Storing the Future: A Modeling Analysis of Illinois Energy Storage Needs

Samuel Dotson
Energy Modeler
sdotson@ucsusa.org

Lee Shaver
Senior Energy Analyst
lshaver@ucsusa.org

James Gignac
Midwest Senior Policy Manager
jgignac@ucsusa.org

Union of Concerned Scientists

Purpose

- To inform a right-sized energy storage target for Illinois by analyzing the amount of storage capacity needed to achieve the decarbonization goals of the Climate and Equitable Jobs Act (CEJA).

Methodology

Methodology

- **Framework:** Python for Power System Analysis (PyPSA)
  - Open-source python environment for simulating modern power and energy systems and optimizing for cost

- **Data:** Publicly available datasets from
  - Energy Information Administration (EIA)
  - National Renewable Energy Laboratory (NREL)
  - Nuclear Energy Institute (NEI)
  - Public Utility Data Liberation Project (PUDL)

- **Workflow:** Snakemake management tool

- **Hosted:** GitHub platform (transparent, publicly accessible)

Heuristics and Assumptions

- **Temporal resolution:** 1 hour
- **Spatial resolution:** Regional transmission organization subregions
  - PJM: ComEd
  - MISO: Zone 4
- **Policies considered:** Illinois Climate and Equitable Jobs Act (CEJA); federal Inflation Reduction Act (IRA) tax credits

Heuristics and Assumptions (cont.)

- **Capital costs**: NREL 2022 Annual Technology Baseline for wind, solar, and storage
- **Operating costs:**
  - Fuel: 2023 monthly EIA data for coal and gas
  - Nuclear: 2023 NEI data for existing nuclear operating costs
- **Renewable resource availability:** Wind speed and solar irradiation modeled for the geographic center of each region (see figure)
- **Transmission**: Optimal and free (i.e., all transmission that is needed is built)
- **Load shape:** Historical load data for PJM and MISO (average of 2019–2023)

Technology Assumptions

Assumption Category	Technology	Note
Expandable	Solar, wind (onshore), lithium-ion batteries (4-hour)	
Maintained	Existing nuclear	Nuclear Regulatory Commission license extensions assumed through 2050
Reduced	Coal, gas	Declining generation limits imposed over time to model CEJA retirement requirements
Not considered	Advanced nuclear, hydrogen, CCS/CCUS, biomass, other storage technologies	Not considered due to uncertain near-term commercial viability, carbon emissions, and/or unfavorable geography

Six Sensitivities

- Core model was built with the outlined heuristics and assumptions.
- Sensitivities were modeled using the two variables (below) believed to have the greatest impact on storage needs.
- Initial demand used as a proxy for whether Illinois is a net electricity exporter.
  - Lower initial demand represents current in-state load.
  - Higher initial demand represents current in-state generation.

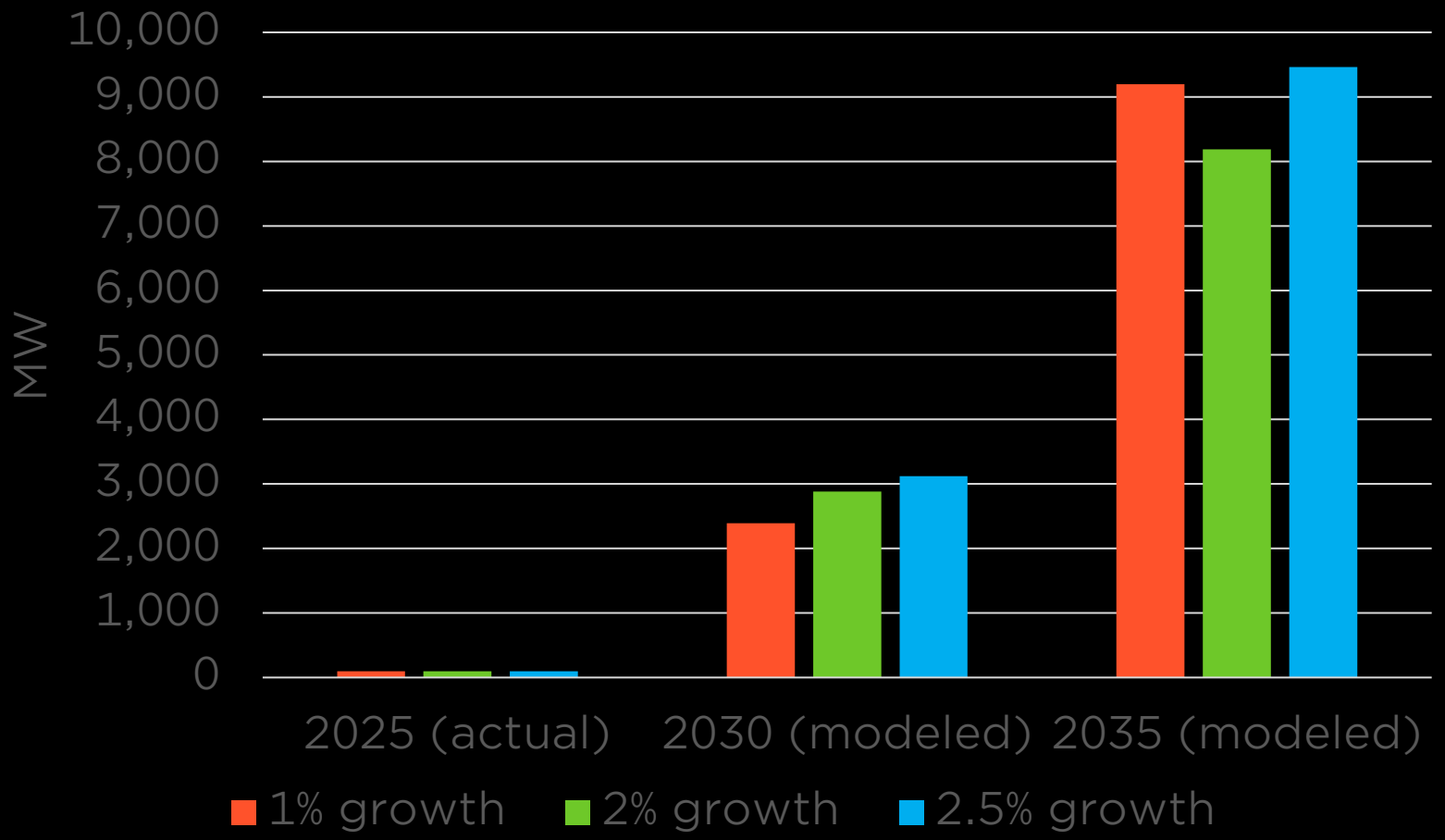
Initial Demand	Annual Demand Growth
• Export (185 TWh) • No export (140 TWh)	• Low growth (1%) • Expected growth (2%) • High growth (2.5%)

Results

Battery Capacity Needs

	Scenario (values in MW)					
	In-State Load ("No Export")			In-State Generation ("Export")		
Year	1% growth	2% growth	2.5% growth	1% growth	2% growth	2.5% growth
2030	400	500	500	2,400	2,900	3,100
2035	5,800	5,400	5,500	9,200	8,200	9,500
2040	15,800	21,200	24,000	35,100	43,400	47,400
2045	56,900	66,900	75,900	83,700	112,800	125,900

Near-Term Battery Capacity Needs (export scenarios)

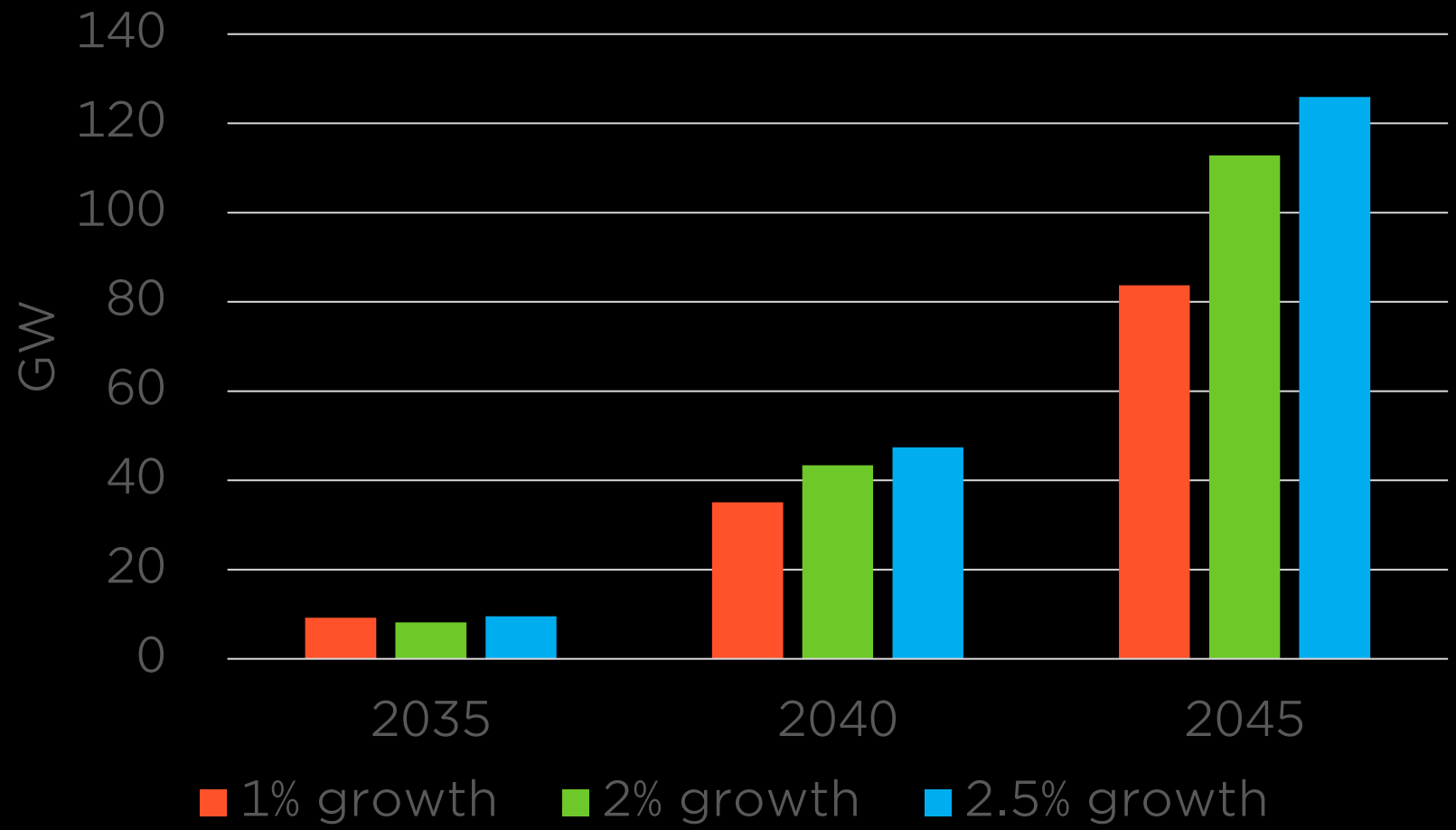


- The significant increase in 2035 is due to the phaseout of fossil fuels beginning in 2030.
- For 2035, less capacity is needed for 2% growth than for 1% because the rapid, early build-out of solar and wind to meet the higher growth slightly reduces storage needs later.

Long-Term Battery Capacity Needs (export scenarios)

Factors influencing large storage needs in later years:

- Cumulative effect of load growth over time
- Illinois maintaining significant energy exports
- Fossil capacity retirement

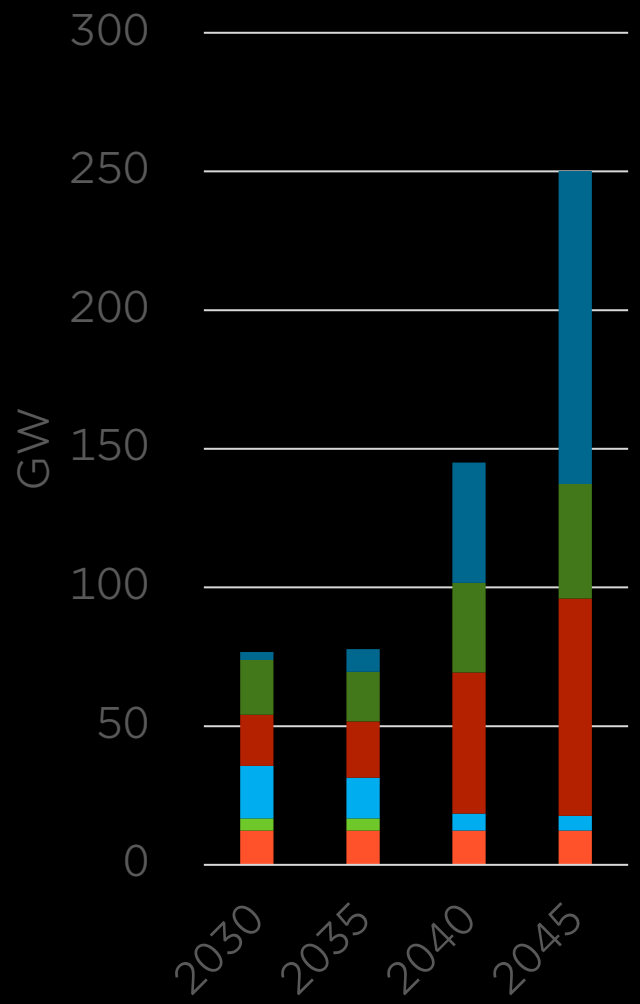


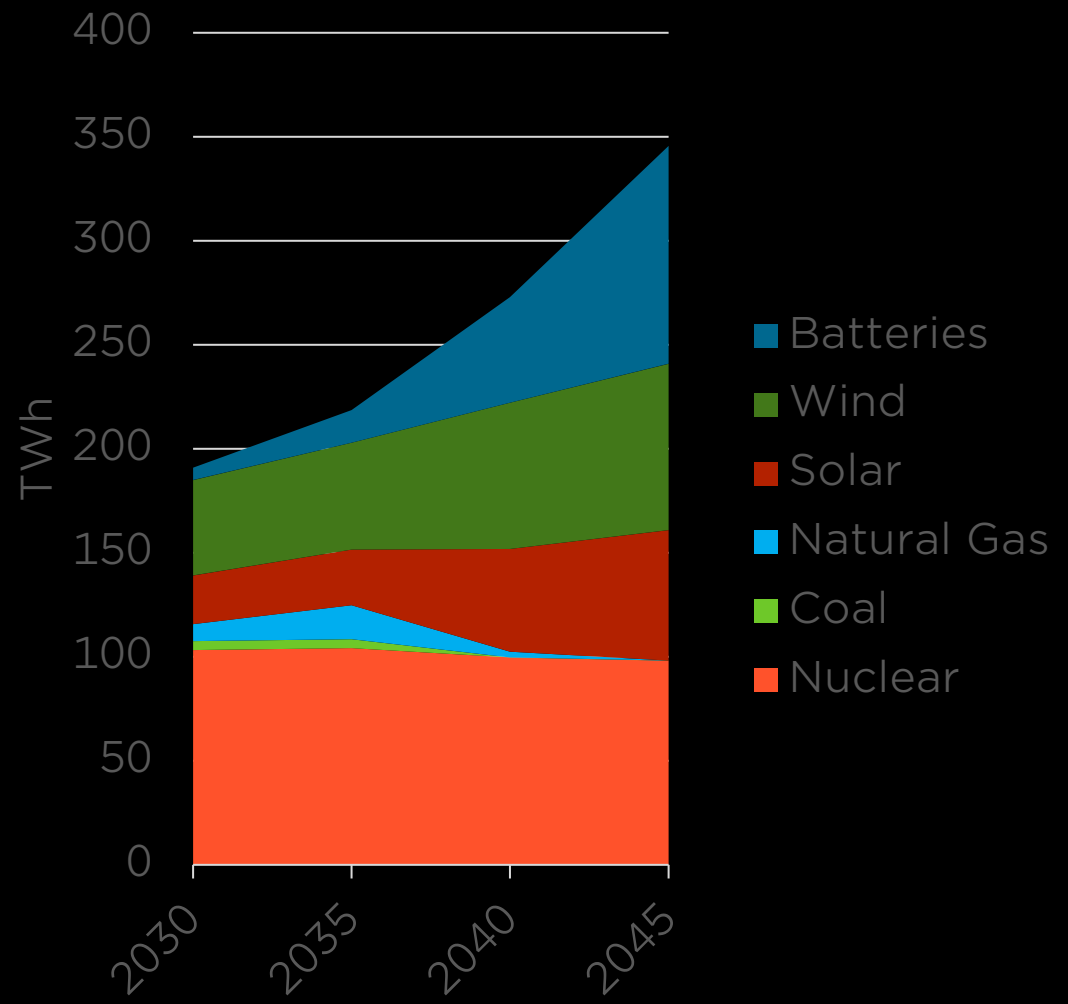
Observations

- Storage needs increase as renewables expand to replace retiring fossil fuel generation.
- 2035 storage needs range from 5.4 to 9.5 gigawatts (GW). The exact amount depends on load growth and whether Illinois maintains energy exporter status.
- Stand-alone energy storage projects can receive investment tax credits under the Inflation Reduction Act until phaseout in 2033 to 2035.
- Investing in energy storage **earlier** (e.g., 2028–2033)
  - ensures projects will benefit from the federal tax credit and reduce financial burden on Illinois ratepayers;
  - develops the energy storage market in Illinois; and
  - informs program adjustments so that Illinois is prepared to meet growing storage needs into the future.
- **A 3 GW deployment goal for 2030 would give Illinois a strong start toward meeting the full range of potential 2035 storage needs.**

Capacity and Generation Mix

- Export, 2% growth scenario provided for context
- Coal and gas generation decline over time
- Solar capacity exceeds wind, but generation is on par due to lower capacity factor





Conclusions & Recommendations

- Across all scenarios, Illinois requires substantial energy storage development to meet long-term CEJA decarbonization goals.
- **Our analysis supports an initial target of at least 3 GW by 2030 to help Illinois increase storage deployment toward 2035 needs, which vary depending on load growth and avoiding a shift in emissions to other states (i.e., maintaining energy export).** *See also* NRDC/Astrape (2024).
- We recommend earlier investments in storage deployment to take advantage of federal tax incentives and to prepare Illinois' grid as renewables increase over time.
- Variability in load growth and Illinois' status as an energy exporter leads to wider ranges in future storage needs. This changeability calls for continual assessment and flexibility in setting longer-term storage targets.
- Our project demonstrates the successful application of public data sources and open-source modeling tools, which we recommend for use by Illinois agencies.


{ Thank You
Want to Learn More?
For complete assumptions, data sources, and methodology, visit:
www.ucsusa.org/resources/storing-future
[Union of Concerned Scientists