

Planning for the Future: Strategies to Meet State Energy Goals

October 28 - 29, 2020 Day 2

National Governors Association Center for Best Practices



Opportunities for Governors to Leverage Electricity Markets to Meet State Energy Goals

Speakers:

Carl Linvill, Director, Principal, Regulatory Assistance Project

Susan Tierney, Senior Advisor, Analysis Group

Moderated by:

Emma Cimino, Senior Policy Analyst, National Governors Association



Opportunities for Electricity Markets to Meet States' Clean Energy Goals

Sue Tierney Analysis Group

October 29, 2020

CHICAGO DALLAS LOS ANGELES MENLO PARK NEW YORK SAN FRANCISCO BEIJING BRUSSELS LONDON MONTREAL PARIS BOSTON DENVER WASHINGTON, DC • • • •

States' clean energy goals



https://www.nga.org/center/publications/governors-leading-energy-transitions/

The states are leading the nation toward a clean energy transition:

- 80% of the U.S. population is in a state with a clean energy requirement
- 75% of the states + DC have a clean energy requirement

- States with 100% clean or renewable energy goals electricity sector only
- States with 100% clean or renewable energy goals economy-wide
- States with Renewable Portfolio Standards or targets

States' clean energy goals

U.S. Clean Energy Goals by State: July 2020



lited States Electric utilities with net-zero power-sector commitments Golfo

And even in many states without a clean-energy policy, the electric utility has made a commitment to net zero emissions

https://www.nga.org/center/publications/gover nors-leading-energy-transitions/ Tierney map of utility commitments

States' clean energy goals – and regions



https://gmlc.doe.gov/sites/default/files/resources/1.3.33_Midwest%20Interconnection%20Seams%20Study_Presentation.pdf

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States' clean energy goals – and regions



https://gmlc.doe.gov/sites/default/files/resources/1.3.33_Midwest%20Interconnection%20Seams%20Study_Presentation.pdf http://www.sciencecodex.com/advanced_powergrid_research_finds_lowcost_lowcarbon_future_in_west-89158



States' clean energy goals – and regions



https://gmlc.doe.gov/sites/default/files/resources/1.3.33_Midwest%20Interconnection%20Seams%20Study_Presentation.pdf http://www.sciencecodex.com/advanced_powergrid_research_finds_lowcost_lowcarbon_future_in_west-89158; https://peguru.com/2018/09/who-controls-the-power-grid-in-usa/



States' clean energy goals – and regions



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Implications re: regional power markets

- Broader regional wholesale power markets can:
 - Open up access to areas with high-quality renewable energy resources, connect them to distant loads, and enable development of projects
 - Allow for efficient dispatch of generating resources
 - Leverage diversity of loads and resources
 - Reduce pancaked transmission rates
 - Maintain state decisions about electric industry structure

Wholesale power markets and state industry structure

Current status of retail restructuring across states

Many states with traditional electric industry structure have chosen to participate in regional wholesale markets, even without retail restructuring



Source: Federal Energy Regulatory Commission NYISO



Wholesale markets = federal regulation

- Jurisdiction of the Federal Energy Regulatory Commission relating directly or indirectly to the electric industry includes:
 - Rates, terms and conditions of transmission in interstate commerce
 - Rates, terms and conditions of wholesale sales in interstate commerce
 - Licensing of hydroelectric facilities and gas pipelines
 - Electric reliability
 - Cyber security on the bulk power system

FERC authority over RTOs and ISOs (e.g., transmission tariff, wholesale market design, transmission planning) relates to the agency's authority over transmission and wholesale sales.



What is not in FERC's jurisdiction

Electricity

- Local distribution of electric energy
- Prices for retail sales of electricity to end users
- Electric resource adequacy
- Approval of utilities' purchases of wholesale power
- Siting of power plants (other than hydropower facilities)
- Siting of transmission lines (except as backstop authority)
- Environmental controls on power plants
- Wholesale sales or transmission not in interstate commerce (ERCOT, Alaska, Hawaii)





Susan F. Tierney, Ph.D. Senior Advisor, Analysis Group Susan.tierney@analysisgroup.com



October 29, 2020

Aligning Clean Energy Goals with Markets: Lessons from the Western Energy Imbalance Market

National Governors Association

Dr. Carl Linvill Principal The Regulatory Assistance Project (RAP)[®] 50 State Street, Suite 3 Montpelier, Vermont United States +1 802 498 0723 clinvill@raponline.org raponline.org

Western EIM Value Proposition is Positive

- Numerous studies: Mutual benefits of extended markets was proven
- California: regional market expansion is a least cost solution for integrating much greater quantities of renewables
- PacifiCorp: alignment between regional market extension and their business plan
- Affected regulators: Ratepayer benefits expected, alignment with energy policy goals

Western EIM is attractive

- Independence of the market operator
- Cost of Entry was very low due to existing platform
- Utilities and their regulators can decide one at a time
- Cost of Exit is zero

Governance: The Transitional Committee is Diverse

- California entities delegated governance to a "transitional committee"
- Transitional Committee voting members (1 representative each):
 - Investor Owned Utilities
 - Publicly Owned Utilities
 - Generators and Marketers
 - Alternative Energy Providers (e.g., solar or wind developer)
 - EIM Participants (e.g., utilities outside of CAISO)
 - Government Agencies (e.g., state PUCs)
 - Public Interest Entities (e.g., environmental/consumer representative)

Governance: EIM Foundations

- An Independent EIM Governing Body appointed by a regional nomination committee
 - Each GB member has no conflict of interest with any market participant
- CAISO Board of Governors to delegate authority over EIM decisions
 - EIM GB has primary authority over market rules that are caused by EIM
 - EIM GB has advisory/hybrid authority over all market rules that affect EIM participants
- Appointment/reappointment driven by the regional nominating committee, not the CAISO BOG or the Governor of California

Governance engendered trust and growth

In 2014 and 2015, EIM was PacifiCorp and the CAISO



2015 Q2 Report Quantifying EIM Benefits, 07/30/2015

BAA	April	May	June	Total
ISO	\$0.62	\$1.00	\$0.84	\$2.46
PACE	\$0.62	\$0.97	\$1.67	\$3.26
PACW	\$0.66	\$1.21	\$2.59	\$4.46
Total	\$1.90	\$3.18	\$5.10	\$10.18

Table 1: Estimated benefits shown are in millions and accrued in the second quarter of 2015



By 2017, NVE, APS, PSE and PGE joined



Graph 1: Estimated maximum transfer capacity

By 2020...

By 2020, EIM includes 10 utilities (including 3 public power), and by 2022 more than 85% of WECC energy will be included (including BPA)



Path	Estimated Max Capacity (MW)			
Path 24 (west to east)	100			
Path 24 (east to west)	35-90			
Eldorado	797			
Path 35 (west to east)	580			
Path 35 (east to west)	538			
Gonder-Pavant	130			
PACW to PGE	320			
Path 66 (ISO to PGE)	627			
Path 66 (PGE to ISO)	296			
Path 66 (ISO to PACW)	331			
Path 66 (PACW to ISO)	432			
Path 17	0-4001 2			
PSE to PACW	300			
Eldorado 500-Moenkopi	732			
Palo Verde, N. Gila	3,151			
Path 78 (PACE to APS)	625			
Path 78 (APS to PACE)	660			
Navajo-Crystal	522			
Mead 500	349			
Mead 230 (APS <-> ISO)	236			
Mead 230 (ISO to NVE)	3,443			
Mead 230 (NVE to ISO)	3,476			
IPCO to PACW (Path 75)	1,500			
PACW to IPCO (Path 75)	400-510			
PACE to IPCO	2,557			
IPCO to PACE	1,550			
NVE to IPCO	262			
IPCO to NVE	390-478			
Powerex <-> PSE	150			
Powerex <-> ISO	150			

¹ Is an optional path available for PACENG/W EM nations and the coprocity is a subset of PACENCO/NCOPACE and Path 72 cospacity. ² When in sam, the available capacity on PACENCO/PCOPACE and Path 72 will be autosequently reduced by the used encount on Path 17, and not double counted.

Current as of July 2020

GRAPH 2: Estimated maximum transfer capacity (EIM entities operating in Q2 2020)

Everyone benefits from the beginning

Benefits

\$1 billion - from November 2014 to July 3, 2020 \$998.69 million - as of Q2 ending June 30, 2020

(millions \$)

EIM PARTICIPANTS	2014	2015	2016	2017	2018	2019	2020		TOTAL
							Q1	Q2	TOTAL
Arizona Public Service Entered 10/2016			\$5.98	\$34.56	\$45.30	\$54.48	\$11.26	\$6.40	\$157.98
BANC Entered 04/2019						\$15.86	\$7.07	\$9.17	\$32.10
California ISO Entered 11/2014	\$1.24	\$12.66	\$28.34	\$36.96	\$67.94	\$44.74	\$9.57	\$21.25	\$222.70
Idaho Power Company Entered 04/2018					\$26.88	\$28.23	\$5.15	\$6.08	\$66.34
NV Energy Entered 12/2015		\$0.84	\$15.57	\$24.20	\$25.55	\$22.87	\$5.36	\$4.73	\$99.12
PacifiCorp Entered 11/2014	\$4.73	\$26.23	\$45.47	\$37.41	\$61.68	\$59.77	\$7.80	\$8.46	\$251.55
Portland General Electric Entered 10/2017				\$2.83	\$27.57	\$42.87	\$6.93	\$9.15	\$89.35
Powerex Entered 04/2018					\$7.84	\$11.94	\$1.09	\$2.84	\$23.17
Puget Sound Energy Entered 10/2016			\$1.56	\$9.86	\$13.68	\$16.15	\$3.67	\$1.15	\$46.07
Seattle City Light Entered 04/2020								\$1.63	\$1.63
Salt River Project Entered 04/2020								\$8.14	\$8.14
TOTAL	\$5.97	\$39.73	\$96.92	\$145.82	\$276.44	\$296.91	\$57.90	\$79.00	\$998.69

Western states, regulators and advocates have been engaged

- Assessing benefits studies and tracking how their ratepayers are expected to benefit
- Requiring utilities to report on the benefits to ratepayers
- Auditing the costs associated with joining the EIM and tracking how much ratepayers are paying for those investments and expenses
- Auditing the cost of transmission and ensuring that their ratepayers aren't subsidizing other participants
- Participating in governance reforms to add a day ahead market product to the Western EIM platform

Key questions states should ask

- What obligation does the governing body have to hear and respect state and stakeholder voices?
- How do states get the information and analysis they need to assess whether state policies are being respected?
- How will ratepayer benefits be measured, tracked and reported?
- How will incremental investments and expenses be measured, tracked and reported?
- How will a level playing field for utility and non-utility participants be ensured?



About RAP

The Regulatory Assistance Project (RAP)[®] is an independent, nonpartisan, non-governmental organization dedicated to accelerating the transition to a clean, reliable, and efficient energy future.

Learn more about our work at raponline.org



Dr. Carl Linvill Principal The Regulatory Assistance Project (RAP)® 50 State Street, Suite 3 Montpelier, Vermont United States +1 802 498 0723 clinvill@raponline.org raponline.org



Moderated Discussion

Speakers:

Carl Linvill, Director, Principal, Regulatory Assistance Project

Susan Tierney, Senior Advisor, Analysis Group

Moderated by:

Emma Cimino, Senior Policy Analyst, National Governors Association



Meeting State Energy Resilience Priorities

Speakers:

Craig Lewis, Executive Director, Clean Coalition

Eric Coffman, Director of Energy Programs, Maryland Energy Administration Moderated by:

Dan Lauf, Program Director, National Governors Association



Community Microgrids

Unparalleled trifecta of benefits

Craig Lewis Executive Director Clean Coalition 650-796-2353 mobile craig@clean-coalition.org

Making Clean Local Energy Accessible Now

29 October 2020



<u>Mission</u>

To accelerate the transition to renewable energy and a modern grid through technical, policy, and project development expertise.

100% renewable energy end-game

- 25% local, interconnected within the distribution grid and facilitating resilience without dependence on the transmission grid.
- 75% remote, dependent on the transmission grid for serving loads.

Natural gas infrastructure is not resilient

Clean Coalition

- Assertion: Gas-driven generation is often claimed to be resilient.
- **Reality:** Gas infrastructure is not resilient and takes much longer to restore than electricity infrastructure.
- **Threats:** Gas infrastructure can be flatout dangerous and is highly vulnerable to earthquakes, fires, landslides, and terrorism.



2010 San Bruno Pipeline Explosion



<u>Source</u>: The City and County of San Francisco Lifelines Study

Typical load tier resilience from a Solar Microgrid



Percentage of time

Percentage of time online for Tier 1, 2, and 3 loads for a Solar Microgrid designed for the University of California Santa Barbara (UCSB) with enough solar to achieve net zero and enough energy storage capacity to hold 2 hours of the nameplate solar (200 kWh energy storage per 100 kW solar). **Clean** Coalition

Diesel generators are designed for limited resilience

Clean Coalition



Percentage of time

A typical diesel generator is configured to maintain 25% of the normal load for two days. f diesel fuel cannot be resupplied within two days, goodbye. This is hardly a solution for increasingly necessary long-term resilience. In California, Solar Microgrids provide a vastly superior trifecta of economic, environmental, and resilience benefits.

Goleta Load Pocket (GLP) Community Microgrid

Clean Coalition



- GLP spans 70 miles of California coastline, from Point Conception to Lake Casitas, encompassing the cities of Goleta, Santa Barbara (including Montecito), and Carpinteria.
- GLP is highly transmission-vulnerable and disaster-prone (fire, landslide, earthquake).
- 200 megawatts (MW) of solar and 400 megawatt-hours (MWh) of energy storage will provide 100% protection to GLP against a complete transmission outage ("N-2 event").
 - 200 MW of solar is equivalent to about 5 times the amount of solar currently deployed in the GLP and represents about 25% of the energy mix.
 - Multi-GWs of solar siting opportunity exists on commercial-scale built environments like parking lots, parking structures, and rooftops; and 200 MW represents about 7% of the technical siting potential.
 - Other resources like energy efficiency, demand response, and offshore wind can significantly reduce solar+storage requirements.

Making Clean Local Energy Accessible Now

Need to properly value local energy

Clean Coalition



Need to streamline Interconnection

Clean Coalition


Need to implement Feed-In Tariffs (FITs)



Direct Relief Solar Microgrid needs a FIT to maximize solar



ENERGY RESILENCE IN MARYLAND

National Governors Association – October 28th, 2020 Eric Coffman, Director of Energy Programs



Maryland

Energy Administration

GRID CHALLENGES

SECTORS

EMERGING TECHNOLOGIES AND CHANGING BUSINESS MODELS severe storms physical and cyber attacks high summer temps frigid winter temps electrification growing distributed energy aging grid infrastructure

health care agrobusiness businesses manufacturing transportation higher learning campuses government facilities multi-family housing

distributed energy resources (DERs) PV storage CHP grid-interactive solutions enterprise energy management

Maryland Energy Administration

Resiliency Fulos

Grants local community resiliency hubs

Sectors: LMI communities, community groups, public buildings

Up to \$3,000 per kilo-watt hour for solar with energy storage that can provide multi-day power supply to allow food distribution, cooling, charging of electronics etc.



Maryland Energy Administration

Resiliency Hubs - <u>P.OW.E.R. House</u>

First solar powered, community-based resiliency hub in the nation. Partnership between MEA, a private renewable energy company, Power52 and the nonprofit, Living Classrooms. The solar panels are connected to battery storage.

The center can maintain critical systems for elderly residents next door like lights, refrigeration (for food and medication), HVAC.



Resilient Maryland

Grants for feasibility planning, design, assessment

Sectors: business, education, government, healthcare, LMI, utilities and more

Resiliency Hub:\$100,000Resilient Facility Power System:\$2Advanced CHP:\$1Resiliency Hub:\$1

\$25,000 \$10,000 \$10,000



FY20 Spotlights

ConAgra-Foods-Packaged-

Maryland.

Montgomery 1

Con

County¶

Foods Holdings, Inc.

Housing Initiative Partnership Inc.

District-Farms-LLC¶

PRI/19647-Fisher

Avenue, LLC¶

Frostburg State University - \$100,000

To develop a campus-scale microgrid to bolster campus energy resilience, further sustainability goals, and provide students with real world job training.

Smart Electric Power Alliance - \$99,725 A collaboration with Baltimore Gas & Electric Company, City of Annapolis and Gabel Associates to plan and design a communityscale microgrid for the Newtowne Twenty multifamily housing community.

Delaware

Groundswell - \$300,000

Working in concert with the city of Baltimore this grant will fund the design of a network of community resiliency hubs.

Frostburg-State-University¶

Questions?

Maryland Energy Administration

eric.coffman@maryland.gov 443-908-1553

MEDIA INQUIRIES:

contact kaymie.owen@maryland.gov 443.694.3651 directly for quotes.



Maryland Energy Administration

Energy.Maryland.gov



Funding and Financing the Energy Transition

Speakers:

Bert Hunter, Executive Vice President, Connecticut Green Bank

Sherri Billimoria, Senior Associate, Rocky Mountain Institute

Moderated by:

Jessica Rackley, Program Director, National Governors Association



Funding and Financing the Energy Transition

NGA Workshop Planning for the Future: Strategies to Meet Governors' Clean Energy Goals

October 29, 2020

Clean + Modern Grid

Utility Business Models | Regulatory Innovation | Grid Integration | Transportation Electrification







Vision

A carbon-free energy system by 2050

Mission

To facilitate the electric power industry's **smart transition** to a clean and modern energy future.







Who Are We?



A membership Founded in 1992 organization Research, Education, Staff of ~45 **Collaboration & Standards** Based in Unbiased Washington, D.C. No Advocacy – 501c3 Technology Agnostic



Membership

88:88

SEPA is an **alliance** of almost 1,200 members made up of utilities, technology solution providers, regulators, and other stakeholders.





SEPA Research & Education



Pathways



Utility Business Models

Utilities have sustainable business models that facilitate and support a carbon-free energy future.

Regulatory Innovation

State regulatory processes enable timely and effective deployment of technologies, partnerships and business models that reduce carbon emissions.



Grid Integration

Carbon-free energy is easily integrated with positive impact to affordability, safety, security, reliability, resiliency, and customer satisfaction.



Transportation Electrification

The nation's fleet of vehicles is powered by carbon-free electricity and capable of providing grid services.





Regulatory Innovation:

Tools for Utility Regulators & Policymakers

to Fund and Finance the Transition

Renovate Initiative Solution Set

The mission of the **Renovate Initiative** is to spur the evolution of state regulatory processes and practices to enable innovation, with a focus on scalable deployment of new technologies and operating models, to meet customer needs and increasing expectations while continuing to provide all with clean, affordable, safe, and reliable electric service.



Renovate INITIATIVE Regulatory • Process • Innovation

SOLUTION SET

IDENTIFYING PROMISING PRACTICES, PROCESSES AND STRUCTURES TO ENABLE INNOVATION

What is the objective of the Renovate Solution Set? This set of solutions showcases a menu of promising regulatory practices, processes and structures to address barriers to innovation. The solutions are actionable and provide demonstrated roadmaps for change. They can be adopted and/or adapted to address environments and objectives within each state.

Why a focus on innovation? New technology, approaches and customer preferences are disrupting the ways utilities and other organizations provide electricity products and services. Without innovation, the current energy system is at risk of not capturing the benefits of system efficiencies for customers, including those driven by customer and competitive solution provider deployment of technologies and distributed energy resources (DERs). Without innovation now, the system will require bigger changes later.

Who are these solutions for? These solutions can be adopted and adapted by a variety of stakeholders. Proposed solutions could include a new commission process, a utility proposal filed with a commission, a legislative change, or an advocate's initiative.

How to use the Renovate Solution Set? The Renovate Task Force and Partners (see Appendix) identified four problems standing in the way of achieving the mission of enabling innovation and scalable deployment of new technologies and operating practices to benefit customers: I. People and knowledge (about the capabilities, benefits and costs of new technologies and operating practices), II. Managing risk and uncertainty, III. Managing increased rate of change, and IV. Complexity of objectives / cross-coordination to address in reaching this goal state.

The problems and potential solutions are complex and interrelated, and circumstances differ in the states where they might be adopted and adapted. The description of each solution includes some of the specific problems it could address, where to start, resources for further reading, and examples of where the solution is being tested or used.

The solution set is organized along two dimensions: the **problem statement** and the **solution type**. Solutions organized by problem statement allow the reader to see a list of tools to address a particular problem. Solutions organized by solution type allow the reader to see solutions that might already be part of the conversation or an approach being used in their jurisdiction/service territory/operating market.

Utility Carbon Reduction Targets



www.sepapower.org/ carbon-reduction-tracker/



major utilities have carbon-free or net-zero goals by 2050 or sooner

32

68%

of customers are served by a utility with a goal of 50% or greater reduction

> Smart Electric Power Alliance

Renovate Initiative Solution Set



THE SOLUTION SET **TABLE OF CONTENTS**

Solutions are grouped by types of approaches that might already be part of the conversation within one's jurisdiction/service territory/operating market.

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3.6 Innovation Fund
3.7 Updated Framework for Benefit Cost Analysis

2. EDUCATION: CONTENT, DELIVERY, & SHARING

2.1 Sub-Type: Education: Content
Formal Education Programs for Commissioners, Staff, Consumer Advocates and Other Stakeholders
2.2 Sub-Type: Education: Sharing Knowledge Repositories & Sharing, Including Pilots and Technology Performance
2.3 Sub-Type: Education: Delivery Online, Onsite, and On-demand Resources

CROSS-COORDINATION

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Building Consensus (or at least a common understanding)



1. COLLABORATIVE AND INFORMAL PROCESSES

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Educating All Stakeholders



2. EDUCATION: CONTENT, DELIVERY, & SHARING

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Regulatory Tools



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Policy Alignment



4. CROSS-COORDINATION



Carbon-free by 2050 starts now!

Janet Gail Besser Managing Director jbesser@sepapower.org



TICUT

Green Liberty Bonds in Honor of the 50th Anniversary of Earth Day

\$16,795,000 State Supported Solar Home Renewable Energy Credit, Green Liberty Bonds, Series 2020 Federally Taxable – Climate Bond Certified

National Governors Association

October 29, 2020

Connecticut Green Bank



Mission Statement and Goals



- Leverage limited public resources to scale-up and <u>mobilize private</u> <u>capital investment</u> in the green economy of Connecticut.
- Strengthen Connecticut's communities by <u>making the benefits of the</u> green economy inclusive and accessible to all individuals, families, and businesses.
- Pursue investment strategies that <u>advance market transformation in</u> <u>green investing</u> while supporting the organization's pursuit of financial sustainability.

Citizen Engagement Research



Types of Green Projects for Investment



REFERENCES

Research conducted by GreatBlue Research on behalf of the Connecticut Green Bank. Two targeted audiences were reached – households that have installed residential solar PV in CT and general population of CT (i.e., households that haven't participated in a Connecticut Green Bank Program).

Citizen Engagement Research



Equitable Access to Green Bond Investment



REFERENCES

Research conducted by GreatBlue Research on behalf of the Connecticut Green Bank. Two targeted audiences were reached – households that have installed residential solar PV in CT and general population of CT (i.e., households that haven't participated in a Connecticut Green Bank Program).

Green Liberty Bonds

Celebrating the 50th Anniversary of Earth Day

Green Liberty Bonds Three Features of the Green Bond

- <u>Use of Proceeds</u> use of proceeds from the bond are invested to *combat climate change* (i.e., support Paris Agreement with mitigation and adaptation projects) and create jobs in our communities
- <u>Retail Accessible</u> bonds available to purchase by *everyday citizens* (vs. institutional investors only) in lower denominations (i.e. \$1,000)
- <u>Certified and Verified</u> –

independently certified (e.g., Climate Bonds Initiative, Green Bond Principles, etc.) and verified as a climate bond or green bond for *consumer protection*

6

CONNECTICUT GREEN BANK

Residential Solar PV in CT

Revenue Bonds

When panels produce electricity for a home, they also produce **Solar Home Renewable Energy Credits (SHRECs).** The Green Bank provides upfront incentives through RSIP and collects all the SHRECs produced per statute (i.e., PA 15-194).

Utilities required to enter into **15-year Master Purchase Agreement (MPA)** with the Green Bank to purchase the stream of SHRECs produced. This helps utilities comply with their clean energy goals (i.e., Class I RPS). The Green Liberty Bonds are secured by SHREC revenues received, the Special Capital Reserve Fund, and any moneys deposited by the Green Bank into the Trust Estate The Green Bank uses the Bond proceeds to support the RSIP incentives, cover admin and financing costs to achieve 350 MW of solar PV deployment and development of local solar PV industry

SHREC / RSIP Process

Green Liberty Bonds 2020

Transaction Diagram

Green Liberty Bonds 2020 Serial and Term Series 2020 Bonds

Maturity (November 15)	Expected Net SHREC Receivables (P90)	Principal Amount	Interest Rate
11/15/2021	1,737,664	1,145,000	0.950%
11/15/2022	1,724,438	1,148,000	1.080
11/15/2023	1,710,748	1,147,000	1.250
11/15/2024	1,696,574	1,146,000	1.450
11/15/2025	1,681,751	1,145,000	1.600
11/15/2026	1,665,495	1,144,000	1.900
11/15/2027	1,646,947	1,144,000	2.000
11/15/2028	1,625,855	1,143,000	2.200
11/15/2029	1,601,717	1,141,000	2.300
11/15/2030	1,577,194	1,138,000	2.400
11/15/2035*	6,961,067	5,354,000	2.900

REFERENCES

Includes estimated P90 cash flows for 2031 through 2034 as well as reserve fund release net of trustee fees, charges, ad expenses in 2035

Green Liberty Bonds Serial and Term Series 2020 Bonds

Senar an	urenn	Selles			12	10	AM
< \$16,899,000 CONNECTICUT (GREEN BANK State Supported	Solar Home Renewable Er	nergy Credit, Green L	iberty Bonds, Series 20.	20 (Federally T Stock (C Series 1	× 8
Overview Retail Mana	agers Investors					Managers/Act	counts ~
CT Retail 48% OT Retail 52% 📕 II	nstitutional 0% 🧧 Stock 0% 🦪	Show All					
4.4x							6%
							5
							- 4
							3
							2
1.58	10% 18%	8%	7%	23% 36%	72%	61%	2
							1
11/21 11/22	11/23 11/2	4 11/25	11/26	11/27 11/28	3 11/29	11/30	\$Mn
Recent Orders	View All (126)	> Summary		View Order Monitor >	Top Managers Top	Accounts	Reports 2
William Jones & Associates	50	\$9,691		00:59:50 ر.	STIFEL		4,059
Individuals	1: 11/15/2035, 2:/50%	TOTAL ORDERS (M)		TIME REMAINING	Ramirez & Co.		2,672
STIFEL	1: 11/15/2030, 2.400%				Academy Securities		1,015
Individuals	1: 11/15/2023 1.250%	3	31%		280 Sec		500
Individuals	5	\$5,296		\$11,603	Janney Montgomery Sc		410
Citigroup Global	1: 11/15/2021, 0.950%	FILL (M)		BALANCE (M)	Citigroup Global		335
Individuals STIFEL	2 1: 11/15/2025, 1.550%				BofA Securities, NY		320
Individuals	25	SHORT (0-10 YR) FILL	MID (11-20 YR)	6 FILL	Wells Fargo Sec		280
BofA Securities, NY	1: 11/15/2028, 2.200%				J.P. Morgan Sec		100
Columbia Management Group, Inc.	100 1: 11/15/2030. 2.400%	-			Ameriprise Fin Serv		0
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Green Liberty Bonds Serial and Term Series 2020 Bonds

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8 \$16,899,000 CONNECTICUT GREEN BANK State Supported Solar Home Renewable Energy Credit, Green Liberty Bonds, Series 2020 (Federally T... Stock 💽 Managers/Accounts Overview CT Retail 23% OT Retail 24% Institutional 46% Stock 7% 🕃 Show All 1.0x 4.4x 1.8x 1.8x 1.7x 1.5x 1.1x 1.0x 44% 30% 7% -\$Mn 11/21 11/22 11/24 11/25 11/26 11/28 11/35 11/23 11/27 11/29 11/30 Recent Orders View All (147) > Summary View Order Monitor > Top Managers Reports > Western International 887_ Ramirez & Co. 10,266 \$21,509 (1.3x) 1: 11/15/2027, 2.000% Ramirez & Co. STIFEL 6,458 Performance Trust (Broker) 4,729 1,015 Academy Securities Ramirez & Co. Individuals 280 Sec 1,000 1: 11/15/2026, 1.900% Wells Fargo Sec 530 \$2,534 \$14,365 Individuals 250 Oppenheimer & Co. 500 1: 11/15/2023, 1.250% Wells Fargo Sec FILL (M) BALANCE (M) Edward D. Jones & Co. 100 Janney Montgomery Sc 410 Ramirez & Co. 76% Citigroup Global 335 Edward D. Jones & Co. 100 Morgan Stanley 325 Ramirez & Co. 1: 11/15/2035, 2.900% Wasmer Schroeder 738 BofA Securities, NY 320 1: 11/15/2028 2 200% S&P 500 ETF (SPY): 321.18 (US 10Y: 0.628 (12:39 PM ET Current MMD Re. 鱼 12:00 PM ET Philadelphia Federal Reserve Bank President Patrick Ha 🦾 File Explorer

Green Liberty Bonds 2020 Performance and Lesson Learned

- <u>"Big Picture"</u> sold out every year and every term – we had more demand than supply! (bigger issuance size)
- Unable to Meet National Demand more than \$10 MM of demand from citizens, and CT served first at nearly \$5 MM and only able to serve \$1 MM national with more than \$5 MM of interest. (more national carve-out)
- Institutional Demand ESG and traditional municipal investors. (bigger issuance size)
- Looking Forward preparing to issue follow-on Green Liberty Bond in FY 2021 and assist others in doing the same (enable more citizen investors – can we lower denomination...zero coupon?)

Green Liberty Bonds 2021



Additional Assets Under Consideration



green bank solar ppa (State and Municipal Facilities)



(Small Businesses)



Shared Clean Energy Facilities

(In-State Manufacturing and LMI Families)

Green Bonds US www.greenbondsus.com



Thank You

Connecticut Green Bank 845 Brook Street, Rocky Hill 300 Main Street, 4th Floor, Stamford (860) 563-0015

www.ctgreenbank.com



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Jason Sandel, Convener

jason.sandel@aztecwell.com

Prepared for National Governors Assn. October 29, 2020

NM RPS & ETA

- 50% carbon-free electricity by 2030.
- 100% carbon-free electricity by 2050.
- Securitization for San Juan Generating Station closure.
- Replacement power to be in affected area – now determined to be solar.
- \$20 Million earmarked for "affected area" assistance Funds with specific purposes
 - \$12 Million to the Department of Workforce Solutions
 - \$2 Million to the Indian Affairs Department
 - \$6 Million the Economic Development Department



COMMUNITY Advisory CMTE.

- Conveners selected, and we decided to work collaboratively to build a unified community advisory committee.
- Developed with Base Closure Commissions as a model.
- Governor & Legislature recognized and prioritized the unique economic landscape of NWNM
 - Impact on tax impact to local school district
 - Natural gas commodity price decline since 2008
 - Intergovernmental relationships with Navajo Nation & other tribal entities.
- Transparency and Inclusion are critical in an effort to build broad based support from the community up.





- Initial focus was **bringing people together**
- Review of ETA and SJGS closure
- Review of local economic studies that had been performed to date.
- Review of impact on employment and labor unions
- Review of Native American impact
- Review current plans & projects that were currently being circulated.
 - Enchant Energy CCUS
 - Office of Outdoor Recreation
 - Film incentives & local initiatives
 - Petrochemical Plant & Railroad Initiative
 - Data center buildout



RFI: HOW & WHY

https://www.dws.state.nm.us/ETA

Second meeting

- Planned inside the "affected area" in March of 2020.
- To solicit additional ideas from the affected communities COVID-19
- Meeting was cancelled.
- Months later still delayed.
- Conveners decided that we must press forward.

RFI

- Effort to restart the process of listening to affected communities and people
- Seeking the information that is required to be gathered to be compliant with the development of each department's plans.
- It turns out that the RFI has generated significant interest from a variety of people and industries.



NEXT STEPS

- Make all RFI submissions publicly available
- Conveners and Executive Departments
 group submissions into similar interests
- Seek additional information as needed, and gauge desire for similar groups to work collaboratively
- Meeting of full committee to review submissions, obtain feedback and public input.



RECOMMENDATION

HAVE THE AFFECTED COMMUNITY'S BEST INTEREST AT HEART RATHER THAN TRYING TO LIVE TO A SPECIFIC AGENDA PRECONCEIVED NOTION OR OBJECTIVE...REMEMBER CIVILITY.

- Be willing to listen
- Be willing to work together
- Be willing to work from inside the community rather than the state house
- Be willing to be flexible
- Be willing to be nimble
- Remember you are dealing with people's livelihoods who might not agree or believe in you, but you must believe in them.



"This is a really big deal. The Energy Transition Act fundamentally change the dynamic in New Mexico. This legislation is a promise to future generations of New Mexicans, who w benefit from both a cleaner environment and a more robust energy economy with exciting career and job opportunities. Crucially, the Energy Transition Act does not leave affected workers and neighbors behind. We lool out for each other. With this law, we sea that promise.

Governor Michelle Lujan Grisham



Energy Affordability and Equity

Speakers:

Yasmin Yacoby, Rhode Island Office of Energy Resources

Mary Shoemaker, American Council for an Energy-Efficient Economy

Moderated by:

Matt Rogotzke, Policy Analyst, National Governors Association



Technology Deep Dive: State Energy Goals and the Role of Nuclear

Speaker:

Jesse Jenkins, Assistant Professor, Princeton University

Moderated by:

Alyse Taylor-Anyikire, Senior Policy Analyst, National Governors Association Building a 100% Clean Electricity Sector Nuclear Power and the Critical Role of Firm Low-Carbon Resources

Jesse D. Jenkins, PhD

Assistant Professor | Princeton University Dept. of Mechanical & Aerospace Engineering | Andlinger Center for Energy & Environment National Governor's Association | May 15,2020

U.S. Decarbonization Commitments I Clean Air Task Force

Map Controls

Electricity Sales and Emissions Charts



Do we need nuclear power to build a 100% clean electricity sector?

1 Do we need existing nuclear to build a 100% clean electricity sector? 2. Do we need new nuclear to build a 100% clean electricity sector?



1 Do we need existing nuclear to build a 100% clean electricity sector? 2. Do we need new nuclear to build a 100% clean electricity sector?



Existing nuclear: essential foundation for 100% clean

2019 U.S. Electricity Generation by Source





- Natural gas
- 🗖 Coal
- Oil & other fossil

Retirements of U.S. Nuclear Reactors (recent, planned, prevented)

 Observation
 Closed since 2013
 Retirement planned
 Policy reprieve
 Other

 9.0
 6.0
 13.3
 81.6

That foundation is crumbling...

The Boston Globe

Carbon emissions rising at New England power plants

By David Abel Globe Staff, May 15, 2016, 10:28 p.m.





The bigger factor in the rise of carbon emissions in the region was probably the 2014 closing of the Vermont Yankee nuclear plant, specialists said. CRAIG F. WALKER/GLOBE STAFF/FILE



MIT Center for Energy and Environmental Policy Research

Working Paper Series

What's Killing Nuclear Power in US Electricity Markets?

Drivers of Wholesale Price Declines at Nuclear Generators in the PJM Interconnection

Jesse Djenkins

Monthly and annual average natural gas spot price at Henry Hub (2001-2019) eia dollars per million British thermal units 14 12 10 monthly average 8 annual average 6 4 2 \$2.57 0 2001 2003 2005 2007 2009 2011 2013 2015 2017 2019

Source: https://www.eia.gov/todayinenergy/detail.php?id=42455

January 2018

CEERWP2018001



Preserving the foundation for progress to 100% clean

The order of operations is clear

First: Eliminate emissions from coal-fired power plants (c. 2030)

Second: Complete the 'natural gas bridge' (modest decline through 2030, ~zero emissions by 2040-2050)

Then: Contemplate retirement of existing nuclear



1. Do we need existing nuclear to build a 100% clean electricity sector? 2. Do we need new nuclear to build a 100% clean electricity sector?



Clean electricity: the linchpin



The Good News: Wind, Solar, Battery Costs Plummet



Data Sources: Wind & solar costs from Lazard (2018), Lazard's Levelized Cost of Energy Analysis – Version 12.0, https://www.lazard.com/media/450784/lazardslevelized-cost-of-energy-version-120-vfinal.pdf/. Battery pack costs from Bloomberg New Energy Finance (2018), Battery Price Survey, https://about.bnef.com/blog/behind-scenes-take-lithium-ion-battery-prices/

The Levelized Cost Mental Model



A race to beat fossil fuels on cost...

Data Sources: Costs from Lazard (2018), Lazard's Levelized Cost of Energy Analysis – Version 12.0, https://www.lazard.com/media/450784/lazards-levelizedcost-of-energy-version-120-vfinal.pdf/. Global renewable energy capacity from IRENA (2019), Renewable Energy Statistics 2019 https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Mar/IRENA_RE_Capacity_Statistics_2019.pdf

Why not just build what's cheapest?



A balanced diet is key





A Race Between Declining Cost & Value

& benetion

E

A Race Against Declining Value (Solar PV)



Data Source: Sivaram & Kann (2016), Solar needs a more ambitious cost target, *Nature Energy* Vol. 1 (April 2016). Solar cost estimate for 2018 from Lazard (2018) op. cit. above.

- 1. Declining "fuel-saving" value (energy substitution)
- 2. Decreasing "capacity value" (capacity substitution)
- 3. Increasing "over-generation" (energy that must be stored or wasted when supply exceeds demand)

Additional factors (aka "integration costs"): Increasing flexibility, ramping and reserve requirements; thermal plant cycling costs; transmission network costs

A Race Against Declining Value (Energy Storage)



Graphic is author's own created with data from: de Sisternes, Jenkins & Botterud (2016), "The value of energy storage in decarbonizing the electricity sector," *Applied Energy* 175: 368-379. Assumes Li-ion storage system with 2 hours storage duration and 10 year asset life. Estimated 2018 Li-ion storage cost per kWh from Lazard (2018), Lazard's Levelized Cost of Storage Analysis – Version 4.0.

- 1. "Niche" markets fill quickly for regulation & reserves
- 2. Increasing energy storage (longer duration) needed to maintain capacity substitution value
- 3. Reduced energy arbitrage (buy-sell) spread
- 4. Declining utilization rate

NEW PAPER: Mallapragada, Sepulveda & Jenkins (2020), "Long-run system value of battery energy storage in future grids with increasing wind and solar generation," *Applied Energy* 275(1). <u>https://authors.elsevier.com/a/1bLLO15eiezzya</u> In the near-term, wind, solar, batteries (and coal to natural gas transition) can drive emissions reductions


Fully decarbonizing electricity requires firm lo carbon substitutes for natural gas and (eventu retiring nuclear units

Joule

ARTICLE | ONLINE NOW

See.

The Role of Firm Low-Carbon Electricity Resources in **Deep Decarbonization of Power Generation**

rage Cost of Electricity Nestor A. Sepulveda 2 4 🖾 • Jesse D. Jenkins • Fernando J. de Sisternes • Richard K. Lester 2 🗠 • Show footnotes

Published: September 06, 2018 • DOI: https://doi.org/10.1016/j.joule.2018.08.006

Highlights
Summary
Graphical Abstract
Keywords
References

Article Info

Highlights

- · Firm low-carbon resources consistently lower decarbonized electricity system costs
- Availability of firm low-carbon resources reduces costs 10%-62% in zero-CO 2 cases
- Without these resources, electricity costs rise rapidly as CO 2 limits near zero

Recommend Joule to Your Librarian

PlumX Metrics

Northern System



CO₂ emissions limit(g/kWh)

Data source: Sepulveda, N., Jenkins, J.D., et al. (2018), "The role of firm low-carbon resources in deep decarbonization of electric power systems," *Joule* 2(11).



Data source: Sepulveda, N., Jenkins, J.D., et al. (2018), "The role of firm low-carbon resources in deep decarbonization of electric power systems," *Joule* 2(11).



CO₂ emissions limit (g/kWh)

Data source: Sepulveda, N., Jenkins, J.D., et al. (2018), "The role of firm low-carbon resources in deep decarbonization of electric power systems," *Joule* 2(11).

One Possible BalancedPortfolio



Without FirmLow-Carbon Resources





il.

Solar, wind & batteries will be stars...

4



Nuclear Reactors

Carbon Capture and Storage

Zero Carbon Fuels

Image: Mitsubishi Heavy Industries

Hydropower with Large Reservoirs

Advanced Geothermal Energy

STATISTICS.



il.

It's time to complete the team!

4

Jesse D. Jenkins Assistant Professor

Department of Mechanical & Aerospace Engineering and Andlinger Center for Energy & Environment Princeton University

jessejenkins@princeton.edu

Twitter: @JesseJenkins

Linkedin.com/in/jessedjenkins

Google scholar: http://bit.ly/ScholarJenkins

RESOURCES

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What aboutstorage?

VIENNES

The *Dunkelflaute* ("Dark Doldrums") Western Interconnection, Renewables + Storage Only (24 hour rolling average power) Wind, Solar, Hydro — Demand 68 days 35 days Gigawatts \mathbf{n}

Long Duration Storage Needed for Renewables + Storage Only Western Interconnection, 0 CO₂ emissions limit

(24 hour rolling average power)

■ H2 Storage State of Charge



Long Duration Storage Needed

Western Interconnection, Renewables + Storage Only

(24 hour rolling average power)

■ H2 Storage State of Charge



A very different kind of storage!

ENERGY STORAGE

Long Duration Breakthrough? Form Energy's First Project Tries Pushing Storage to 150 Hours

Minnesota utility Great River Energy will use new storage technology from the Bill Gates-backed startup to replace coal power with dispatchable wind.

JULIAN SPECTOR MAY 07, 2020

ENERGY STORAGE

Utah Aims to Shatter Records With 1,000MW Energy Storage Plant

The one-of-a-kind facility would combine compressed air storage in salt caverns with hydrogen storage, large flow batteries and solid-oxide fuel cells.

JULIAN SPECTOR MAY 30, 2019

Coming soon...

Evaluating the Technology Design Space for Long-Duration Energy Storage and Role in Deep Decarbonization of Power Systems

Nestor A. Sepulveda^{1,2,*}, Jesse D. Jenkins³, Aurora Edington¹, Dharik Mallapragada¹, and Richard K. Lester⁴

¹Massachusetts Institute of Technology, MIT Energy Initiative, Cambridge, MA
²Massachusetts Institute of Technology, Department of Nuclear Science and Engineering, Cambridge, MA
³Princeton University, Andlinger Center for Energy and the Environment and Department of Mechanical and Aerospace Engineering, Princeton, NJ
⁴Massachusetts Institute of Technology, Office of the Provost, Cambridge, MA
*Corresponding Author nsep@mit.edu

ABSTRACT

We evaluate the role of long duration energy storage (LDES) in decarbonized electricity systems and identify cost and efficiency performance necessary for LDES to reduce electricity costs and displace firm low-carbon generation. We find that energy capacity cost and discharge efficiency are the most important performance parameters. Charge/discharge power cost and charge efficiency play secondary roles. Energy capacity costs must be \leq 20/kWh to reduce electricity costs \geq 10%. With current electricity demand profiles, energy capacity costs \leq 10/kWh are required to fully displace nuclear power; costs must be \leq 1/kWh to fully displace natural gas w/CCS or combustion of hydrogen (or similar fuels). Electrification of heating, transportation, and other end-uses in a northern-latitude context makes full displacement of firm generation more challenging and requires performance combinations unlikely to be feasible with known LDES technologies. Finally, LDES systems with the greatest impact on electricity cost and firm generation have storage durations exceeding 100 hours.



Conference Wrap Up

Dan Lauf, Program Director, National Governors Association