100 percent clean grid



Hawaiian Electric

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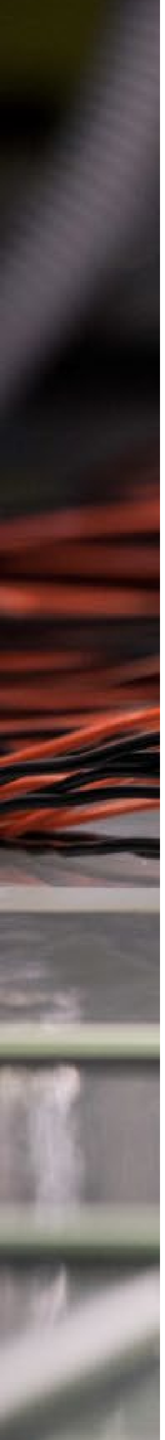

Thank you

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