Electricity Storage: A Technology Whose Time has Come?

An Analysis Using NEMS-REStorePlus

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Objective

Assess the Potential Impact For Grid Storage

- Alternative Resource Base
  - Baseline
  - Low Resource
- Alternative Grid Storage Costs
  - Baseline
  - Low Cost
- Alternative PV and Wind Costs
  - Baseline
  - Low Cost

Scenarios

	Resource Levels	
Cost Levels	OnLocation Baseline (***Adjusted*** EIA High Resource Case)	Low Resource Levels (***Adjusted*** EIA 2018 Low Resource Case)
Baseline Storage Costs	Base Cost	Low Resource - Base Cost LR Base
Lower Storage Costs	Low Cost	Low Resource - Low Cost LR Low Cost
Lower Storage Costs and Lower Wind and PV Costs	Low RE Cost	Low Resource - Low Cost LR Low RE Cost

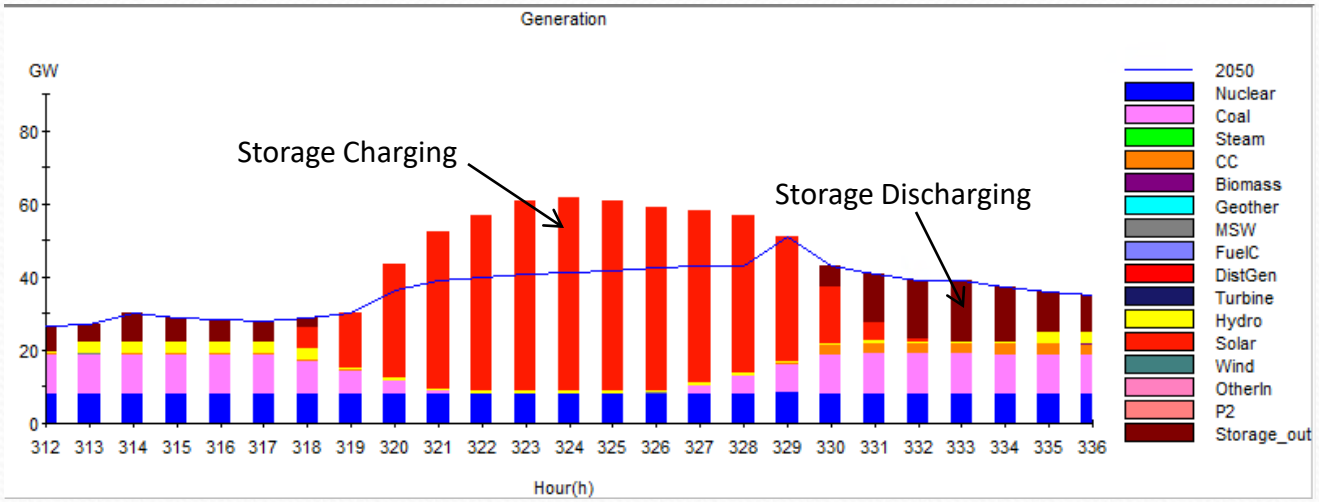
Approach

- Using NEMS-REStorePlus (OnLocation's modified version of EIA's AEO 2018 NEMS model), analyze a set of scenarios targeting alternative Grid Storage, gas prices/resource availability and renewable technology costs
  - ReStorePlus model is an add-on to the NEMS model that includes a more detailed hourly dispatch to allow for the arbitrage loading and discharging of grid storage

REStore Plus

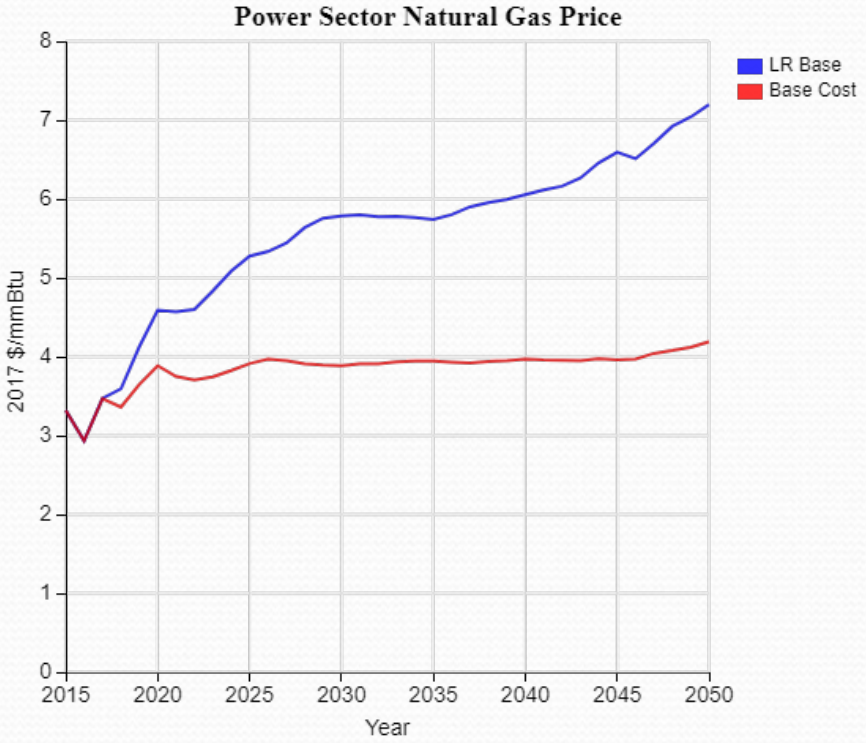
- Hourly dispatch model can be run stand-alone or in conjunction with NEMS
- Provides Electricity Market Module of NEMS with storage arbitrage value, loading and discharge schedule and any curtailments of variable renewable generation (i.e. wind and solar PV)
- Focus is on storage providing energy and capacity reserves; analysis does not include possible operating reserve, other ancillary values or transmission deferments; utility scale only

Illustrative Example of Hourly Dispatch



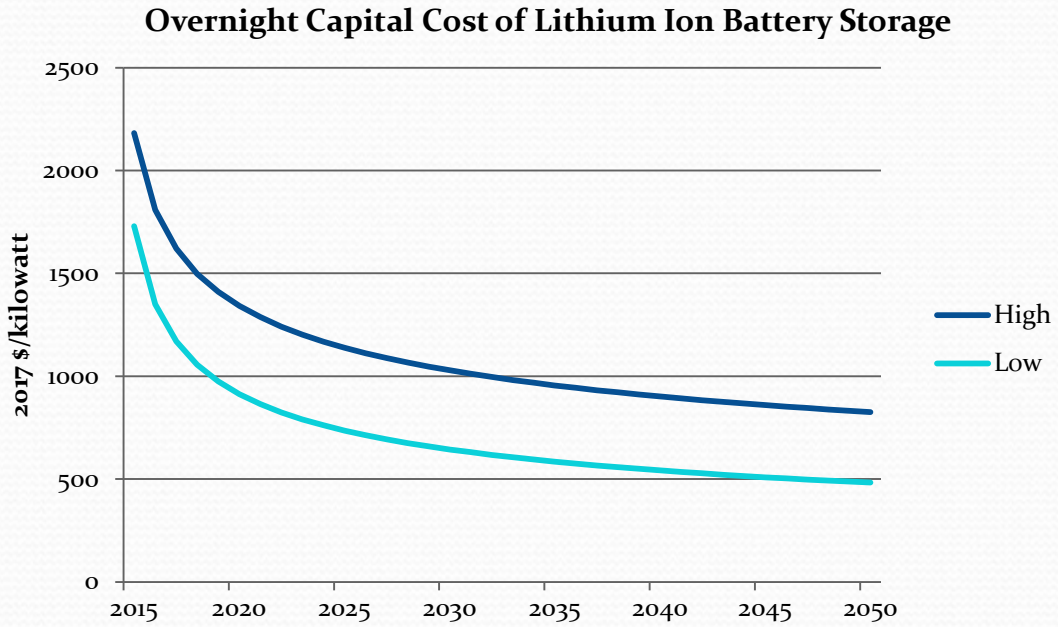
Natural Gas Prices

- The Base cost case assumes 25 percent higher oil and gas resources and 25% higher rate of technological improvements compared to the AEO2018 reference case
  - Prices are projected to be relatively constant over time
- The Low Resource case assumes 25% lower resources and technology improvement
  - Gas prices increase to roughly $7/MMBtu by 2050



Battery Costs

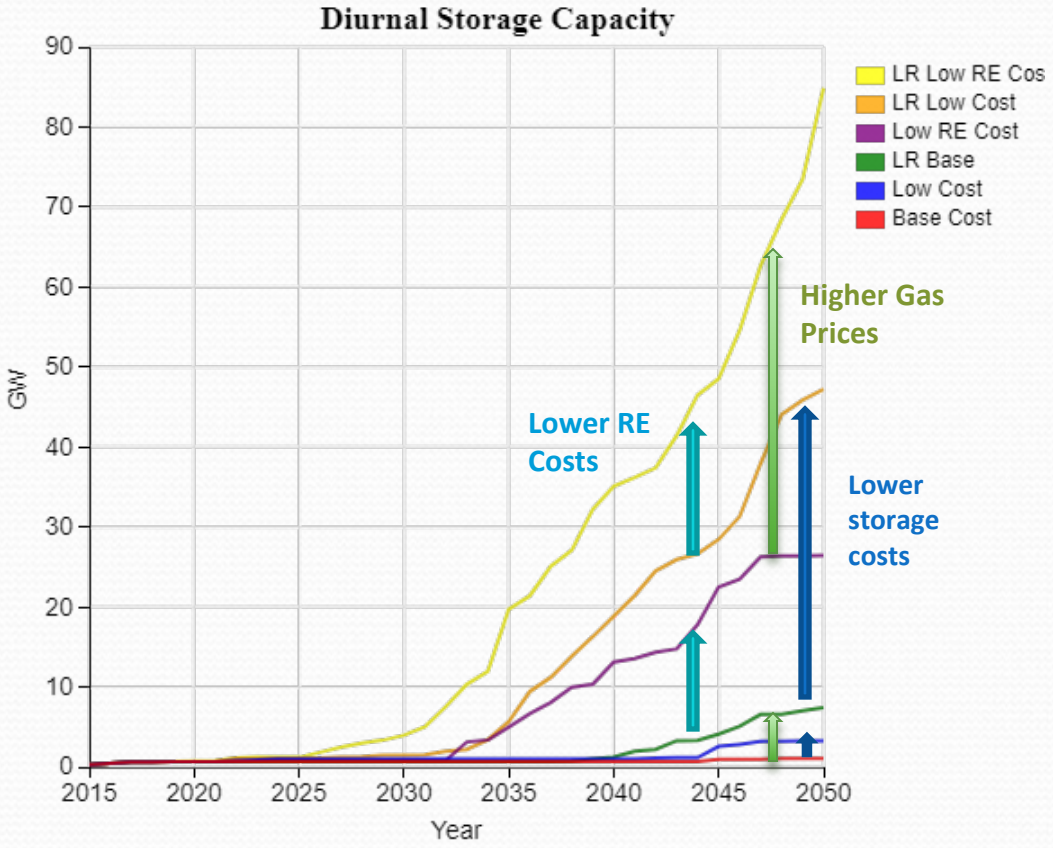
- Recent rapid declines in lithium ion battery costs seem likely to continue



Source: "Lazard's Levelized Cost of Storage Analysis - Version 3.0," November 2017, as adjusted and extrapolated by OnLocaton, Inc.

Storage Capacity

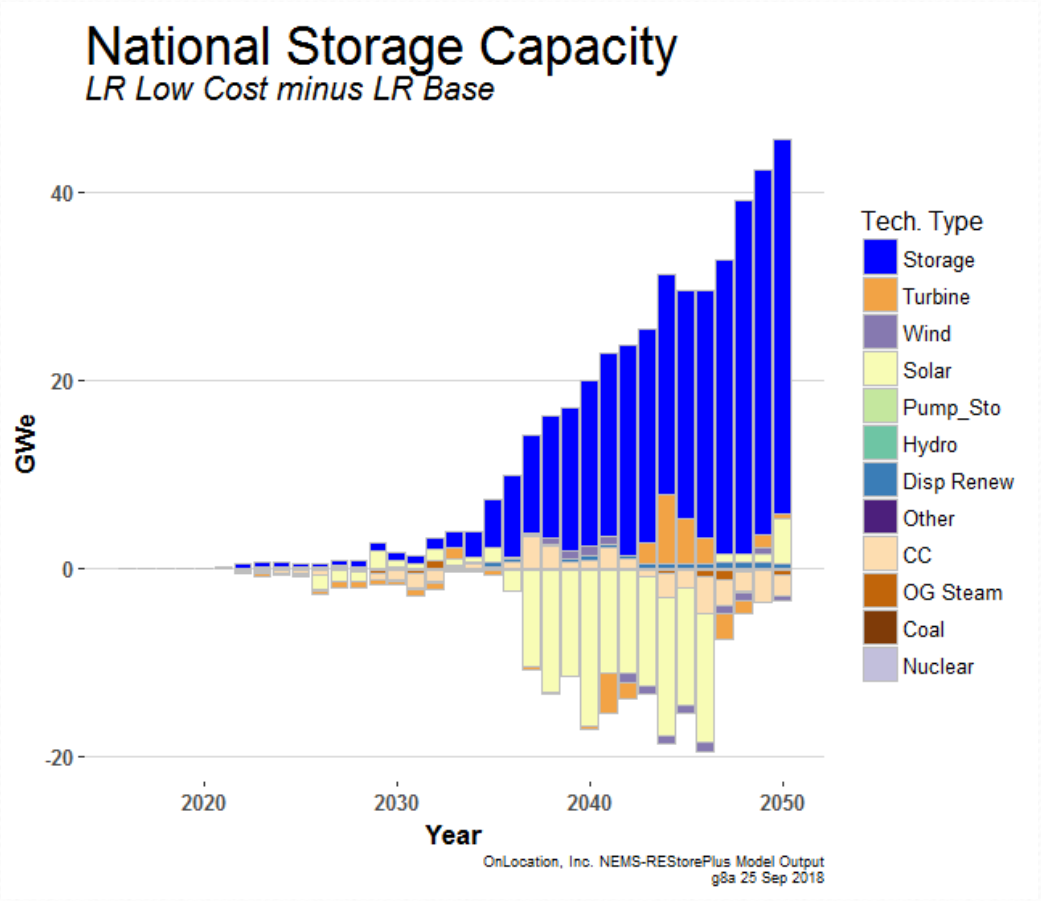
- Projected storage capacity ranges from 3 GW to 85 GW and is highly dependent on natural gas prices, storage costs and renewable costs
- As expected, lower storage costs lead to greater adoption
- Higher gas prices also increase storage capacity growth
- The overlay of lower renewable costs and hence higher renewable capacity increases storage adoption even more.



Low Cost Impact

Focusing on the Low Resource Scenario

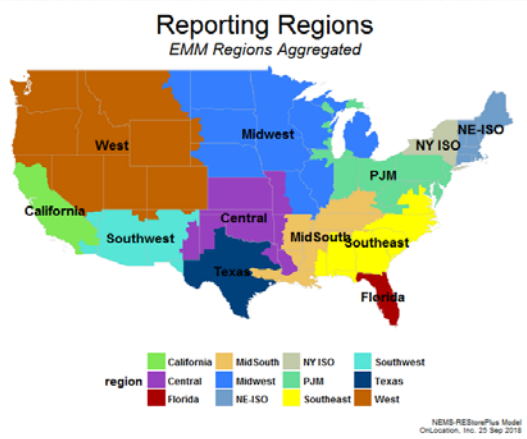
- In this scenario, an additional 40 GW of storage is added by 2050 when lower battery costs are assumed.
- The primary technology storage displaces is solar PV, albeit by a small portion of the total solar PV penetration.

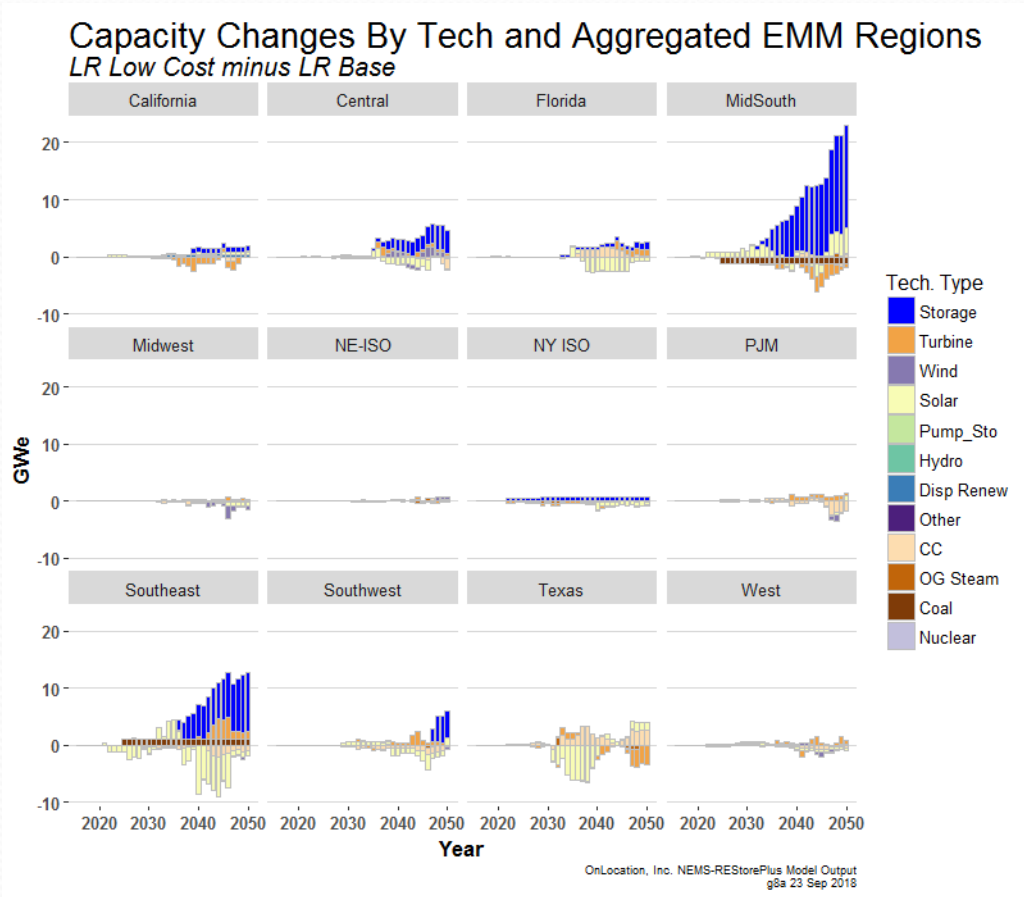


Regional Impacts

Focusing on the Low Resource Scenario

- The differences between the low cost and base cost scenarios are shown
  - Most of the action is in the MidSouth, Southeast, Central, and Southwest regions

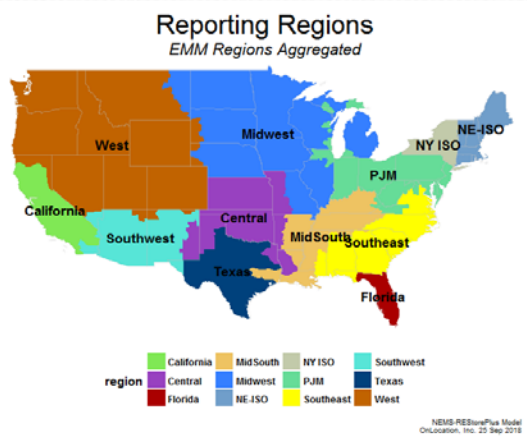


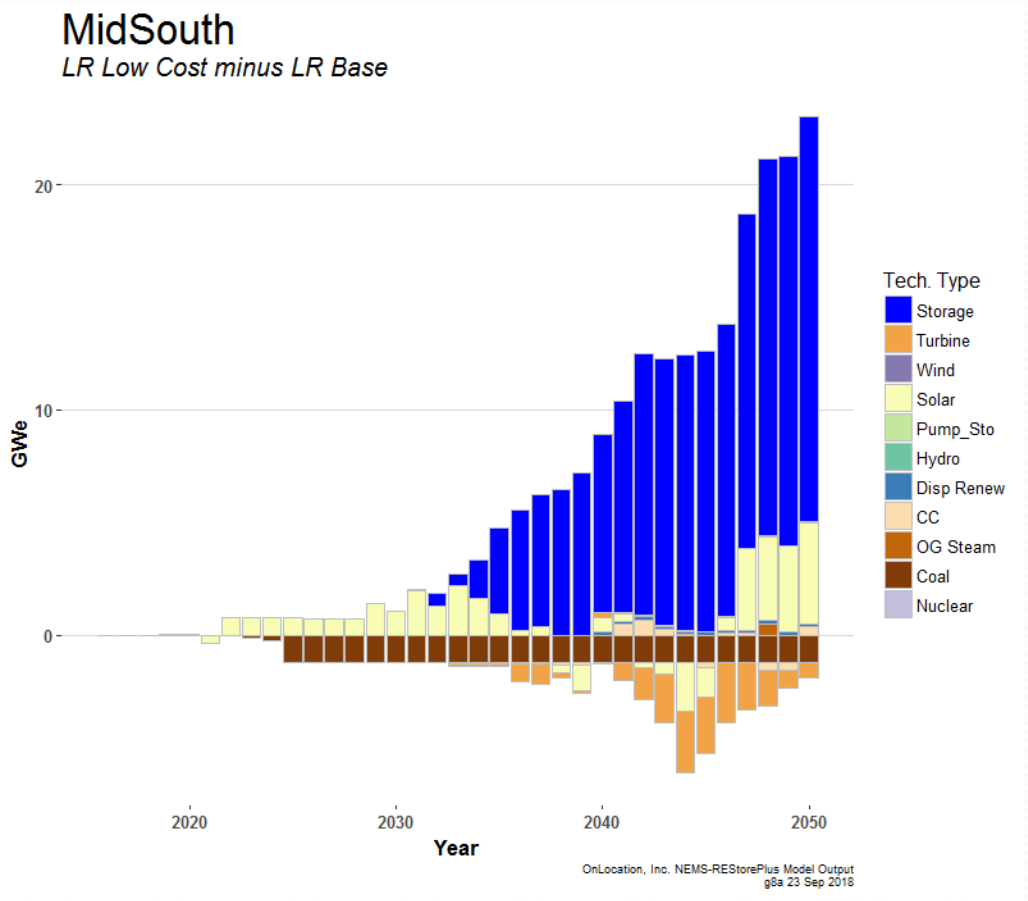


MidSouth Focus

Focusing on the Low Resource Scenario

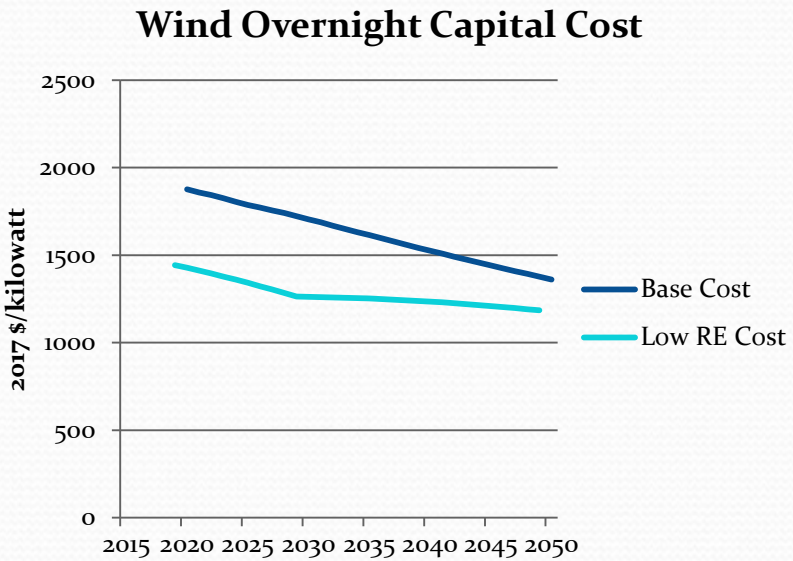
- In the MidSouth, lower cost storage displacing leads to slightly more solar and displacement of turbine capacity.

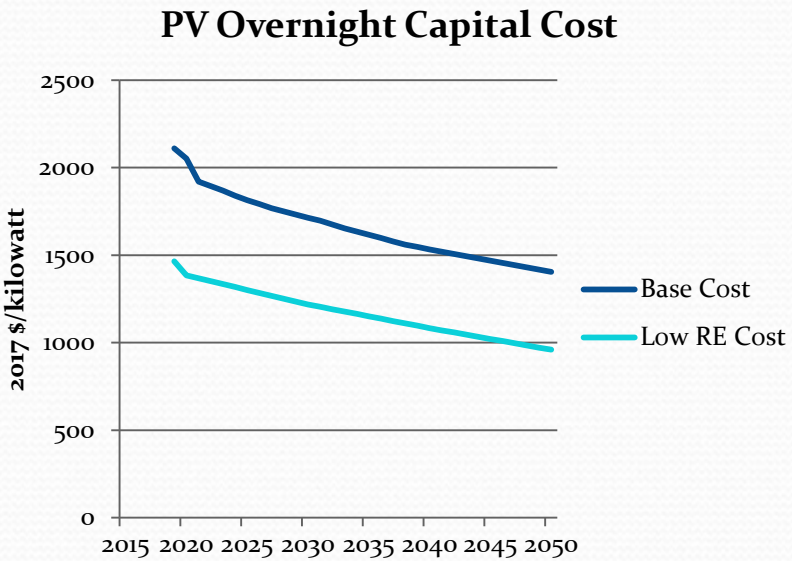




Technology Costs

- Base capital costs are from the AEO2018 while the Low Costs are the mid case from NREL's 2017 Annual Technology Baseline

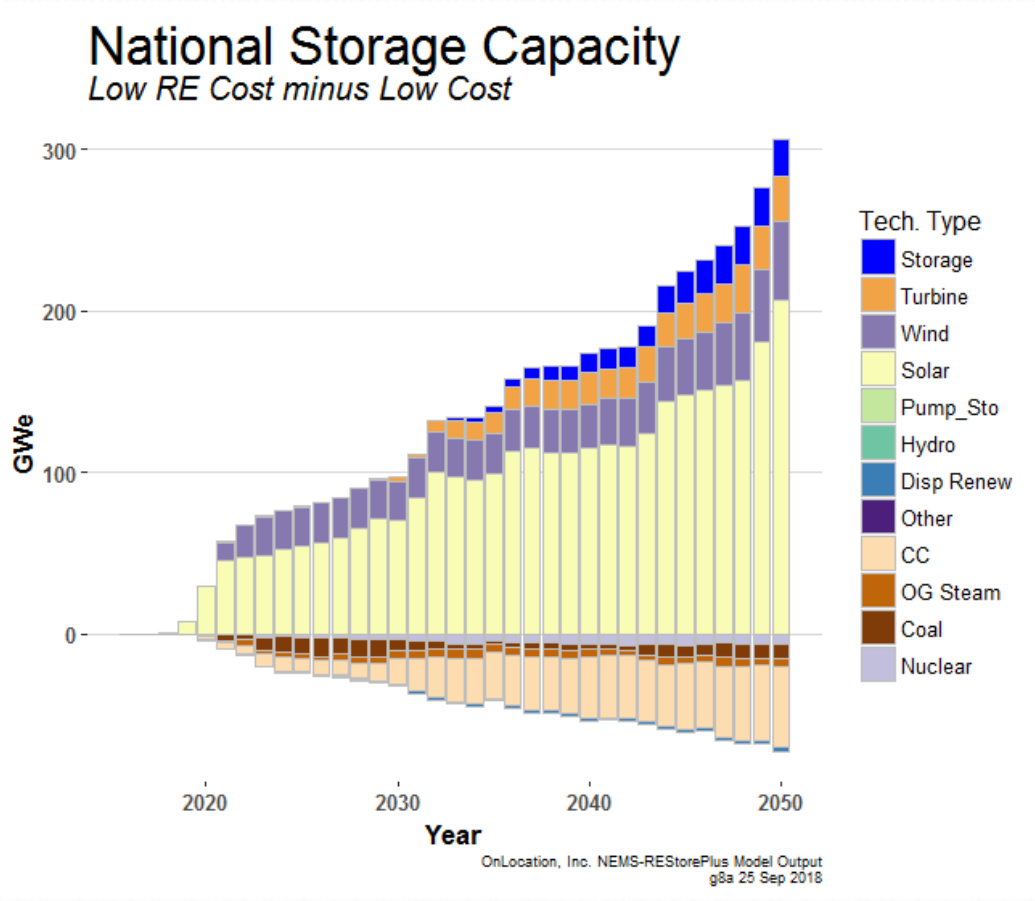




Low RE Cost Impact

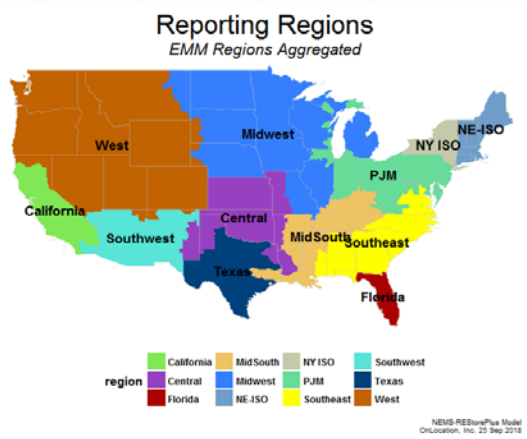
Focusing on Low Renewable Costs

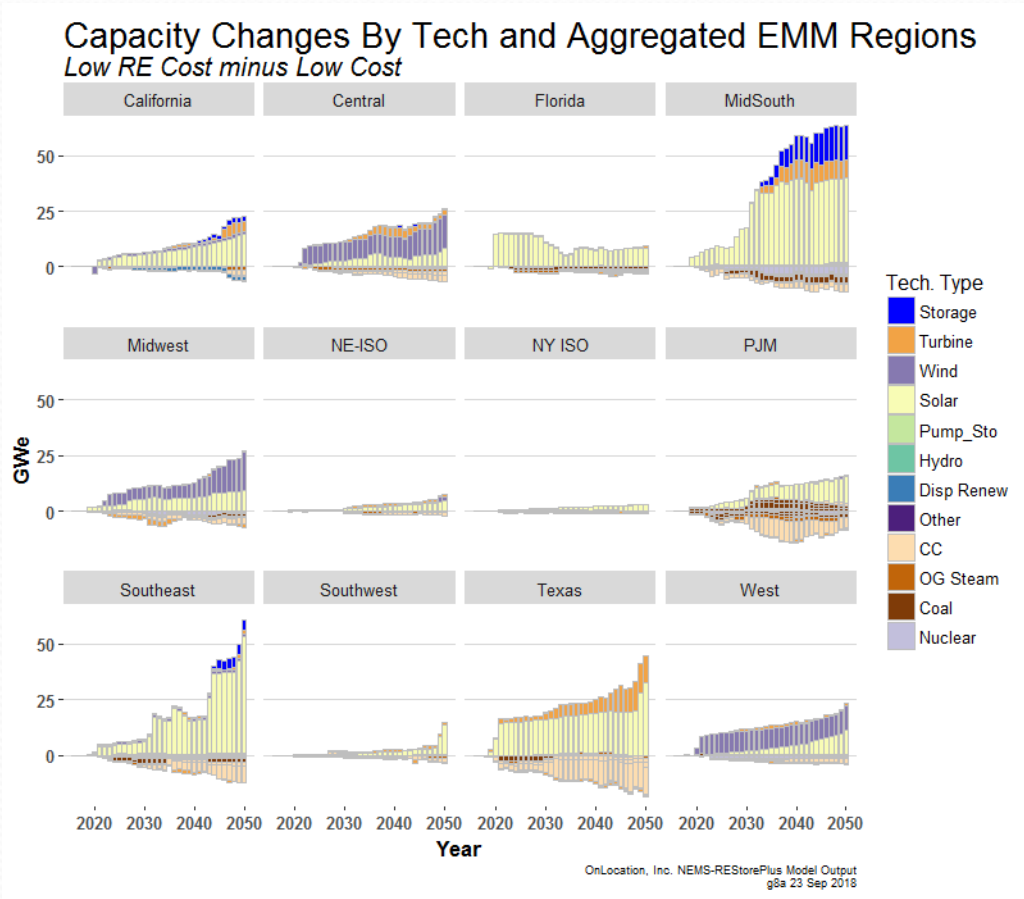
- Lower cost wind and solar technologies leads to a significant increase in solar PV and, to a lesser extent, wind capacity.
- Storage and turbine capacity also increases ~~due~~ to provide firm power.
  - Storage increases by 23 GW
- This combination of resources displaces combined cycle, coal and oil and gas steam capacity but not one-for-one.



Low RE Cost Impact

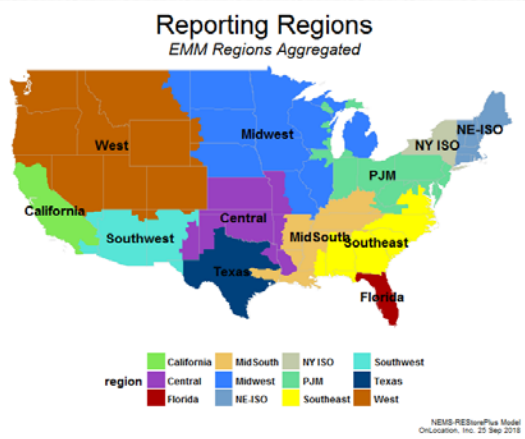
- Lower cost renewables make storage more attractive
  - Storage additions are primarily in the MidSouth, Southeast, and California regions

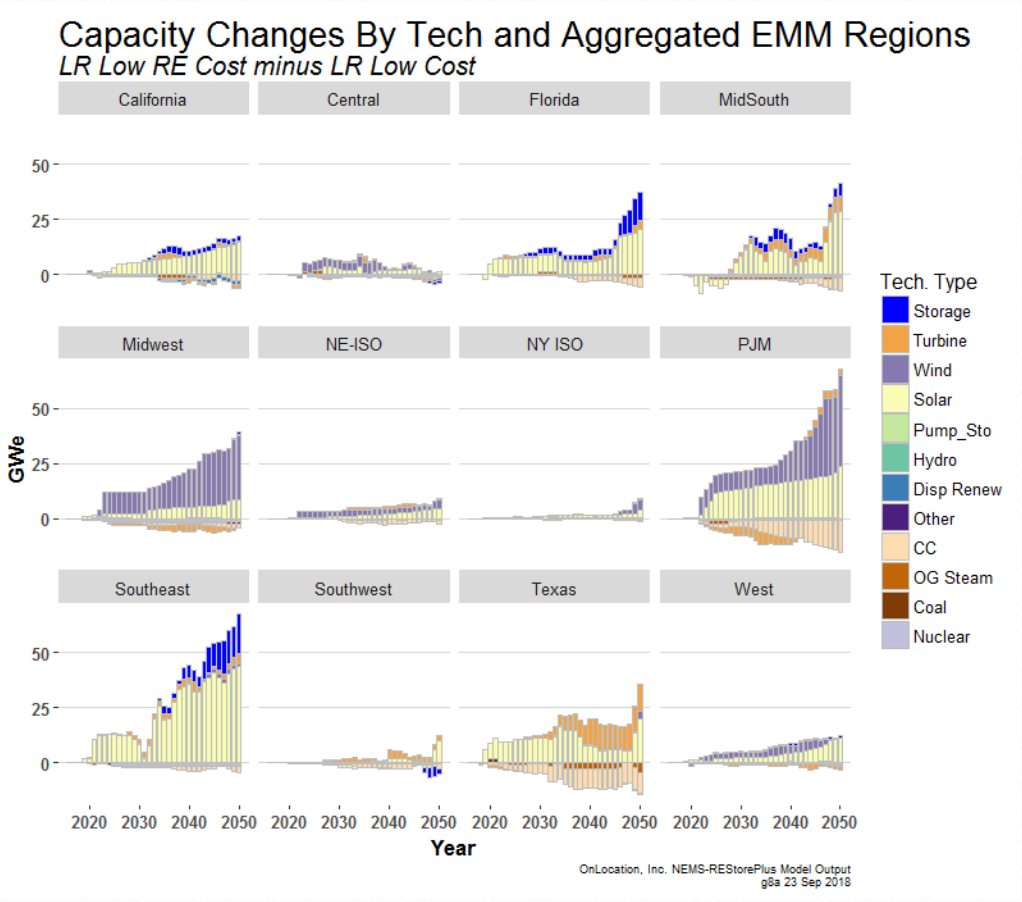




Resource and Cost Impacts

- Lower cost renewables in conjunction with high gas prices make storage even more attractive
  - The greatest increases in storage are in the Southeast, Florida, MidSouth, and California regions
  - Storage capacity increases a total of 38 GW relative to low resources alone





Observations

- Adoption of storage to serve energy and capacity markets is highly dependent on several factors
  - Storage costs – lower than current costs are required
  - Natural gas prices – higher gas prices provide greater arbitrage values by increasing peak prices and encouraging more renewable generation that can provide low cost charging opportunities
  - Wind and solar technology costs and capacity expansion
- The combination of low storage and renewable costs combined with higher natural gas prices leads to roughly 85 GW of storage by 2050

Acknowledgements

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