The Next Generation of Energy Resource Planning

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

PRESENTED TO

National Conference of State Legislatures
2019 Legislative Summit

PRESENTED BY

Kathleen Spees

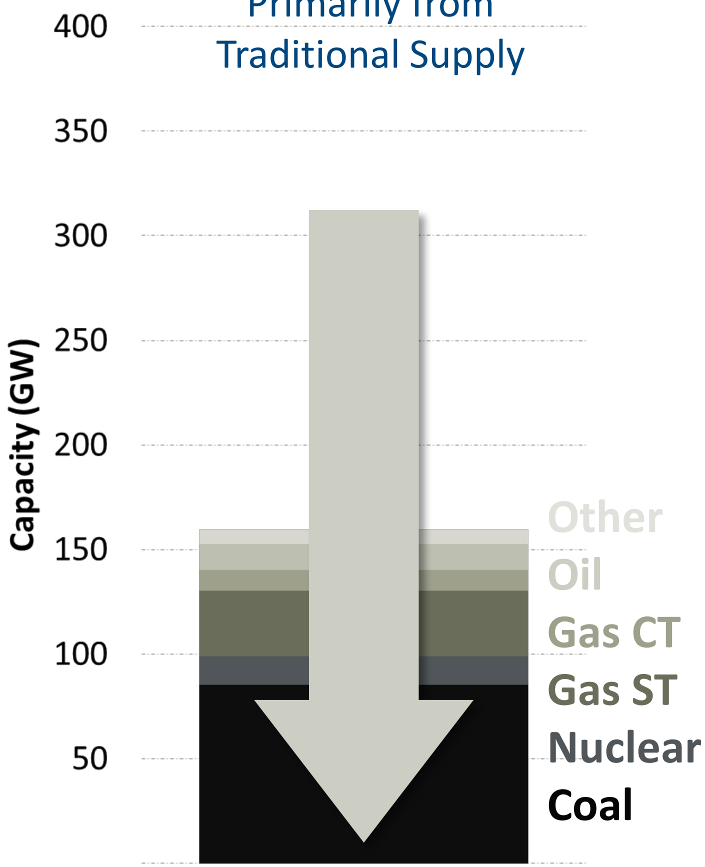
August 4, 2019

THE Brattle GROUP

New Technologies & Engaged Customers Are Rapidly Overtaking Traditional Supply

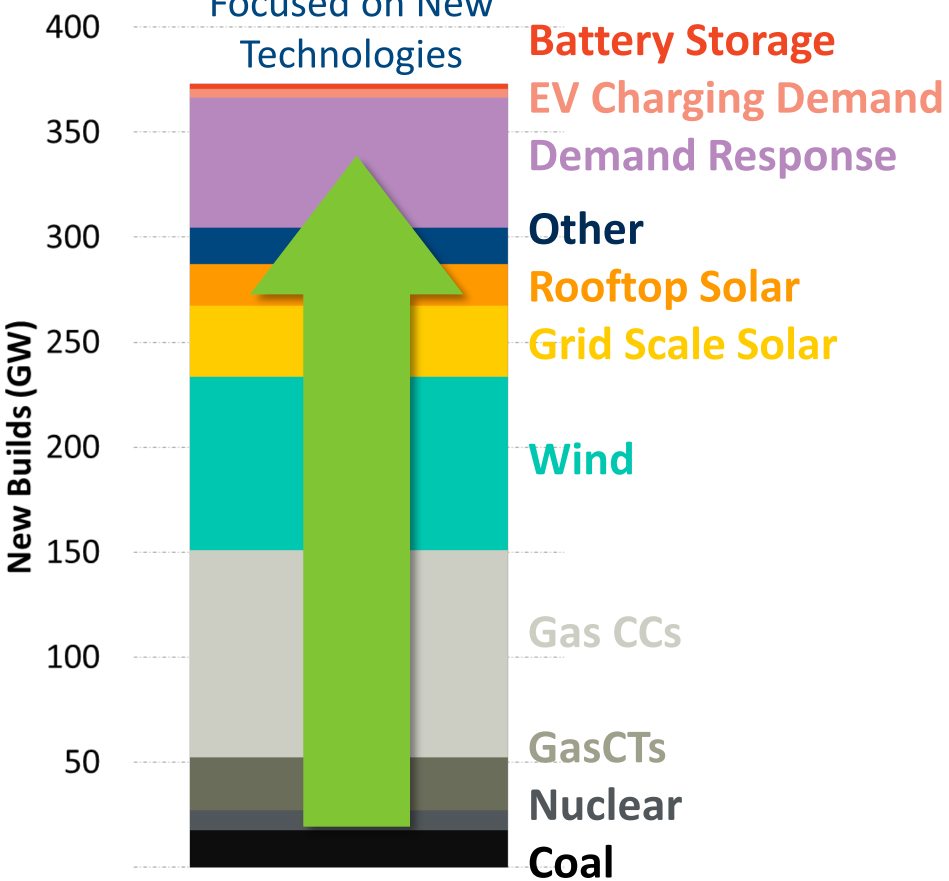
Retirements

Primarily from Traditional Supply



New Builds

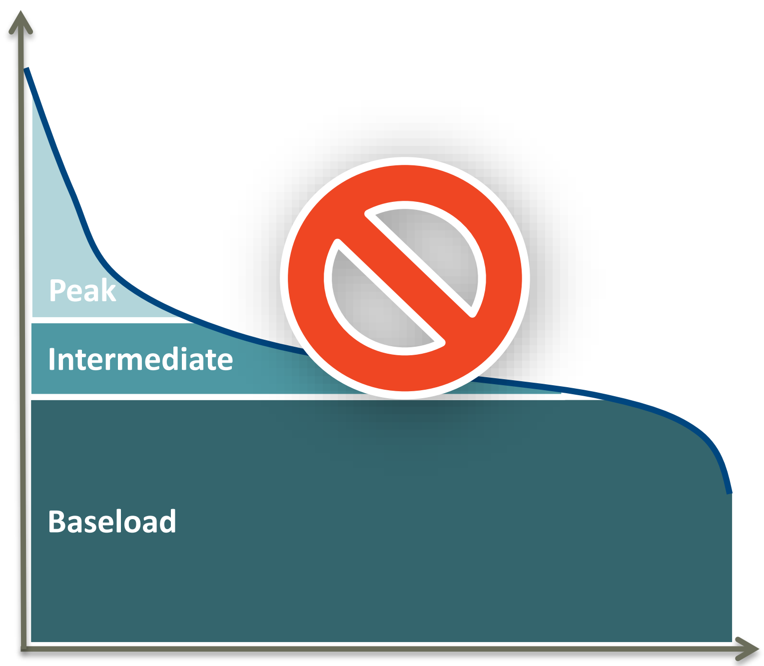
Focused on New Technologies



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?

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 polices and resource plan on employment and local GDP

RESULTS

OPTIMAL ELECTRICITY RESOURCE MIX & DISPATCH

RATEPAYER & SOCIETAL COSTS

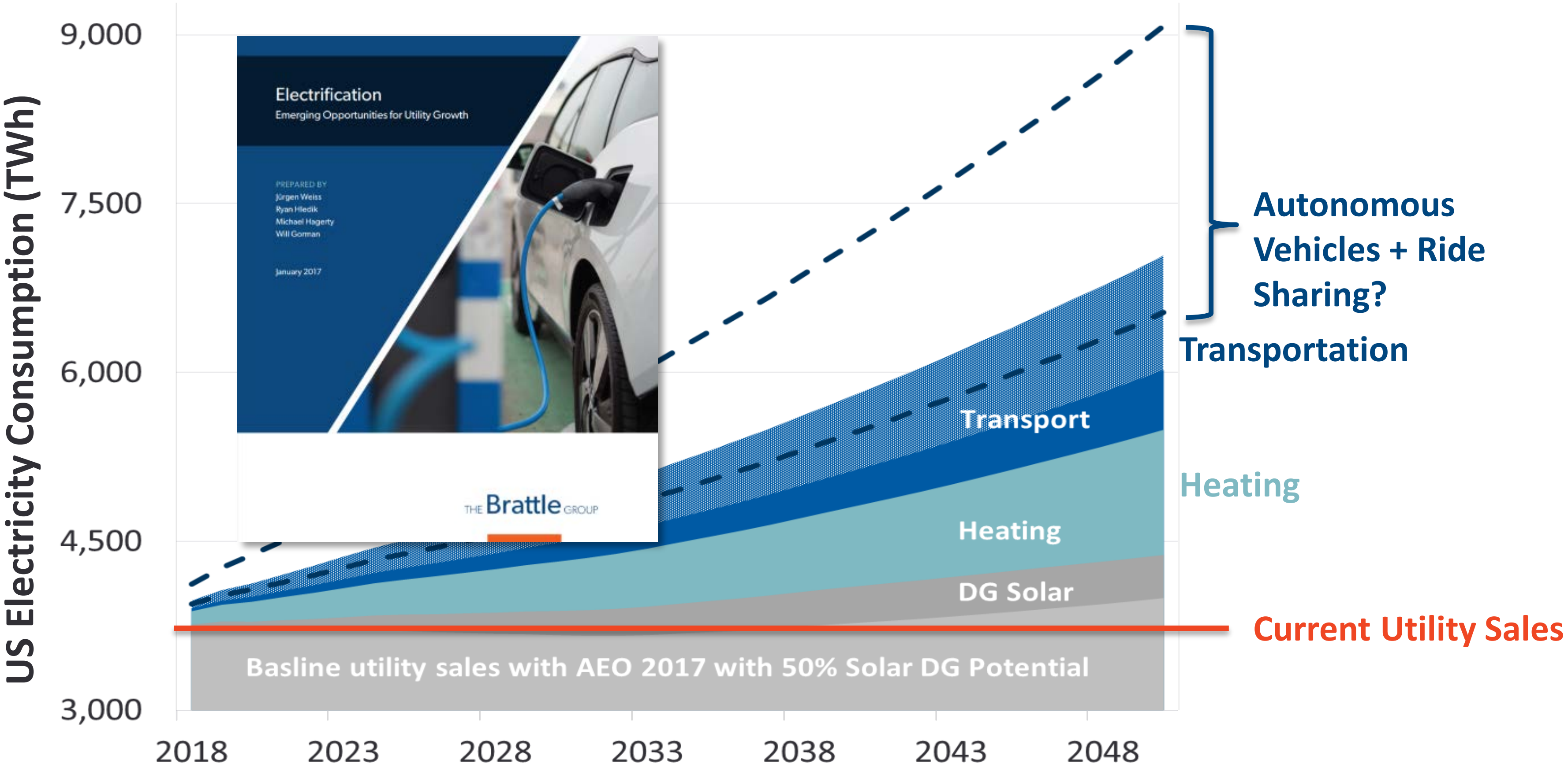
EMISSIONS & ENVIRONMENT

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)



Source: The Brattle Group, *Electrification* (2017).

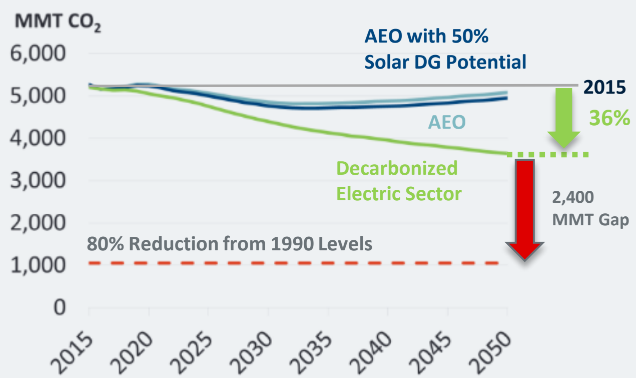
Electrification: Currently the Primary Feasible Path to 80% Decarbonization for States and Cities Aiming to Hit 80x50 Goals

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

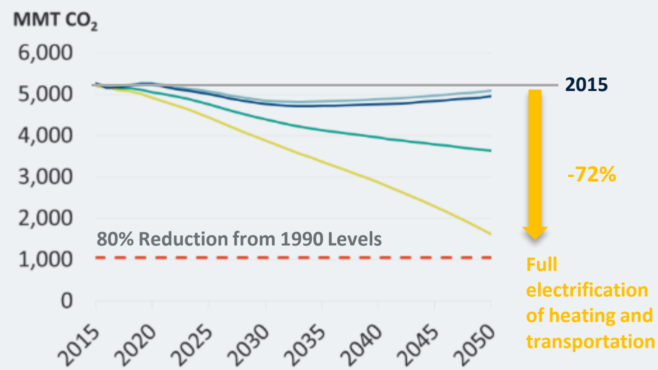
Electrification

Economy-Wide CO_2e Emissions

Without Electrification:
36% Carbon Reduction Potential



With Electrification:
72% Carbon Reduction Potential

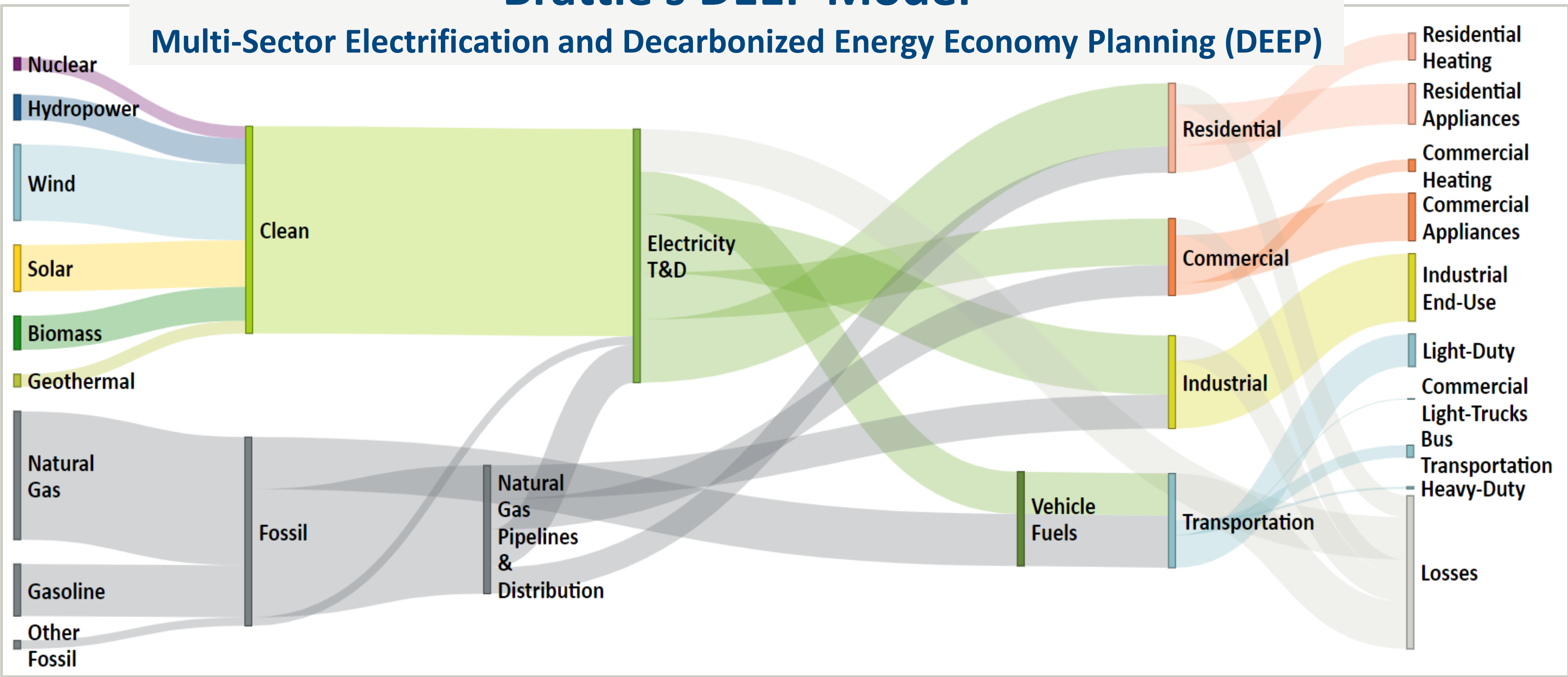


How Can Utility and State Planning Account for Electrification-Driven Demand?

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)

Brattle's DEEP Model

Multi-Sector Electrification and Decarbonized Energy Economy Planning (DEEP)



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?

Myths

Intuition may give us a false sense that the grid won't stay reliable unless we….

- Save baseload plants from retirement (or coal, or nuclear, or gas)
- Save a specific "favored" plant
- Stop building renewables
- Build a gas pipeline
- Impose on-site fuel requirements

Realities

It's not all hype. It will be a big challenge to maintain reliability while going clean…

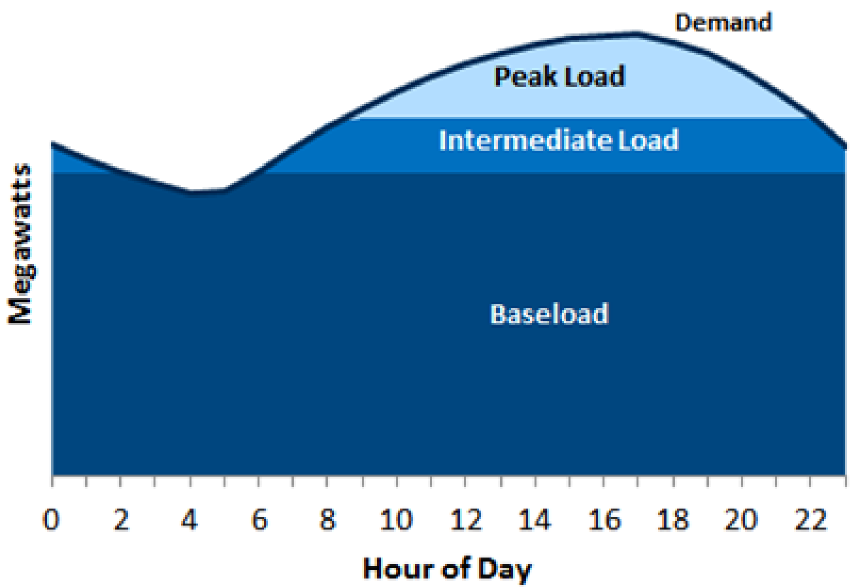
- Many customers and policymakers want to go clean (reliability concerns won't stop them)
- Intermittent renewables do not provide the same bundle of reliability services as traditional thermal plants
- Grid services we used to get "for free" will need to be defined and paid for
- Grid operators must learn to rely on non-traditional resources to provide these grid services
- Customers may prefer to save money by allowing some outages

To Clarify: Why Do We Need "Baseload" Plants Again?

…. We don't. We can drop "baseload" from planning vocabulary.

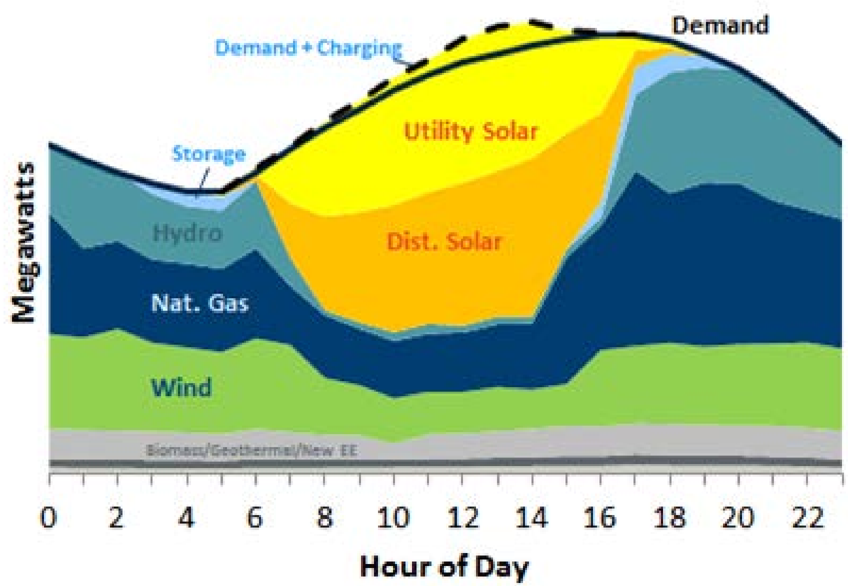
Traditional Planning

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.



Source: Chang, Geronimo-Aydin, Pfeifenberger, Spees, Pedtke. Advancing Past "Baseload" to a Flexible Grid. June 2017.

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

System Needs	Coal	CC	CT	Nuclear	RoR Hydro	Hydro w/ Storage	Wind	Solar	Battery Storage	DR	EE	Imports
Day-Ahead Energy	✓	✓	O	✓	✓	✓	✓	✓	O	O	O	✓
Real-Time Energy (5 Min)	✓	✓	O	O	✓	✓	✓	✓	O	O	O	O
Regulation	✓	✓	O	X	✓	✓	O	O	✓	O	X	O
Spinning Reserves	✓	✓	✓	X	O	✓	X	X	✓	O	X	O
Non-Spinning Reserves	X	✓	✓	X	X	✓	X	X	✓	O	X	O
Load following / Flexibility	O	✓	✓	O	O	✓	O	O	✓	O	X	O
Capacity	✓	✓	✓	✓	O	✓	O	O	O	✓	✓	✓
Clean Attributes (RECs)	X	O	O	✓	✓	✓	✓	✓	O	O	✓	✓
Reactive / Voltage Support	✓	✓	✓	✓	✓	✓	O	O	✓	X	X	O
Black Start	O	✓	✓	X	✓	✓	X	X	O	X	X	O

Technical Capability for Service
- ✓ Well Suited
- O Somewhat Capable
- X Not / Poorly Suited

Even non-traditional & carbon-free supply can provide essential grid services (<u>if</u> 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:

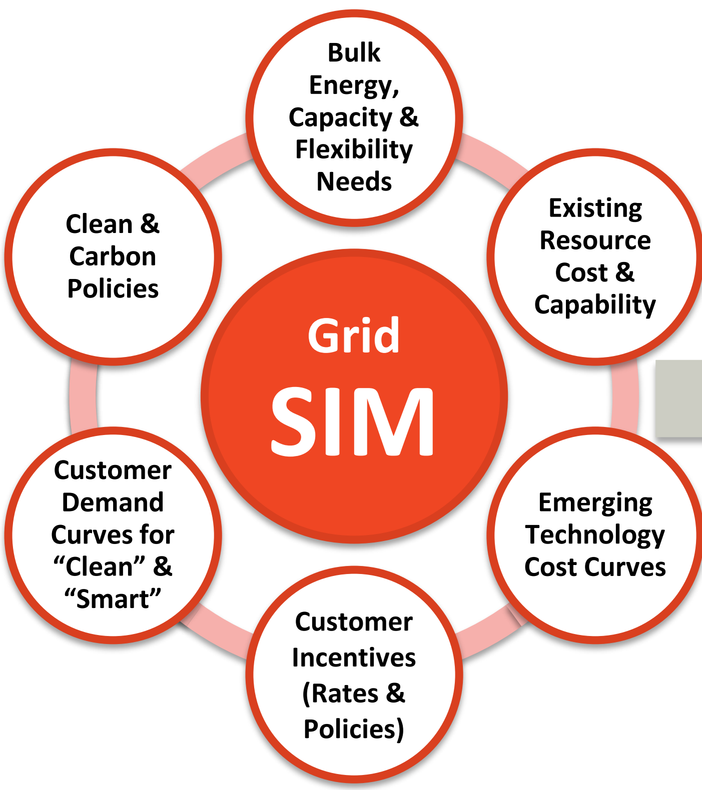
Controllable Demand
Bulk Storage
Grid Solar
Wind

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

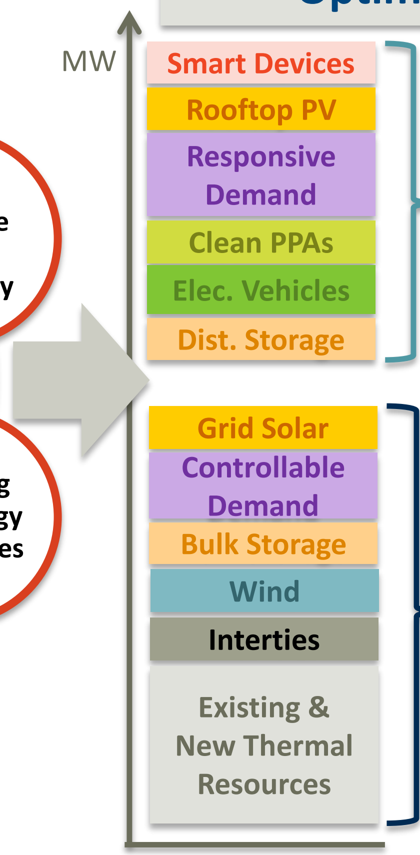
How Should a Modern Resource Plan Fairly Evaluate Disparate Technologies?

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

"Optimal" Resource Mix & Policy Design



Resources Chosen by Customers

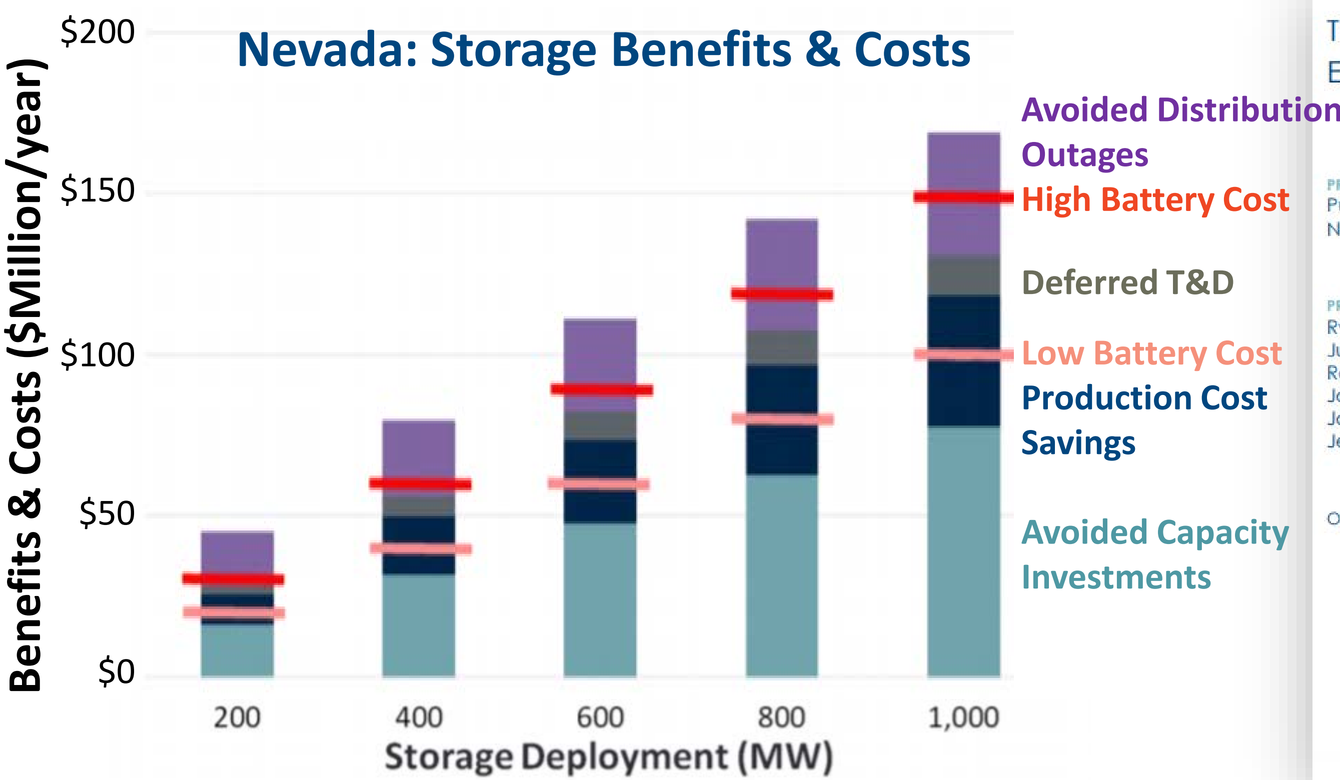
- Less predictable (requires scenarios)
- Role of IRP: Select well-designed rates, policy & enabling infrastructure to guide (but not dictate) grid evolution

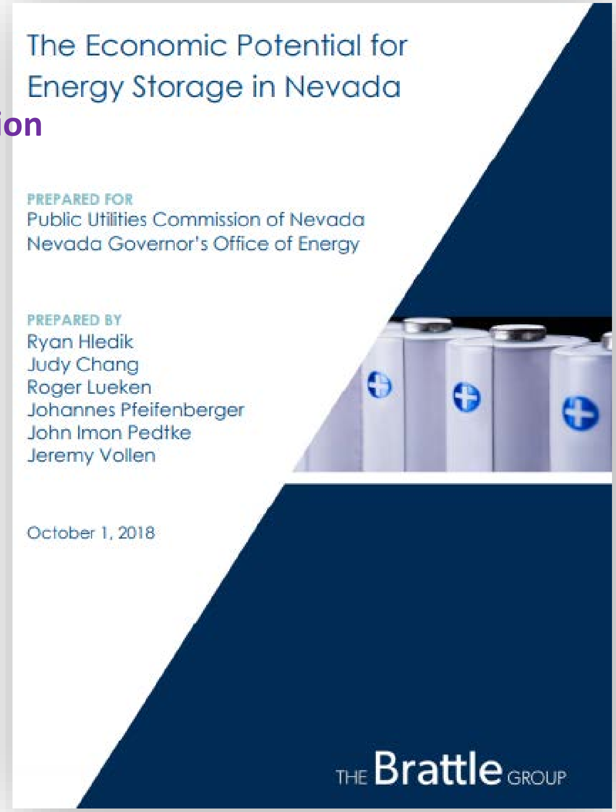
Resources Selected by Utility / State

- 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

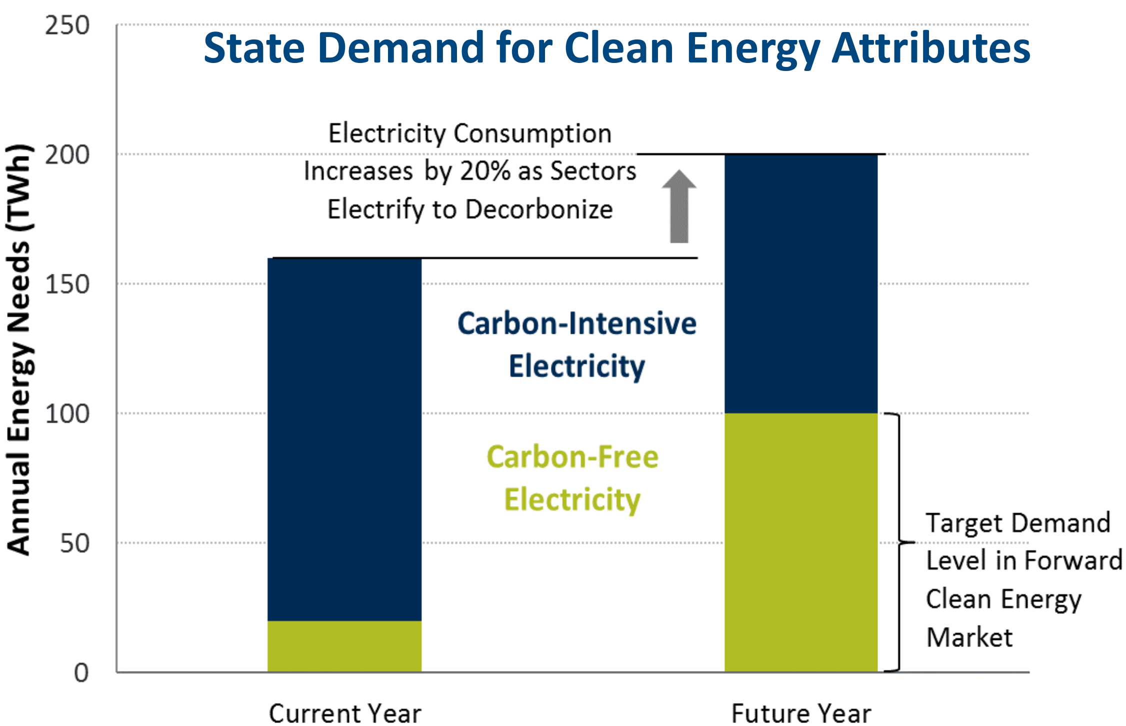
How Can Competitive Procurements Enable More Competition?

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




How States, Cities, and Customers Can Harness Competitive Markets to Meet Ambitious Carbon Goals

THROUGH A FORWARD MARKET FOR CLEAN ENERGY ATTRIBUTES

PREPARED FOR

nrg

PREPARED BY

Kathleen Spees
Samuel A. Newell
Walter Graf
Emily Shorin

April 2019

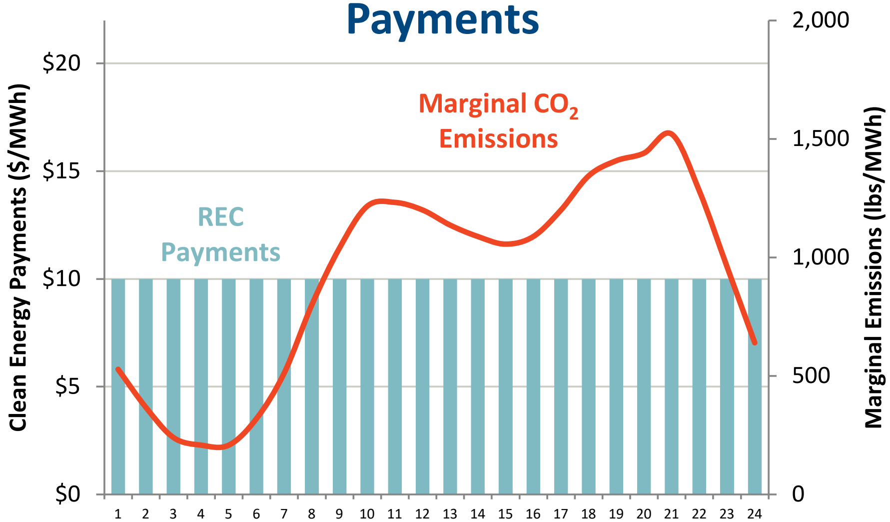
Sources and Notes:

See the full design proposal in *How States, Cities, and Customers Can Harness Competitive Markets to Meet Ambitious Carbon Goals Through a Forward Market For Clean Energy Attributes*, April 2019.

Better Product Definition: Achieves Faster Decarbonization at a Lower Cost

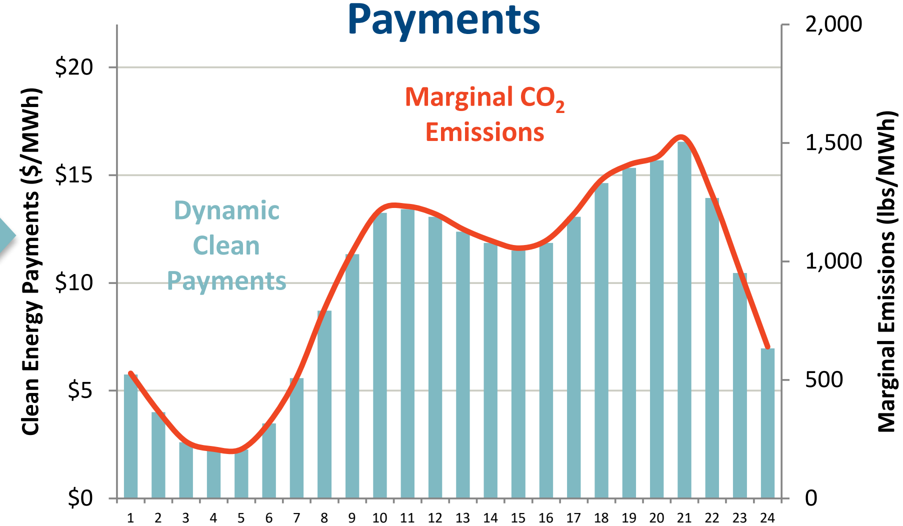
Enhanced "dynamic" clean energy attributes approach would align payments with marginal carbon abatement

Illustrative Traditional REC Payments



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

Illustrative "Dynamic" Clean Payments

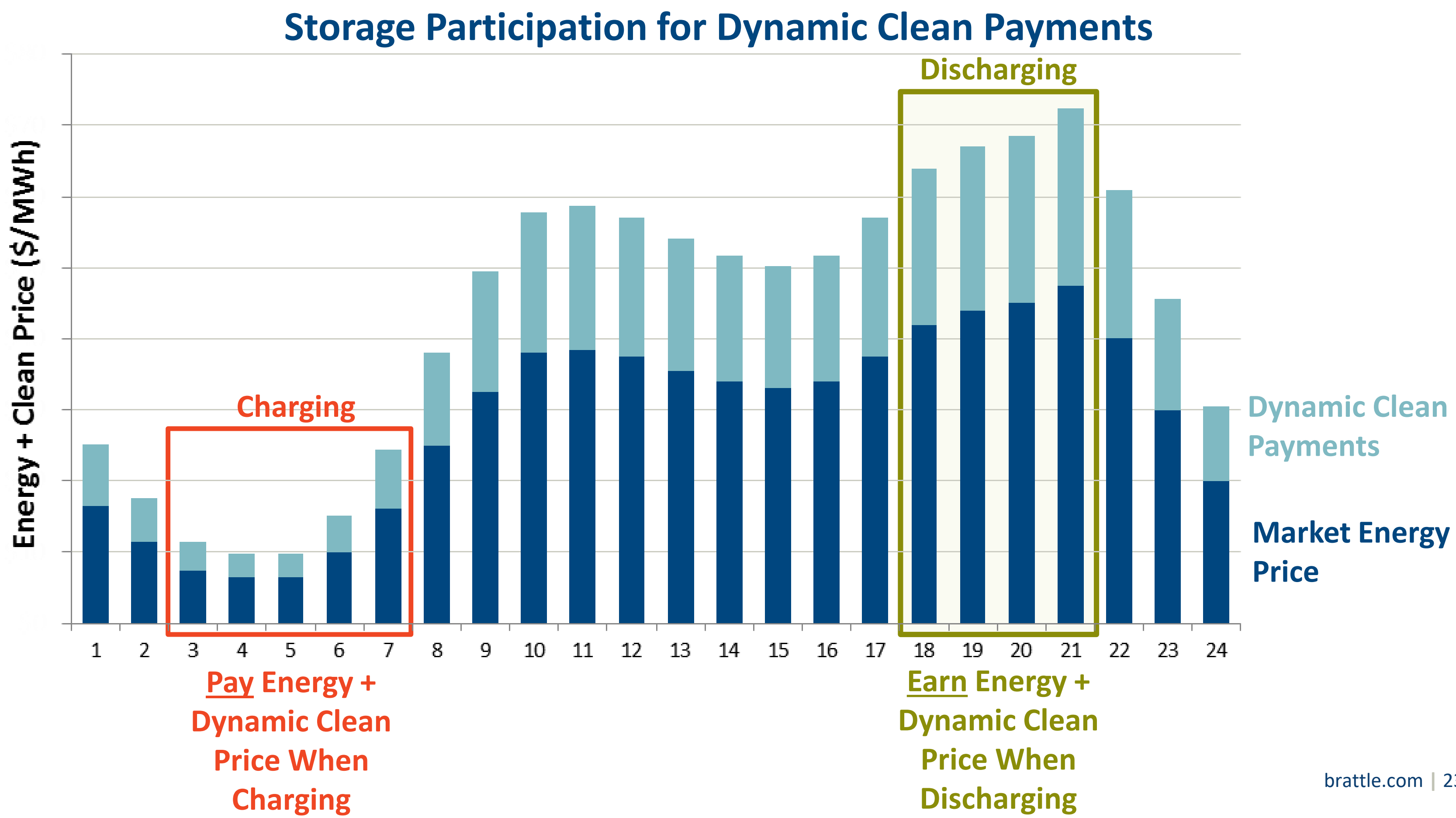


- Payments scale in proportion to marginal CO_2 emissions (by time and location)
- Incentive to produce clean energy when and where it avoids the most CO_2 emissions
- No incentive to offer at negative prices

Sources and Notes:
See the full design proposal here: http://www.nepool.com/uploads/IMAPP_20170517_LT_Straw_Dynam_Clean_Energy_Market.pdf

Enabling Competition: Lets Innovative Players Identify Creative Solutions

Dynamic payments incentivize clean energy at the right times to displace the most CO_2 emissions, enabling storage to compete with other technologies



Takeaway:

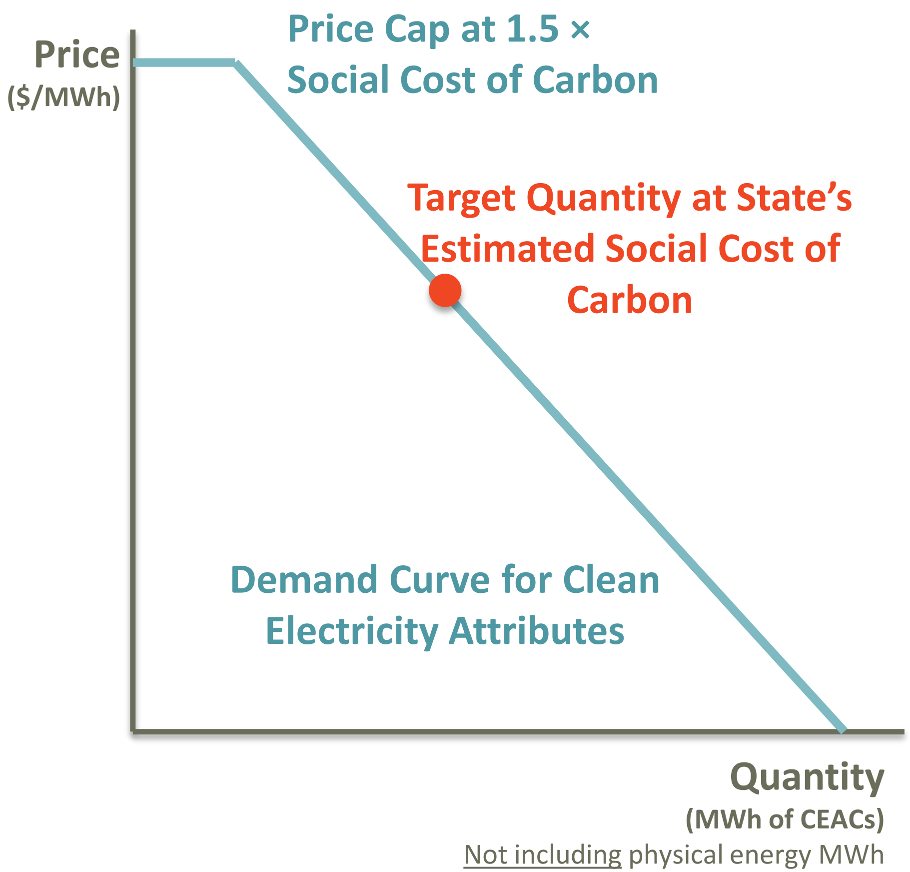
It's time to rethink nearly every aspect of the traditional IRP to...

Support Large-Scale Electrification	Redefine Reliability Needs	Enable New Technology	&	Enhance Competitive Procurement

Appendix

How Would the Forward Clean Energy Market Work?

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

PRESENTED BY

KATHLEEN SPEES

PRINCIPAL | WASHINGTON, DC

1.202.419.3390
KATHLEEN.SPEES@BRATTLE.COM

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 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.

Our Practices and Industries

ENERGY & UTILITIES

- Competition & Market Manipulation
- Distributed Energy Resources
- Electric Transmission
- Electricity Market Modeling & Resource Planning
- Electrification & Growth Opportunities
- Energy Litigation
- Energy Storage
- Environmental Policy, Planning and Compliance
- Finance and Ratemaking
- Gas/Electric Coordination
- Market Design
- Natural Gas & Petroleum
- Nuclear
- Renewable & Alternative Energy

LITIGATION

- Accounting
- Analysis of Market Manipulation
- Antitrust/Competition
- Bankruptcy & Restructuring
- Big Data & Document Analytics
- Commercial Damages
- Environmental Litigation & Regulation
- Intellectual Property
- International Arbitration
- International Trade
- Labor & Employment
- Mergers & Acquisitions Litigation
- Product Liability
- Securities & Finance
- Tax Controversy & Transfer Pricing
- Valuation
- White Collar Investigations & Litigation

INDUSTRIES

- Electric Power
- Financial Institutions
- Infrastructure
- Natural Gas & Petroleum
- Pharmaceuticals & Medical Devices
- Telecommunications, Internet, and Media
- Transportation
- Water

Our Offices


BOSTON


BRUSSELS


LONDON


MADRID


NEW YORK


ROME


SAN FRANCISCO


SYDNEY


TORONTO


WASHINGTON