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RENEWABLE ENERGY & ENERGY STORAGE TRENDS

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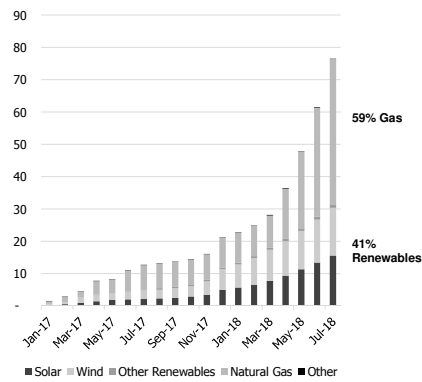
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Renewable capacity continues to come into the market in large scale

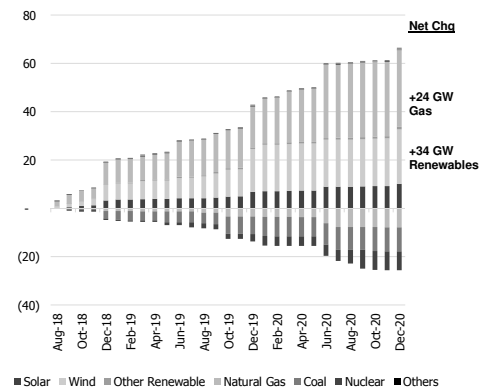
Renewables have added ~30 GW of new capacity since Jan 2017

By 2020, new renewable capacity will in fact out pace new gas capacity by 10 GW

Cumulative Net Capacity Additions, 2017-Present (GW)



Cumulative Planned Net Capacity Change, Present-Dec 2020 (GW)



Morgan Lewis Source: EIA-860 data

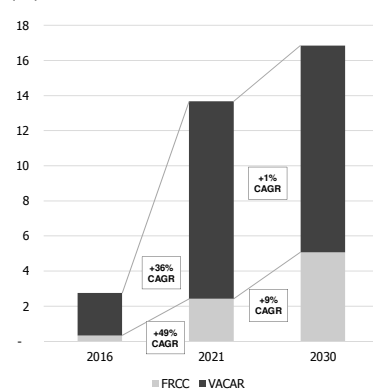
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US markets to become more dependent on solar generation

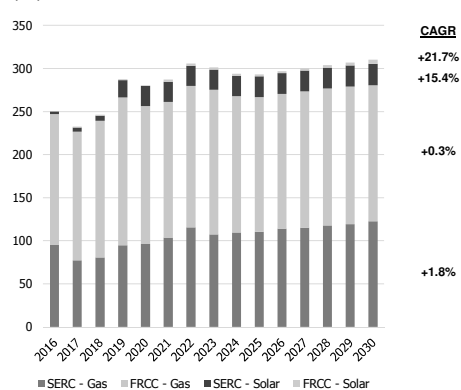
Solar capacity growth is expected to strongly grow ...

... and will take on a more prolific role as a source for peaking generation.

PV Solar Generation Capacity in VACAR & FRCC (GW)



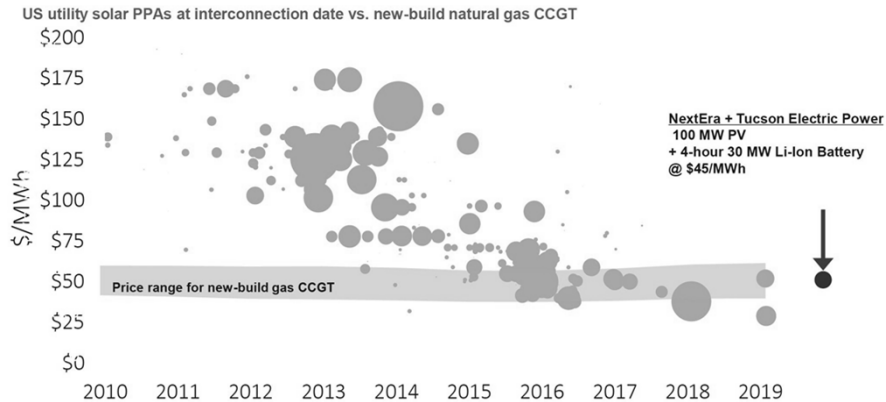
PV Solar and Gas Generation in VACAR & FRCC (GW)



Morgan Lewis Source: DOE AEO 2018

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Solar PPA's have hit a point of parity with new-build gas combined cycle



Source: GTM Research U.S. Utility Solar Service, Wood Mackenzie North American Power and Renewables Service

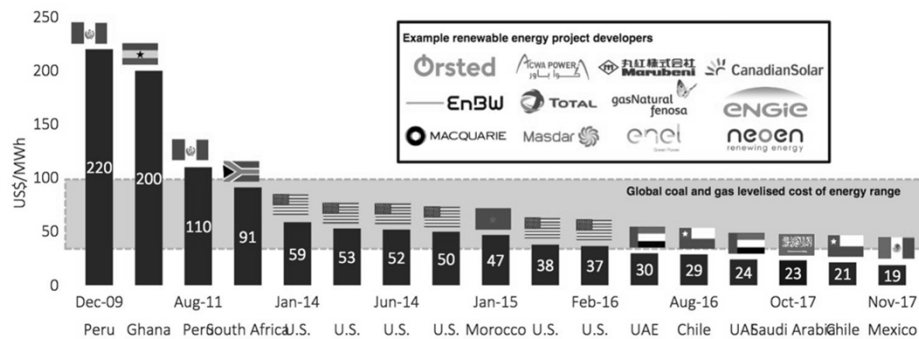
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This phenomenon is not just isolated to the US market

Solar is now cheaper than the global levelized cost of coal and gas in Chile, Mexico and parts of the Middle East.

Seven world record-low solar PV PPA prices since the start of 2016



Source: GTM Research

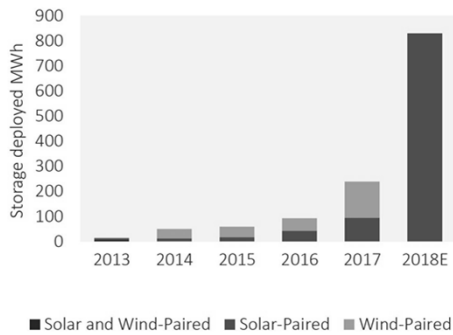
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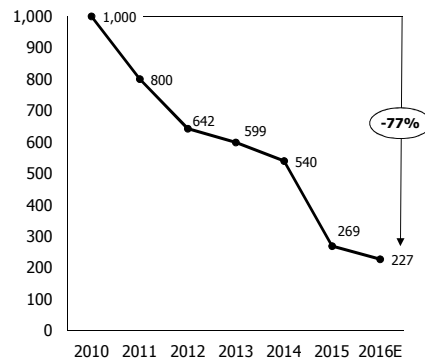
Energy storage has played a key role in supporting renewables, especially solar

Battery costs expected to continue their decline - Wood Mackenzie projects costs as low as \$40/kWh by 2040

Global renewables-plus-storage 2013 – 2018E (MWh)



Average Battery Pack Cost ⁽¹⁾ (\$/kWh)

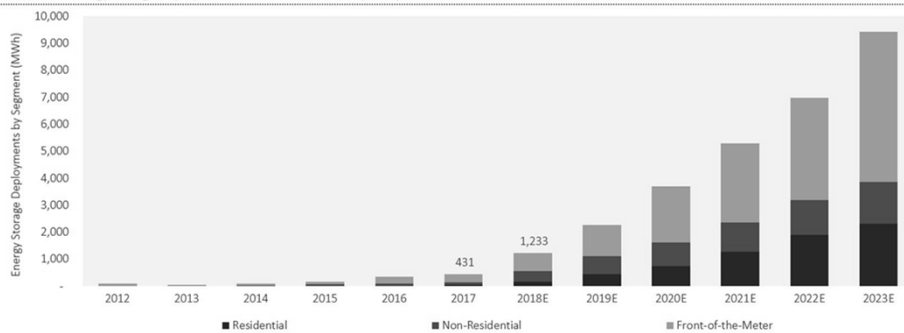


Morgan Lewis Sources: Greentech Media, McKinsey, and Lazard

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Therefore energy storage deployments are expected to ramp up significantly

U.S. Annual Energy Storage Deployment Forecast, 2012-2023E (MWh)



GTM Research estimates that the annual value of the U.S. energy storage market will exceed \$1.2 billion in 2019

Morgan Lewis Source: Greentech Media

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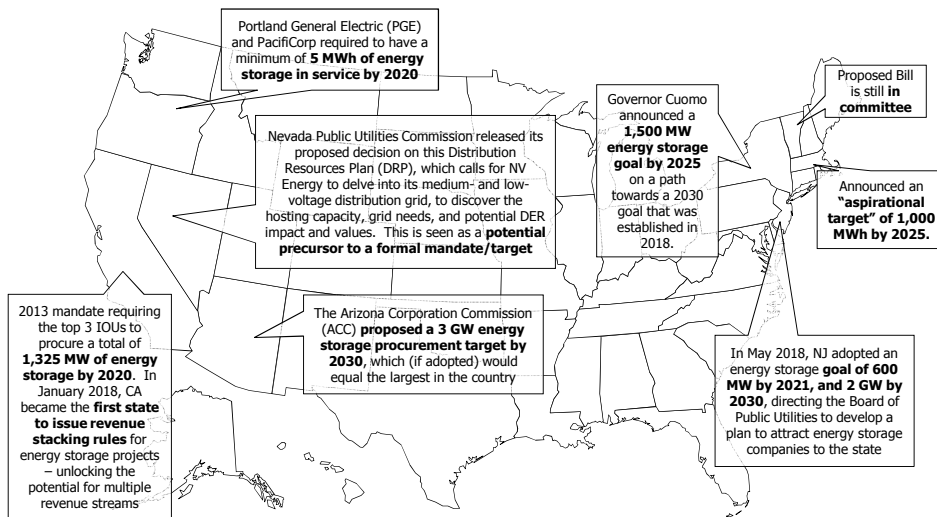
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Current state of energy storage policy

- ☐ Mandate/target in place
- ☐ Proposed mandate/target
- ☐ State mandated studies



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State-Level Policies

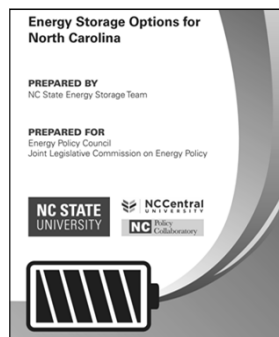
- In October 2017, the California Public Utilities Commission (CPUC) **unanimously rejected** the proposed refurbishment of the Ellwood Peaker Plant.
- Around the same time frame, the California Energy Commission was going to recommend rejection of the permit for the Puente Power Project, ultimately leading to the suspension of the CEC approval process by NRG.
- The New Mexico Public Regulation Commission unanimously voted in 2017 to mandate the inclusion of energy storage into utilities' submitted IRPs as a commercially feasible energy resource. Following the order, PNM issued an RFP soliciting bids for renewable and energy storage projects totaling 456 MW¹
- Hawaii is Growing
 - PUC approved a PPA for 4.88MW of solar with a 3MW / 15MWh battery energy storage system on the island of Molokai (17¢/kWh)
 - KIUC 13 MW solar array with 52 MWh SolarCity Project (14.5¢/kWh)
 - KIUC AES Distributed Energy 28 MW solar array with a 100 MWh battery (11¢/kWh)
- Arizona
 - SRP 20 MW / 10 MW li-ion (pricing and MWh not disclosed) NextEra Project
 - Tucson Electric Power 100 MW solar, 30 MW, 120 MWh battery, < 4.5¢/kWh, NextEra Project
 - APS / First Solar Project -- Solar + Storage to address "Peaking Capacity" RFO
- Colorado – Initial PSCo bids - \$21 for wind plus storage / \$36 for solar plus storage (publicly reported)
- Massachusetts Department of Public Utilities (DPU) has approved a rate increase for Eversource Energy utilities NSTAR Electric and Western Massachusetts Electric that includes \$15 million for a 5 MW storage facility on Martha's Vineyard and up to \$40 million for a 12 MW energy storage project on Cape Cod.

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(1) http://cnee.colostate.edu/wp-content/uploads/2018/09/State-Brief_NM_Sept-Update.pdf

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State Mandated Studies Support Further Policy Actions

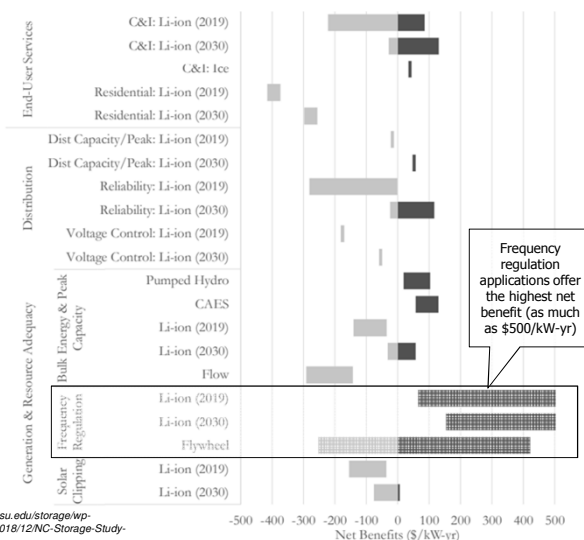


*"Integrated across all service categories, we envision the **potential for storage capacity to exceed 1GW by 2030.**"*

- NC State Energy Storage Team (Dec 2018)

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Source: <https://energy.ncsu.edu/storage/wp-content/uploads/sites/2/2018/12/NC-Storage-Study-FINAL.pdf>



North Carolina



"Menu of recommendations" to state lawmakers with regards to storage policy:

PREPARE

- Update & clarify planning provisions
- Update & clarify definition and ownership of storage
- **Evaluate net metering rules**
- **Update interconnection rules**
- Provide guidance for updating local codes

FACILITATE

- **Develop competitive procurement process**
- Standard offer program for smaller projects
- **Develop new tariff structures**
- Streamline interconnection process for behind-the-meter systems
- Promote data access
- **Expand cost-recovery funding streams**
- Establish procurement goal

ACCELERATE

- **Develop storage-specific incentives**
- **Incorporate storage within the NC REPS**
- Develop a clean peak standard
- **Establish a procurement requirement**

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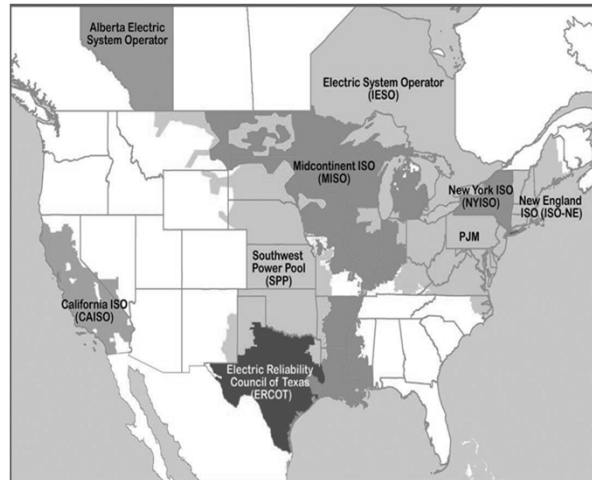
FERC and Energy Storage

- Various FERC rulemakings and administrative issuances have focused on issues relevant to storage since at least 2011.
- Notable examples:
 - Order No. 755: Frequency Regulation Compensation in the Organized Wholesale Power Markets
 - Order No. 784: Third Party Provision of Ancillary Services; Accounting and Financial Reporting for New Electric Storage Technologies
 - Order No. 792: Small Generator Interconnection Agreements and Procedures
 - Order No. 819: Third-Party Provision of Primary Frequency Response Service
 - Policy Statement: Utilization of Electric Storage Resources for Multiple Services When Receiving Cost-Based Rate Recovery
- **Order No. 841**

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Order No. 841 Application



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Order No. 841

- FERC adopted its NOPR proposal to require each RTO/ISO to revise its tariff to include a model to facilitate the participation of electric storage resources.
- Order No. 841 grants RTOs/ISOs flexibility to tailor market rules that best suit their individual market designs.
 - Rules must recognize physical and operational characteristics of electric storage resources.
 - Any storage participation model modified to comply with Order No. 841 must be made available for all types of electric storage resources.
 - Existing participation models may be preserved (e.g., participation models for pumped-hydro resources or demand response).
- FERC objective is for new market rules to ensure a level playing field for all resources.
 - Electric storage resources may still need to meet minimum technical thresholds to participate.
- RTOs/ISOs required to file tariff changes to implement the Order 841 requirements by December 3, 2018.
 - Implementation by December 3, 2019, assuming FERC approval.

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RTO/ISO Implementation

- CAISO
 - Highlighted existing tariff provisions that already implement technology-agnostic participation models for storage resources at different interconnection levels
 - Main participation framework for traditional battery technologies is the “non-generator resource” or “NGR” model.
 - Allows resources to be dispatched as generation or load and operate continuously across their entire capacity range.
 - Separate model for pumped-storage hydro resources
- MISO
 - New ESR category to eventually replace SER - Type II.
 - Proposed model facilitates participation in MISO’s Energy and Operative Reserve Markets.
 - Ability for storage resources to participate as supply and demand.
 - Eight different dispatch commitment statuses
 - Dispatch status allows storage resource to dictate product being offered.
 - Exclusionary “Not Participating” energy dispatch status will allow storage resource to providing only ancillary services or energy, if desired.

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RTO/ISO Implementation

- PJM
 - Three operational modes: continuous, charge, or discharge.
 - Continuous mode allows for both charge/discharge, and imposes no ramping limitations
 - Some potential concerns over proposed requirements limiting value for storage resources
 - Minimum 10-hour duration not feasible for most resources
 - Separate accounting proposal with earlier requested effective date
 - Ability to test proposed metering and accounting methodology before model implementation
- NYISO
 - New framework for participation in the Day-Ahead and Real-Time Markets tailored specifically to energy storage resources.
 - Applicable to resources capable of injecting energy on to the grid for longer durations than Limited Energy Storage Resources.
 - Proposed model contemplates that participating energy storage resources will be dispatch-only.
 - Ability to bid energy across their entire operating ranges

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RTO/ISO Implementation

- ISO-NE
 - Introduction of the terms “Binary Storage Facility” and “Continuous Storage Facility”
 - Proposed reforms differentiate between pumped-storage hydro (the predominant storage technology in the ISO-NE region) and other electric storage technologies
 - Binary Storage Facilities (i.e., pumped-storage hydro facilities)
 - Allowed to be either on line to charge or on line to discharge, but not both simultaneously
 - Must be capable of switching on within 30 minutes.
 - Continuous Storage Facilities (e.g., batteries)
 - Can continuously transition between charging and discharging.
- SPP
 - Introduction of Market Storage Resource (“MSR”) participation model
 - Exclusive to energy storage resources.
 - MSR registration option will allow SPP to dispatch the MSR to withdraw energy from the market; include the physical and operational characteristics of MSRs in the market dispatch
 - Transmission charges will not apply for MSR withdrawals when those withdrawals are a result of the MSR responding to an SPP dispatch.

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Contract Structures – Basic PPA

- **Conventional Generation PPA:**

- Fixed Cost Recovery (Capacity Payments)
- Variable Cost Recovery (Energy Payments)
- Tolling and non-Tolling Structures (fuel cost pass-through)

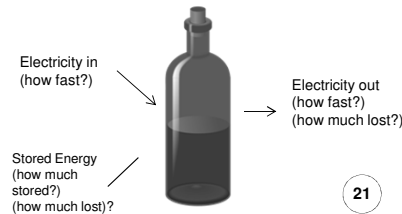


- **Renewable Generation PPA:**

- Fixed and Variable Recovery Through Energy Payments
- Output is typically forecasted at various probability levels (P50, P90, P99) to provide assurances that energy payments will cover both fixed and variable costs.
- Variable costs tend to be very low (if any).

- **Energy Storage:**

- Both Structures are Possible!



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All-Outputs Energy Storage Agreement

- Comparable to Traditional PPA for Conventional Generation
 - Fixed Capacity Payments
 - Variable Energy Payments
 - May be based on amount of energy charged and discharged
 - Adjustments for:
 - Availability
 - Efficiency
 - Ancillary Services
 - Many developers overbuild to avoid ~100% state of charge and ~0% state of charge
 - Operating Limitations based on vendor specifications
 - Station Use energy is separately metered
- One variation of this is a payment for Capacity with a financial settlement for energy / ancillary services

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Capacity Only Contract

- Utilities may elect to only procure Capacity
- What is Capacity?
 - Depends on the market
 - California has “Resource Adequacy” (and “Flexible Resource Adequacy”)
 - Essentially, the ability to generate electricity
- Fixed Payments for Capacity
- Generator retains full control of the unit
- Variation of this structure for “Local Resource Constrained Days” – Utility can direct unit to “bid” into market at certain times.
- This structure (and variant) are oftentimes used for transmission deferral
 - Allows utility to achieve lower overall cost than if they contracted for all outputs

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Many Options for Solar + Storage

- Pay per MWh
 - Capacity payments or no capacity payments
 - Utility controls dispatch over battery with certain performance requirements
 - Take or pay for all energy that cannot be stored within battery
- Pay per MWh based on Time-of-Delivery
 - No capacity payments
 - Seller retains dispatch control
 - Time of delivery payments are setup to incentive deliveries when required
- Take or pay with ramping
 - No capacity payments
 - Storage is used to ramp up and down
 - We have seen this structure for smaller grids

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Some Practical Advice for Putting it All Together in the RFO Process

- **Utility Side**

- Many utilities will run a two stage “Request for Offers”
- Consider carefully what is required by your system and include in contract
- Balance the need for specificity in the initial offer with the unknowns associated with emerging technologies
- Consider accounting issues carefully as these can have big impacts on how your PPA is structured

- **Sponsor Side**

- Work with your vendors to develop performance measurements, warranties / performance guaranties and an operating profile to complete your bid package
- Identify key limitations early on in the process
- Understand the needs of your customer

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THANK YOU

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