The Next Generation of Energy Resource Planning

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

PRESENTED TO
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PRESENTED BY
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New Technologies & Engaged Customers Are Rapidly Overtaking Traditional Supply

**Retirements**
Primarily from Traditional Supply

**New Builds**
Focused on New Technologies

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**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

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

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
How Do You “Plan” for the New Grid?

The next generation of modern IRPs may need to...

- Support Large-Scale Electrification
- Redefine Reliability Needs
- Enable New Technology &
- Enhance Competitive Procurement
At Brattle, We Have Had to Completely Rebuild Our Suite of Modeling Tools to Capture These Fundamentally Different Questions

**INPUTS: ASSUMPTIONS & SCENARIOS**

- **ECONOMIC FUNDAMENTALS**
- **TECHNOLOGICAL CAPABILITIES & UPTAKE RATES**
- **POLICY LEVERS**

**ANALYSIS: BRATTLE’S ADVANCED MODELING SUITE**

**ELECTRIFICATION & DECARBONIZED ENERGY ECONOMY PLANNING (DEEP) MODEL**
DEEP models customer- and policy-driven electrification with a multi-sector model of primary energy production, conversion, emissions, and consumption

**TECHNICAL & ECONOMIC POTENTIAL**
Fossil, nuclear, demand response, efficiency, on/offshore wind, storage, solar, and DERs

**RELIABILITY & FLEXIBILITY NEEDS ASSESSMENT**
Capacity, ancillary service, and flexibility grid services

**TRANSMISSION PLANNING**
Economic and reliability benefit-cost analysis of tradeoffs of resource potential by location

**RESOURCE MIX AND DISPATCH**
Optimized resource mix and dispatch to meet energy, capacity, ancillary, flexibility, and policy requirements

**ECONOMIC IMPACTS ANALYSIS**
Broader economic impact of policies and resource plan on employment and local GDP

**RESULTS**

- **OPTIMAL ELECTRICITY RESOURCE MIX & DISPATCH**
- **RATEPAYER & SOCIETAL COSTS**
- **EMISSIONS & ENVIRONMENT**
The Next Generation of Modern IRPs May Need to...

Support Large-Scale Electrification
In Many Regions, Electrification Has the Potential to **Double** Total Demand by 2050

Understanding pace, locations, and resulting infrastructure needs requires deeper understanding of customers, and more active engagement (e.g., if vehicle loads are to be controllable)

Electrification: Currently the Primary Feasible Path to 80% Decarbonization for States and Cities Aiming to Hit 80x50 Goals

- Without Electrification: 36% Carbon Reduction Potential
- With Electrification: 72% Carbon Reduction Potential

Sharing Economy (Ride and car sharing)
New modes of transport (bikes, e-bikes...)
Autonomous driving
EV technology and cost progress
Changing role of cars as status symbol
Urbanization
Climate change
Government policies
New entrants

Economy-Wide CO₂ Emissions

AEO with 50% Solar DG Potential
AEO
Decarbonized Electric Sector
2,400 MMT Gap
80% Reduction from 1990 Levels

2015

2015

Full electrification of heating and transportation
How Can Utility and State Planning Account for Electrification-Driven Demand?

Especially in regions with 80x50 goals, states and utilities may need to expand planning to meet energy needs across all energy-intensive economic sectors (considering load, emissions, cost, and job impacts).
The Next Generation of Modern IRPs May Need to...

Redefine Reliability Needs
# Transition to a Cleaner Grid: Are We Headed for Blackouts When the Sun Goes Down?

<table>
<thead>
<tr>
<th>Myths</th>
<th>Realities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intuition may give us a false sense that the grid won’t stay reliable unless we....</td>
<td>It’s not all hype. It will be a big challenge to maintain reliability while going clean...</td>
</tr>
<tr>
<td>• Save baseload plants from retirement (or coal, or nuclear, or gas)</td>
<td>• Many customers and policymakers want to go clean (reliability concerns won’t stop them)</td>
</tr>
<tr>
<td>• Save a specific “favored” plant</td>
<td>• Intermittent renewables do not provide the same bundle of reliability services as traditional thermal plants</td>
</tr>
<tr>
<td>• Stop building renewables</td>
<td>• Grid services we used to get “for free” will need to be defined and paid for</td>
</tr>
<tr>
<td>• Build a gas pipeline</td>
<td>• Grid operators must learn to rely on non-traditional resources to provide these grid services</td>
</tr>
<tr>
<td>• Impose on-site fuel requirements</td>
<td>• Customers may prefer to save money by allowing some outages</td>
</tr>
</tbody>
</table>
To Clarify: Why Do We Need “Baseload” Plants Again?

... We don’t. We can drop “baseload” from planning vocabulary.

Traditional Planning

Concept: Baseload plants contributed to a cost-effective resource mix and provided many grid services “for free” as a byproduct of producing energy.

Future Supply Mix

Concept: Equation is flipped. Energy will be “free” most of the time. Flexibility and other grid services have to be defined and paid for.

How Should Advanced Resource Plans Rethink Reliability Needs?

- **Easy (but wrong):** First instinct of RTOs and utilities may be to continue relying on traditional thermal plants even as they become uneconomic.

- **Harder (but right!):** Do the hard work of fully specifying a comprehensive suite of unbundled grid services... before the problem becomes an emergency requiring costly interventions.

How Do You Maintain Reliability at Low Cost in High-Renewable Systems?

- Express Reliability Needs as Well-Defined, Unbundled Products
- Determine the Efficient Quantity and Willingness to Pay
- Enable All Resource Types to Compete
- Procure Needed Services in a Co-Optimized, Competitive Fashion
Properly Decomposing System Needs Can Enable Grid Transition at Lower Costs

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

### Technology Types

<table>
<thead>
<tr>
<th>System Needs</th>
<th>Coal</th>
<th>CC</th>
<th>CT</th>
<th>Nuclear</th>
<th>RoR</th>
<th>Hydro</th>
<th>Storage</th>
<th>Wind</th>
<th>Solar</th>
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<th>Storage</th>
<th>DR</th>
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</tbody>
</table>

Even non-traditional & carbon-free supply can provide essential grid services (if enabled to compete)
The Next Generation of Modern IRPs May Need to...

Enable New Technologies
Typical Question: How to Replace a Retiring Coal Plant?

Resources Needed
To meet 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:

- 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
How Should a Modern Resource Plan Fairly Evaluate Disparate Technologies?

Planning tools and methods have to fully account for all system needs and all resource types’ capabilities on a level playing field.

**Grid Scenario Impact Model**

- **Clean & Carbon Policies**
- **Customer Demand Curves for “Clean” & “Smart”**
- **Customer Incentives (Rates & Policies)**
- **Existing Resource Cost & Capability**
- **Emerging Technology Cost Curves**
- **Bulk Energy, Capacity & Flexibility Needs**

**“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)
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.
The Next Generation of Modern IRPs May Need to...

Enhance Competitive Procurement
How Can Competitive Procurements Enable More Competition?

Following best practices in all-source, competitive procurements can invite innovative solutions that may not have been considered in the resource planning:

- Subject high-impact resource planning decisions to a “market test” and all-source solicitation to help identify lower-cost solutions
- Establish product definitions that match the underlying system needs (define the need, not a resource type)
- Unbundle all services to maximize competition across markets and technologies
- Technology-neutral qualification and uniform-price payments for suppliers of each service
- Broad regional competition
- Open, transparent solicitation process designed to co-optimize across needs at lowest cost
- Care to ensure alignment with energy, ancillary, and capacity markets where relevant
Example: Forward Clean Energy Market for States, Cities, and Customers with Large-Scale Decarbonization Goals

Best-practices design proposal is the basis for draft legislation in multiple states. Would enable all-source competition to achieve clean energy needs at lower costs than traditional PPAs.

Sources and Notes:
Better Product Definition: Achieves Faster Decarbonization at a Lower Cost

Enhanced “dynamic” clean energy attributes approach would align payments with marginal carbon abatement

**Illustrative Traditional REC Payments**

- Flat payments over every hour
- Incentive to offer at negative energy prices during excess energy hours

**Illustrative “Dynamic” Clean Payments**

- Payments scale in proportion to marginal CO₂ emissions (by time and location)
- Incentive to produce clean energy when and where it avoids the most CO₂ emissions
- No incentive to offer at negative prices

Sources and Notes:
Enabling Competition: Lets Innovative Players Identify Creative Solutions

Dynamic payments incentivize clean energy at the right times to displace the most CO₂ emissions, enabling storage to compete with other technologies.
Takeaway:

It’s time to rethink nearly every aspect of the traditional IRP to...

- Support Large-Scale Electrification
- Redefine Reliability Needs
- Enable New Technology
- Enhance Competitive Procurement
Appendix
Best practices design would maximize competition and enable new investment when needed

**Design Features**

- Unbundled procurement of clean energy attribute credits (CEACs)
- Resource neutral (renewables, nukes, existing/new)
- 3-years forward, 1-year delivery period
- 7-year price lock-in for new supply
- Uniform price auction
- Downward-sloping demand curve
- Developers face merchant risk in CEAC, energy, and capacity markets
- States procure 100% of needs every year, creating stability to sellers
- Voluntary buy bids enabled from cities, companies, and retailers
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 US 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 Ph.D. in Engineering and Public Policy within the Carnegie Mellon Electricity Industry Center and her M.S. in Electrical and Computer Engineering from Carnegie Mellon University. She earned her B.S. in Physics and Mechanical Engineering from Iowa State University.

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- Electrification & Growth Opportunities
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- Energy Storage
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