The Cutting Edge in Resource Planning

RETHINKING SYSTEM NEEDS AND IN A FUTURE DOMINATED BY RENEWABLES, NEW TECH, AND ENGAGED CONSUMERS

PRESENTED TO

Solar Energy Industries Association

PRESENTED BY

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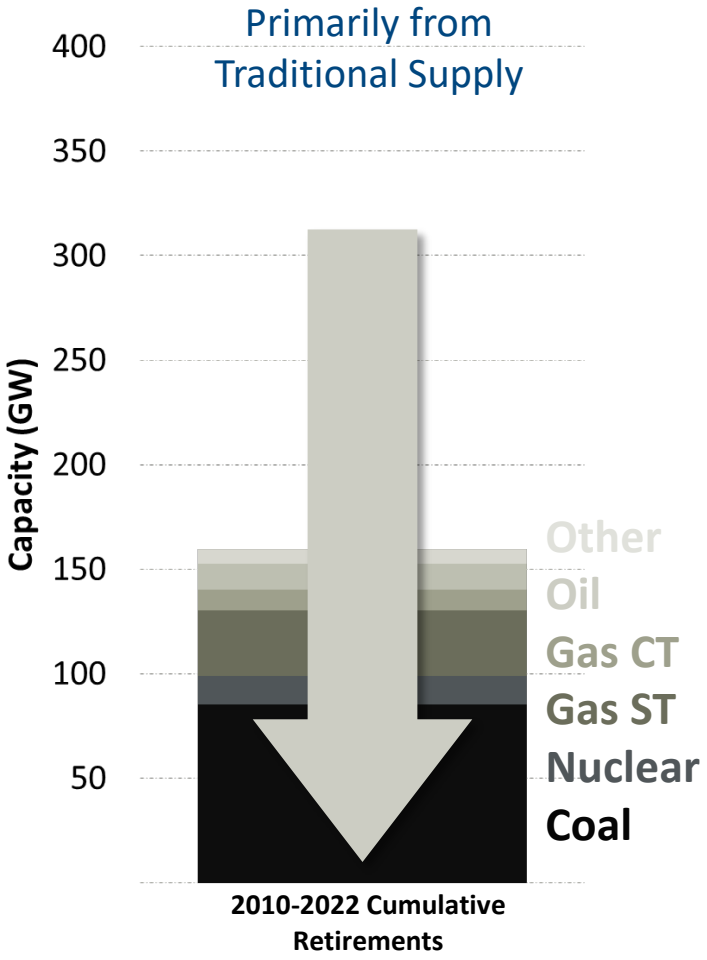
THE Brattle GROUP

New Technologies & Engaged Customers Are Rapidly Overtaking Traditional Supply

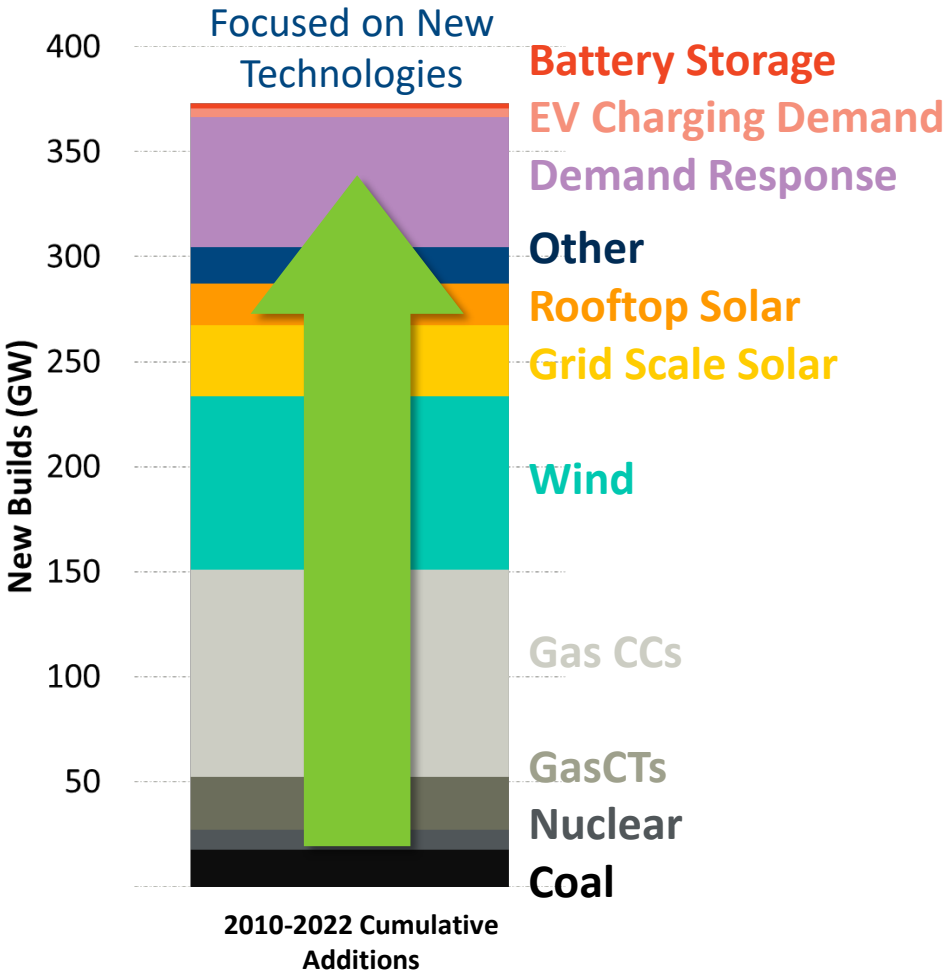
Retirements

Primarily from Traditional Supply



New Builds

Focused on New Technologies



Data Source: Energy Velocity Suite (US and Canadian generation) and Brattle research (US-only distributed resource and storage).

The "Old" IRP Model Doesn't Work Anymore

The Traditional IRP

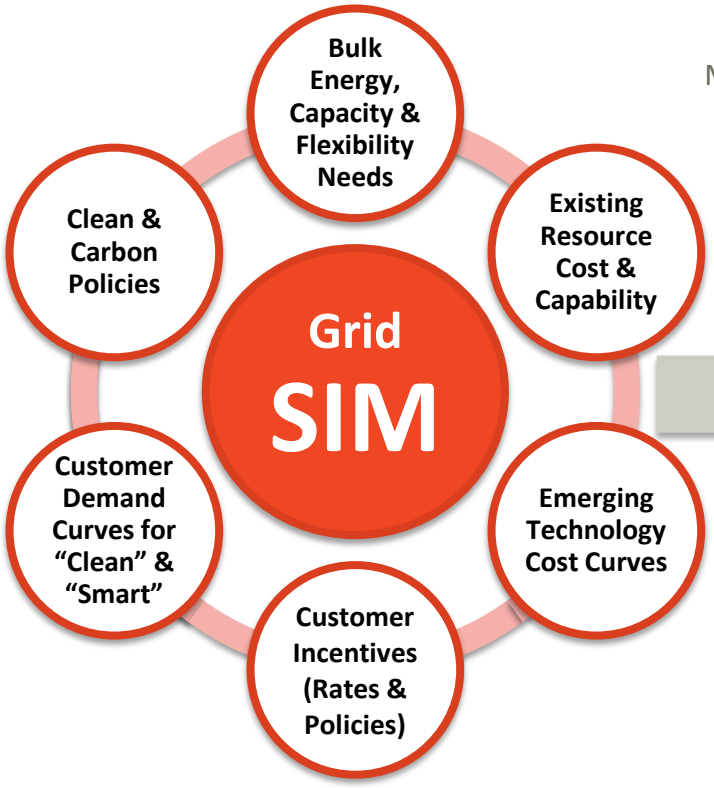
What's Missing?

- New reliability & flexibility needs
- Policy goals
- New technologies
- Corporate sustainability goals
- Customer preferences
- Distributed resources uptake
- Electrification vs. grid defection
- Enabling policies & infrastructure

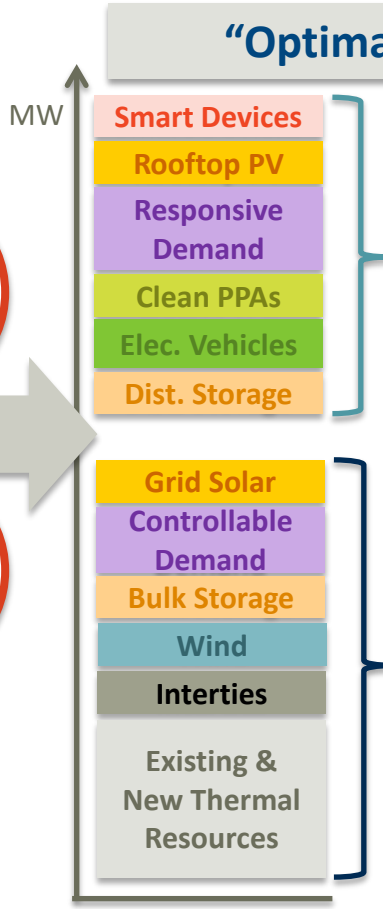
In other words…. Traditional IRP approaches are ill-equipped to address almost every major driver that is reshaping the grid!

How Do You "Plan" for the New Grid?

At Brattle, we have had to completely re-build our strategic approach and modeling tools to characterize emerging trends & uncertainties



Grid Scenario Impact Model



"Optimal" Resource Mix & Policy Design

Resources Chosen by Customers

- Less predictable (requires scenarios)
- Role of IRP: Select well-designed rates, policy & enabling infrastructure to guide (but not dictate) grid evolution

Resources Selected by Utility / State

- Must support grid reliability & flexibility
- Must meet policy & carbon goals
- Must fairly compare value contributions of traditional vs. new resource types
- Role of IRP: Select bulk transmission & supply assets that meet reliability & policy needs at reasonable cost (across many plausible scenarios)

Typical Question: How to Replace a Retiring Coal Plant?

Resources Needed

to Load Growth + Retirements

Supply Gap

Traditional Planning Model Proposes:

Gas
CC & CT

Because….

- Gas is the cheapest "baseload" (high energy & capacity value)
- Renewables offer cheap energy but require 100% gas backup for reliability

Modern IRP Approaches May Identify:

- Controllable Demand
- Bulk Storage
- Grid Solar
- Wind

Because….

- Renewables + DR/storage is cheaper than gas (depending on scenario)
- Together these resources can meet all energy, flexibility & capacity needs
- They may offer additional system values: T&D, clean attributes

Properly Decomposing System Needs Can More Accurately Compare Range of Resources

Compared to traditional planning and procurement, technology-neutral (capability-based) evaluations are more competitive

Technology Types

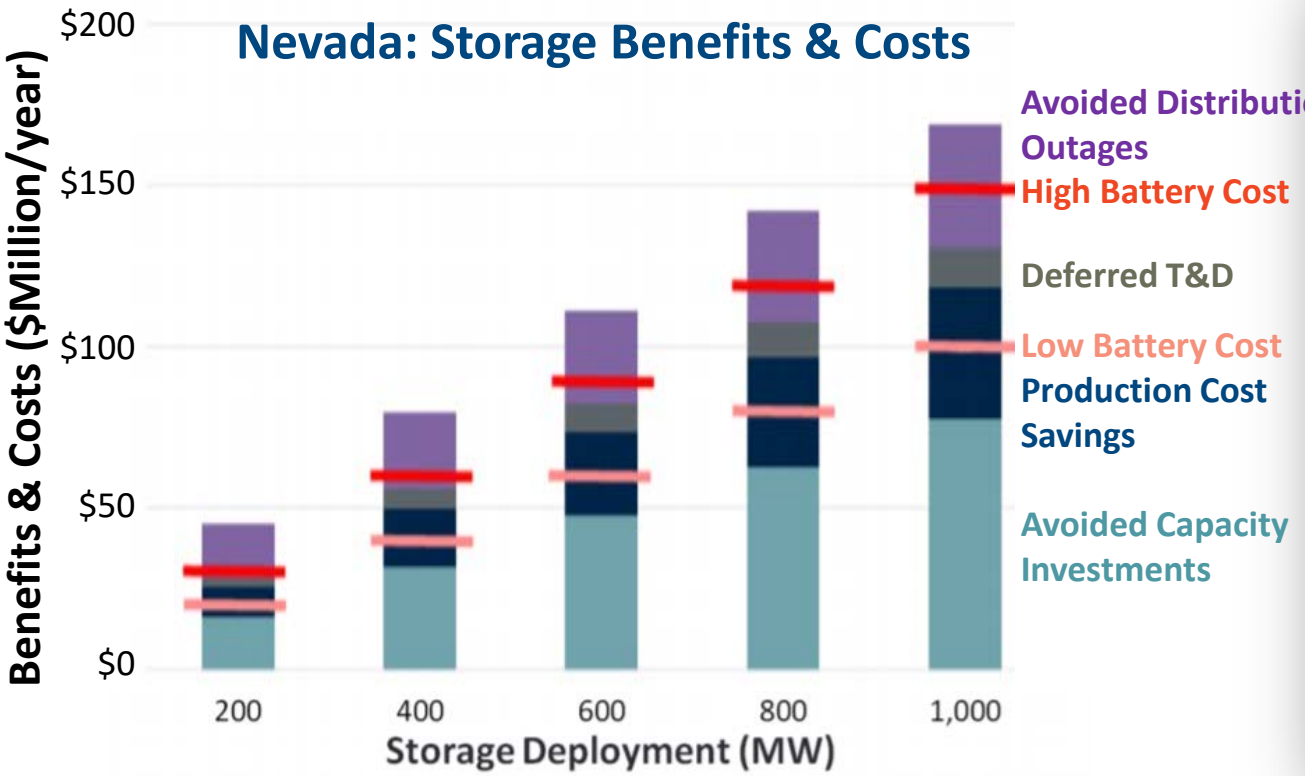
System Needs	Nuclear	RoR Hydro	Hydro w/ Storage	Coal	CC	CT	Wind	Solar	Battery Storage	DR	EE	Imports	Competing Technologies
DA Energy	✓	✓	✓	✓	✓	○	✓	✓	○	○	○	✓	10
RT Energy (5 min)	○	✓	✓	✓	✓	○	✓	✓	○	○	○	○	9
Regulation	X	✓	✓	✓	✓	○	○	○	✓	○	X	○	7.5
Spinning Reserves	X	○	✓	✓	✓	✓	X	X	✓	○	X	○	6.5
Non-Spinning Reserves	X	X	✓	X	✓	✓	X	X	✓	○	X	○	5
Load following / Flexibility	○	○	✓	○	✓	✓	○	○	✓	○	X	○	7.5
Capacity / Res. Adequacy	✓	○	✓	✓	✓	✓	○	○	○	✓	✓	✓	10
Clean Energy	✓	✓	✓	X	○	○	✓	✓	○	○	✓	✓	9
Reactive / Voltage Support	✓	✓	✓	✓	✓	✓	○	○	✓	X	X	○	8.5
Black Start	X	✓	✓	○	✓	✓	X	X	○	X	X	○	6

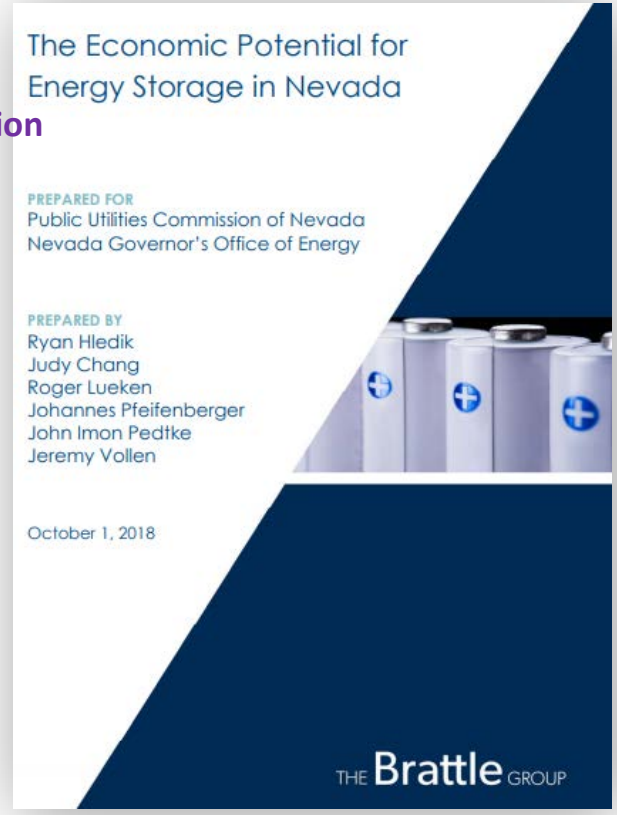
Legend — **Technical Capability to Provide Service**

- ✓ Well Suited (1.0)
- ○ Neutral (0.5)
- X Not / Poorly Suited (0)

Example: Brattle Estimates 700-1,000 MW Nevada Storage Potential (50,000 MW US-Wide!)

Achieving economic potential depends on "stacking" value streams: energy, ancillaries, capacity, T&D, environmental, and avoided outages

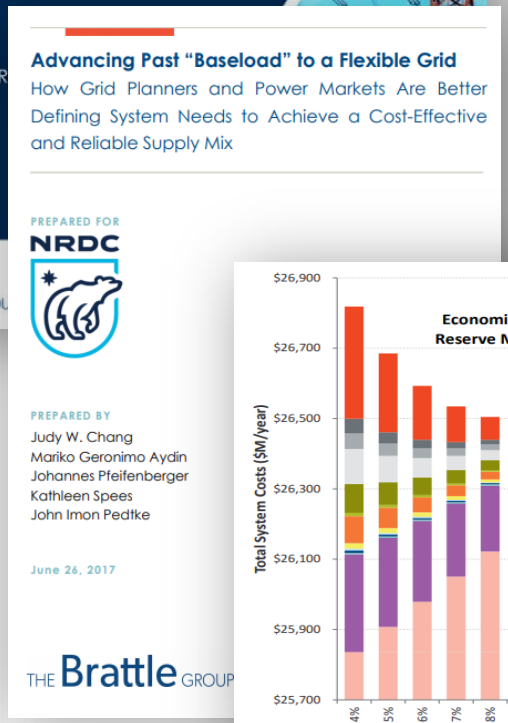


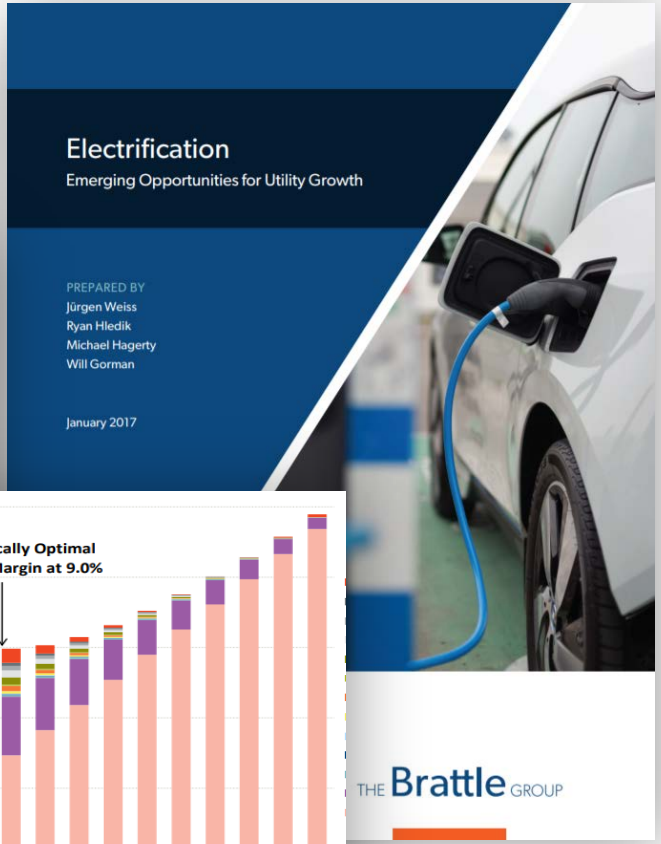


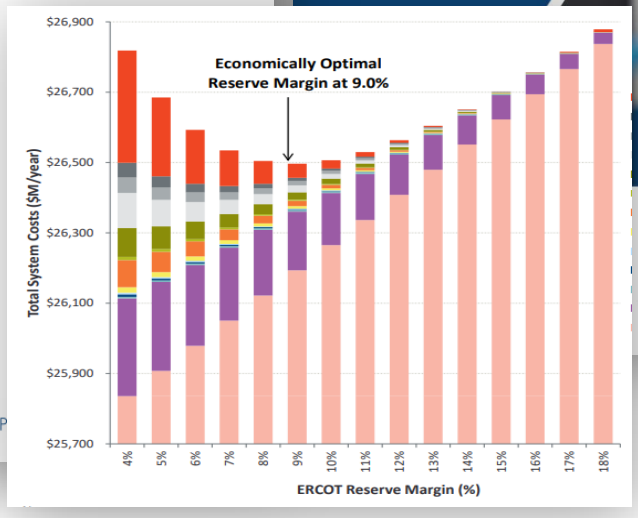
Sources and Notes:
Nominal dollars. Assumed energy storage configuration of 10 MW / 40 MWh. Brattle Storage potential studies for Nevada and US.

Takeway: It's Time to Rethink Nearly Every Aspect of the Traditional IRP…

…in order to support ambitious policy objectives, enable engaged customers, and leverage new technologies







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Dr. Kathleen Spees is a principal at The Brattle Group with expertise in wholesale electricity markets design and environmental policy analysis.

Dr. Kathleen Spees is a Principal at The Brattle Group with expertise in designing and analyzing wholesale electric markets and carbon policies. Dr. Spees has worked with market operators, transmission system operators, and regulators in more than a dozen jurisdictions globally to improve their market designs for capacity investments, scarcity and surplus event pricing, ancillary services, wind integration, and market seams. She has worked with U.S. and international regulators to design and evaluate policy alternatives for achieving resource adequacy, storage integration, carbon reduction, and other policy goals. For private clients, Dr. Spees provides strategic guidance, expert testimony, and analytical support in the context of regulatory proceedings, business decisions, investment due diligence, and litigation. Her work spans matters of carbon policy, environmental regulations, demand response, virtual trading, transmission rights, ancillary services, plant retirements, merchant transmission, renewables integration, hedging, and storage.

Dr. Spees earned her PhD in Engineering and Public Policy within the Carnegie Mellon Electricity Industry Center and her MS in Electrical and Computer Engineering from Carnegie Mellon University. She earned her BS in Physics and Mechanical Engineering from Iowa State University.

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