PJM solar and battery forecast 2022: Phase II Forecasts

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Agenda

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Methodology and assumptions

Solar PV and battery forecasting methodology

IHS Markit solar photovoltaics (PV) power and battery forecasting methodology

Analytical framework

The IHS Markit outlook for solar power takes into account multiple drivers and inhibitors that reflect the maturity of the market and its growth potential for solar and batteries.

Key components of our framework for assessing market attractiveness for solar are

- State renewable policy (including renewable portfolio standard [RPS], net energy metering [NEM], community solar, and renewable corporate policies)
- Regulatory incentives
- Solar resources
- Site approval
- Grid access and offtake

Short-term data points

In the short term (one to four years), our forecast is based primarily on existing policies, the late-stage project pipeline, and status of procurement and equipment orders.

Key data inputs collected and assessed by IHS Markit energy analysts include

- Project announcements
- Utility request for proposals (RFPs), auctions, and tenders
- Existing mandates and incentives
- Project development track record
- Reported costs and pricing
- Supply chain announcements and equipment orders

Longer-term assumptions

In the longer term (5–15 years), our forecast draws upon rigorous bottom-up research and on economic fundamentals, energy prices, and macroeconomic factors.

Key data inputs and assumptions include

- Policy and regulatory trends
- Power demand growth and capacity retirements
- Annual solar power pricing forecasts
- Power and gas prices
- Transmission and grid infrastructure

Source: IHS Markit

Key assumptions

Solar forecast scenario overview			
Assumptions	**Scenario 1: "Supply chain woes"**	**Scenario 2: "Base case"**	**Scenario 3: "Accelerated solar build"**
Federal policy support	Current ITC schedule (post-IRA)	Current ITC schedule (post-IRA)	Current ITC schedule (post-IRA)
NEM policies and retail rate structures	Utilities/PUCs (and regulators approve) reform NEM policy earlier owing to costly DG programs. Current retail rate structures are adjusted; existing NEM caps are maintained (and many reduced). Utilities and PUCs also phase out "community solar" and carve-outs for DERs.	From 2021 to 2025, utilities adopt (and regulators approve) changes to NEM and retail rate structures, which result in a more cost-based approach to customer-sited solar compensation (see slide 5); current detailed state NEM policy (see slides 6–8).	Reflecting a greater emphasis distributed solar as a resource for decarbonization, current retail rate structures and NEM are maintained for three years beyond the reform timeline in the base case; they are then reformed in a similar manner.
Solar costs ($/kW)	Solar costs plateau for the next four years owing to continued supply chain disruptions before resuming their prior rate of decline. Disruptions are linked to the ongoing Auxin trade dispute, shipping backlogs, and elevated raw material prices due to elevated global demand. Panel availability is restricted through the mid-2020s. Ultimately costs decline by 4–20% in nominal terms from 2022 to 2038.	Solar costs decline by 17–30% in nominal terms from 2022 to 2038 (42–50% in real terms).	Solar costs decline by 28–40% in nominal terms from 2022 to 2038, driven by a combination of technology advancements and policy incentives. Supply chain issues disappear leading to low prices and widespread availability.
State policy support	Current RPS policies and state-level incentives are maintained.	Current RPS policies and state-level incentives are maintained.	Current RPS policies and state-level incentives are maintained.
Power demand	Base-case demand	Base-case demand	Base-case demand

Note: DG = distributed generation. ITC = investment tax credit. PUCs = public utility commissions. DERs = distributed energy resources; IRA = Inflation Reduction Act

Source: IHS Markit

US federal tax credits

US renewable energy tax credit availability, reflecting changes made in August 2022 Inflation Reduction Act

			Start of construction†						
			2006-2019	2020-2021	2022	2023-2032	2033	2034	2035
ITC	**Base rate** (project does not meet labor requirements*)	Base credit	30%	26%	6%	6%	6%	6%	0%
		Domestic content**				2%	1.5%	1%	0%
		Energy community***				2%	1.5%	1%	0%
	Full rate (project meets labor requirements)	Base credit			30%	30%	22.5%	15%	0%
		Domestic content				10%	7.5%	5%	0%
		Energy community				10%	7.5%	5%	0%
PTC for 10 years (2022 $/MWh) ††	**Base rate** (project does not meet labor requirements)	Base credit	$10-$26	$15	$5	$5	$4	$3	0%
		Domestic content				$1	$0.75	$0.5	0%
		Energy community				$1	$0.75	$0.5	0%
	Full rate (project meets labor requirements)	Base credit			$26	$26	$20	$13	0%
		Domestic content				$3	$2	$1	0%
		Energy community				$3	$2	$1	0%

* Labor bonus requires developers to meet prevailing wage and apprenticeship requirements
** Domestic content bonus requires a certain percentage (rising over time) of components to be made domestically
*** Energy community bonus requires projects to be sited in census tracts that formerly hosted coal plants or had a significant amount of employment from fossil fuel industries
† Start of construction is defined as having incurred 5% of final qualifying project costs or having completed "physical work of significant nature". Both definitions require that projects make continuous progress toward completion once construction has begun and be placed into service within four years of starting construction to qualify for tax credits.
†† Technology eligibility rules have been relaxed under the IRA, meaning solar PV and geothermal are eligible for the PTC, and standalone storage is eligible for the ITC

Options for NEM and retail rate reform

- IHS Markit will not predict specific changes to state or utility NEM policies or rate structures; however, we assume states will choose from a variety of options that reduce the compensation for customer-sited solar but still provide sufficient compensation for a moderate pace of additions.
- Holistic rate reform options for all residential customers: lower volumetric (dollars per kilowatt-hour) price in favor of higher
  - Minimum (fixed) bill charge
  - Peak-demand (dollars per kilowatt) charge
- Narrowly tailored NEM reform options:
  - Reduce bill credits for all solar generation exported to the grid in real time (may require new meters)
  - Add “standby” or similar charges for NEM customers only
- NEM replacement options:
  - Value-based tariff (adjusted periodically to account for changes in wholesale power markets, transmission and distribution costs, etc.)
  - Transition toward time-of-use (TOU) pricing for all NEM customers
  - Competitive process (for example, rolling tenders or RFPs)

RPS and NEM policy assumptions by state

Current RPS policy by state

State	RPS target (percentage of retail sales)*	Solar carve-out percentage of retail sales)*/Distributed carve-outs
DE	25% by 2025, 28% by 2030, 40% by 2035	3.5% by 2025, 5% by 2030, 10% by 2035
DC	100% by 2032	2.85% by 2023, 5.50% by 2032, 10% by 2041
MD	50% by 2030	14.5% by 2030
NJ	50% by 2030*	5.1% by 2021, gradually reduced to 1.1% by 2031
OH	8.5% by 2026	0.5% of total electricity supply in 2026 and thereafter
PA	18% by 2021	0.5% by 2021
WV	-	-
IN	10% by 2025 (voluntary)	-
IL	40% by 2030, 50% by 2040**	1.5% by 2025
KY	-	-
MI	15% by 2021***	
NC	12.5% by 2021****	0.2% by 2020****
VA	100% by 2045*****	1,100 MW by 2035 (Dominion only), Dominion is required to meet 1% of RPS requirements from DG sources (>1 MW to <3 MW)
TN	-	-

Note: RPS includes solar carve-outs. *New Jersey RPS target only includes Class I renewable technologies and the solar carve-out. **Illinois solar carve-out requires that 50% of the solar procurements must be from distributed/community solar. RPS mandates at least 75% of the standard come from wind and solar. Climate and Equitable Jobs Act invests $580 million a year to increase Illinois's clean energy from 9% to 50% by 2040 ***Utilities in Michigan have agreed to 25% by 2030. ****RPS compliance in North Carolina can be achieved through energy efficiency and renewable energy credits (RECs) from any state. *****Phase 1 utilities are required to achieve 14% by 2025, 30% by 2030, 65% by 2040, and 100% by 2050 while Phase II utilities are required to achieve 26% by 2025, 41% by 2030, and 100% by 2045. The primary drivers for solar development include existing Public Utility Regulatory Policies Act (PURPA) policy, planned requests for proposal (RFPs), solar resources, solar costs, and the previous state tax credit.

Source: IHS Markit

RPS and NEM policy assumptions by state

Current RPS and NEM policy by state

State	Utility/territory	NEM cap	NEM system size limits (MW)
DE	All utilities	8% of the capacity needed to meet the electric utility's average Delaware transmission peak demand for the preceding 3 years	0.025 (residential), 2 (Delmarva nonresidential), 0.5 (Delaware Electric Cooperative [DEC], Delaware Municipal Electric Corporation [DEMEC] nonresidential)
DC	Potomac Electric Power Co (Pepco)	N/A	For 2021, no more than 140% of the customer's historical 12-month usage, increasing 20% every year until 2024
MD	All utilities	3 GW	2 MW or 200% of customer load
NJ	Investor-owned utilities (IOUs), electric suppliers	None****	100% of customer load
OH	IOUs	N/A	Not to exceed 120% of customer annual average load
PA	IOUs	N/A	0.050 (residential), 3 (nonresidential), 5 (microgrids)
WV	All utilities	3% of peak demand during previous year	0.025 (residential), 2 (industrial for large IOUs), 0.500 (commercial for large IOUs), 0.050 (C&I for small IOUs)
IN	IOUs	1.5% of utility's summer peak load or by July 2022 *******	1
IL	IOUs, retail suppliers	Removed the NEM cap, but included a cap date of December 31, 2024 or whenever new compensation values are approved, whichever is sooner	5
KY	IOUs, electric cooperatives except TVA	1% of utility's peak load in prior year	0.045
MI	All utilities	1% of utility's average of the previous 5-year peak load. Voluntary cap increase by Consumers Energy and UPPCO to 2%.	0.15
NC	IOUs, electric suppliers	N/A	2 (residential customer-owned systems), 1 (commercial systems up to 200% of contract demand)
VA	IOUs, electric cooperatives	6% of load, 1% are reserved for low-income customers	0.025 (residential), 3 (nonresidential)
TN	N/A	N/A	N/A

*NEM remuneration is a tariff structure under which the utility pays customers for excess generation, up to a given amount. The most common arrangement is "full retail rate NEM," in which excess generation is paid the same volumetric price that the customer pays for electricity; so, exports are effectively netted against grid consumption over a given period (typically one year). **NEG over that period is sometimes paid at a lower rate, often based on the utility's avoided cost. ***Total remaining excess kWh at the end of the calendar year (valued at the generation rate) that amounts to greater than $25 will be refunded as a check to the customer, if less than $25 it will be given as a credit. ****While no mandatory cap exists, it as at the discretion of the NJBPU to cap at 5.8% of retail sales. *****TREC = transition renewable energy credits. ******Virtual meter aggregation is limited to the account holder's meters and only those within two miles of the POI. *******As of July 2022, the Indiana Utility Regulatory Commission has approved four utilities in Indiana to transition from net metering to a new lower rate known as "excess distribution generation" and proposed to instantaneous netting rather than monthly net metering.

Source: IHS Markit

RPS and NEM policy assumptions by state (continued)

Current RPS and NEM policy by state

State	NEM remuneration for on-site use or export generation*	NEG remuneration**	Community solar
DE	Retail (For commission-regulated utilities, retail does not include the societal benefits charges)	Monthly carryover. At the end of the annualized billing period, excess kWh credits shall revert to the electric distribution company and are not reimbursed, credited or otherwise remunerated. Excess kWh credits do not include charges for the societal benefits program	Virtual net metering (less than 4 MW)
DC	Retail	Carries over at retail rate indefinitely, at generation rate for systems over 100 kW***	Virtual net metering (less than 5 MW)
MD	Retail	Credited to customer's next bill at retail rate; reconciled annually in April at the commodity energy supply rate	Virtual net metering (less then 5 MW)
NJ	Base $152 TREC price ($0.152/kWh), nonresidential rooftop receives full TREC and ground mount receives 60%; residential rooftop, ground-mount, and carport receive 60%*****	Fixed $152 TREC price ($0.152/kWh)	85% of TREC Price ($0.12920/kWh)
OH	Less than retail	Credited to next bill at unbundled generation rate (includes energy component but excludes capacity-related compensation	None
PA	Retail	Credited at retail rate for a year, then any leftover excess is credited at generation and transmission portion of the retail rate, but not the distribution	Virtual meter aggregation******
WV	Retail (credits cannot reduce monthly bills below the fixed monthly charge)	Retail	Virtual net metering
IN	Full retail through 2047 for net metering facilities installed through 2017 and through 2032 for those installed through 2022; 125% of average energy market price for facilities installed after 2022 or 1.5% cap is met. Per SB 309, retail rate net metering has been phased out by July 2022. As of July 2022, the Indiana Utility Regulatory Commission approved proposals from four utilities for a net billing system with instantaneous netting.	Full retail through 2047 for net metering facilities installed through 2017 and through 2032 for those installed through 2022; 125% of average energy market price for facilities installed after 2022 or 1.5% cap is met. As of July 2022, the Indiana Utility Regulatory Commission approved proposals from four utilities for a net billing system with instantaneous netting.	None
IL	Retail (TOU for customers paying TOU rates)	Credited to next bill at retail rate, excess at end of year is granted to utility	Virtual net metering
KY	Less than retail	Utility will purchase all electricity produced at the rate set by the PSC, instead of the retail rate	Utility-run program
MI	Approximately 50% of retail	Less than retail	None
NC	Retail	Carries over at retail rate, granted to utility at beginning of summer billing period	Utility-run program
VA	Retail	Retail	Utility-run program
TN	N/A	Retail	None

*NEM remuneration is a tariff structure under which the utility pays customers for excess generation, up to a given amount. The most common arrangement is “full retail rate NEM,” in which excess generation is paid the same volumetric price that the customer pays for electricity; so, exports are effectively netted against grid consumption over a given period (typically one year). **NEG over that period is sometimes paid at a lower rate, often based on the utility’s avoided cost. ***Total remaining excess kWh at the end of the calendar year (valued at the generation rate) that amounts to greater than $25 will be refunded as a check to the customer, if less than $25 it will be given as a credit. ****While no mandatory cap exists, it as at the discretion of the NJBPU to cap at 5.8% of retail sales. *****TREC = transition renewable energy credits. ******Virtual meter aggregation is limited to the account holder's meters and only those within two miles of the POI.

Source: IHS Markit

RPS and NEM policy assumptions by state (continued)

Current RPS and NEM policy by state

State	Unbundled energy attribute certificates	Virtual power purchasing allowed	Renewable energy offerings from utilities or electric suppliers/green tariff	Production for self-consumption—net metering*
DE	Allowed	Allowed	Retail choice	Up to 2 MW
DC	Allowed	Allowed	Retail choice	Up to 1 MW
MD	Allowed	Allowed	Retail choice	Up to 2 MW
NJ	Allowed	Allowed	Retail choice	Cannot exceed on-site load
OH	Allowed	Allowed	Retail choice	No size limit
PA	Allowed	Allowed	Retail choice	Up to 3 MW, 5 MW for microgrids
WV	-	Allowed	-	Up to 2 MW
IN	-	-	Green tariff enabled to guarantee sufficient RECS; does not require new build	No size limit under green tariff
IL	Allowed	Allowed	Retail choice	Up to 5 MW
KY	Voluntary	-	Green tariff enabled	Up to 45 kW
MI	Allowed	-	-	1 MW***
NC	Allowed	Allowed**	Green tariff in development	Up to 1 MW
VA	Allowed	Allowed****	Green tariff enabled	Up to 1 MW
TN	-		-	-

Note: Green tariffs only include programs where utilities build new renewables on behalf of corporate customers. * Production for self-consumption—net metering refers to the NEM system size limits outlined by state or utility specific policies **In specific utilities. ***Applies to Consumers Energy and UPPCO service areas. ****Applies to agricultural sites and school districts for projects up to 10 MW capacity.

Source: IHS Markit

Federal and regional energy storage policy assumptions

Federal and regional energy storage policy assumptions

Category	Policy	Base case
Federal	Investment Tax Credit (ITC)	Updated phaseout schedule owing to COVID-19, assuming four-year "under construction" guidance (deadline increased to 15 October) or ending 31 December 2023. BESS only eligible if colocated with solar PV and charged directly from associated resource for first five years of operation.
Regional	PJM capacity market (as applicable to battery)	Assume Minimum Offer Price Rule (MOPR) is revised All other existing market rules, including draft effective load-carrying capability (ELCC) values, remain in place over forecast period
State/city	Energy storage targets	Remain in current form
State	Tax credits	Remain or expire as currently scheduled
State	Incentives (e.g., rebates)	Assume Virginia's and New Jersey's utilities roll out an incentive program for BTM batteries in effort to comply with state target. Other states remain unchanged

Note: BESS = battery energy storage system. BTM = behind the meter.

Source: IHS Markit

Battery policies by state

Detailed state energy storage policy assumptions

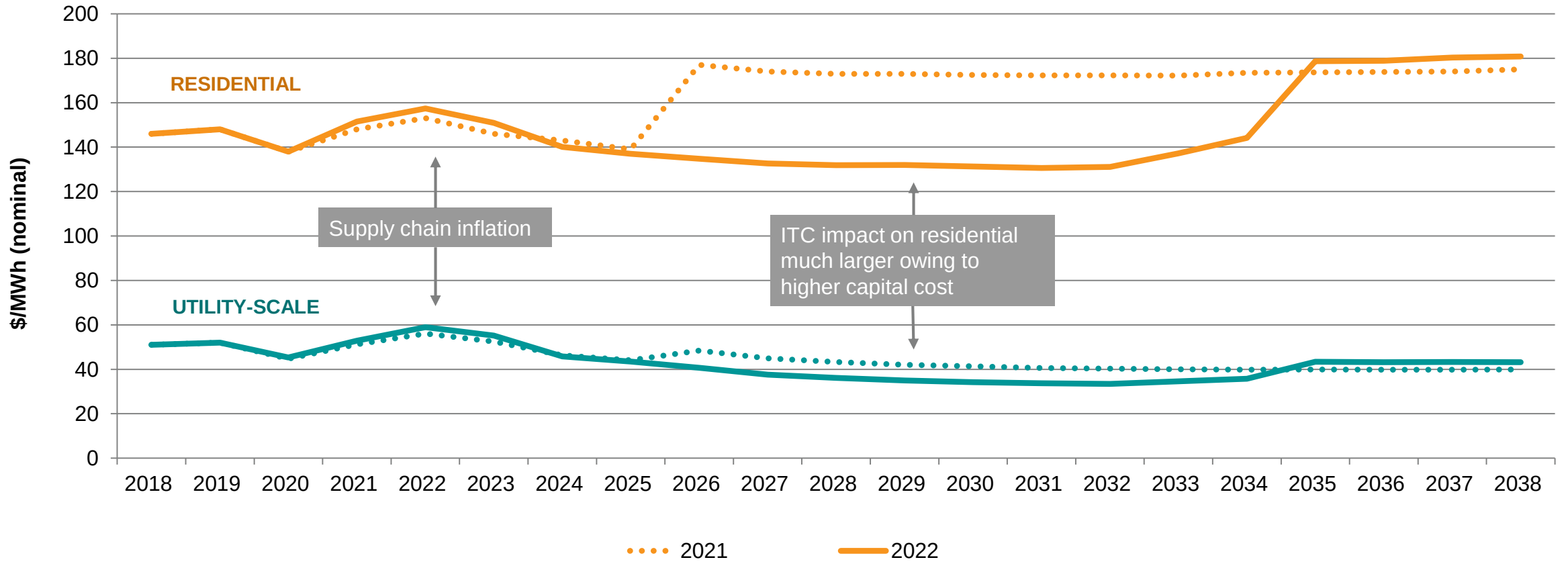
State	Energy storage target (MW)	Tax credits/Incentives
DE		
DC		
MD	Two 5 MW and 15 MWh pilots by 2022*	30%**
NJ	2 GW by 2030	
OH		
PA		
WV		
IN	8% storage by 2039***	
IL		Per the Climate and Equitable Jobs Act, the distributed generation rebate program has been expanded to include energy storage. Utilities must provide US$250/kWh in rebates for installed capacity of energy storage paired with distributed generation for customers that are not eligible for net metering, or US$300/kWh for customers that are.
KY		
MI	1 GW by 2025, 4 GW by 2040	
NC		
VA	2.7 GW by 2035 (Dominion), 0.4 GW (Appalachian Power Company)****	Energy storage systems greater than 5 MW and less than 150 MW are exempt from sales tax.
TN	2.4 GW by 2028 and 5.3 GW by 2038 (Tennessee Valley Authority)	

*Maryland's "Energy Storage Pilot Project Act" solicitation offers for IOUs at least two energy storage projects with a cumulative size of at least 5 MW and 15 MWh. **Maryland Energy Administration (MEA) 2018 Energy Storage Tax Credit Program offered 30% tax credit of the total installation costs (up to $5,000 for a residential project and $75,000 for commercial). ***In May 2018, lawmakers passed legislation (S 2314/A 3723) to implement energy storage targets of 600 MW by 2021 and 2 GW by 2030 and requires the BPU to establish a process and mechanism for achieving these targets. ****The regulations instruct Appalachian Power Company and Dominion to construct or acquire 400 MW and 2,700 MW, respectively, of front-of-the-meter energy storage resources by 2035. ***Indianapolis Power & Light's (IPL) 2019 IRP proposes replacing coal power with renewables and storage, amounting to approximately 240 MW based on an assumed installed capacity of 3 GW.

Source: IHS Markit

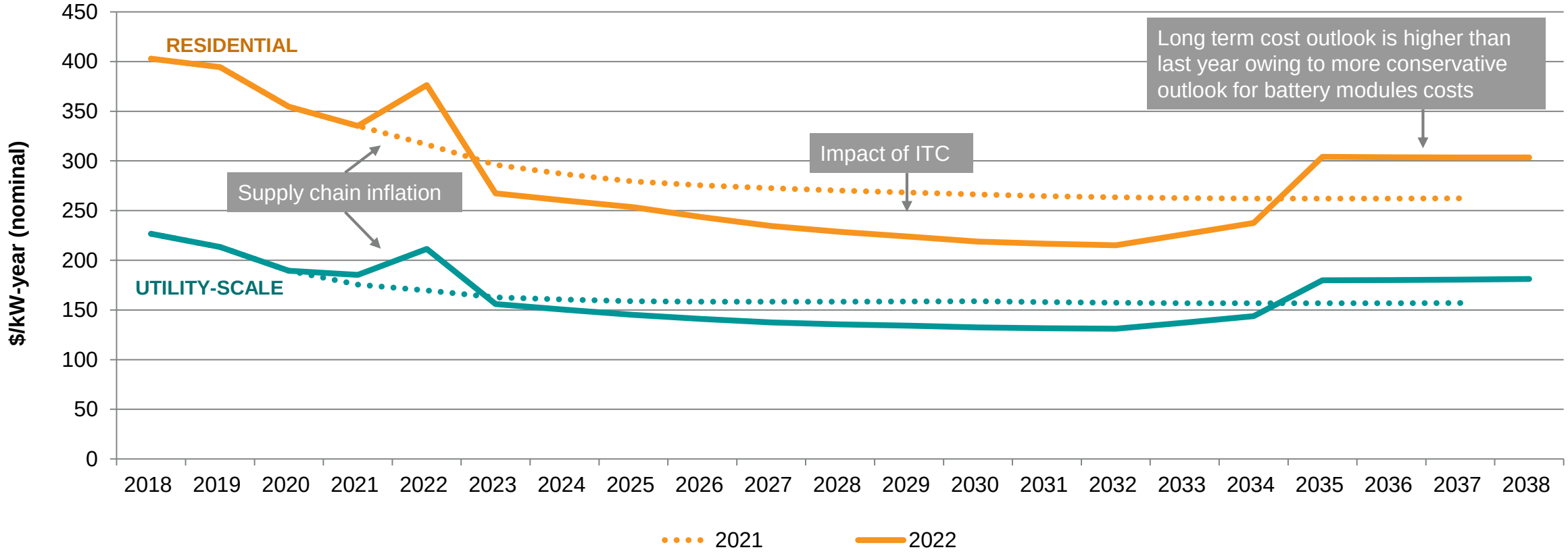
Solar levelized cost outlooks

Solar PV levelized cost outlook (including subsidies), base case compared to last year



Notes:
Source: IHS Markit

Battery energy storage levelized cost outlook, base case compared to last year

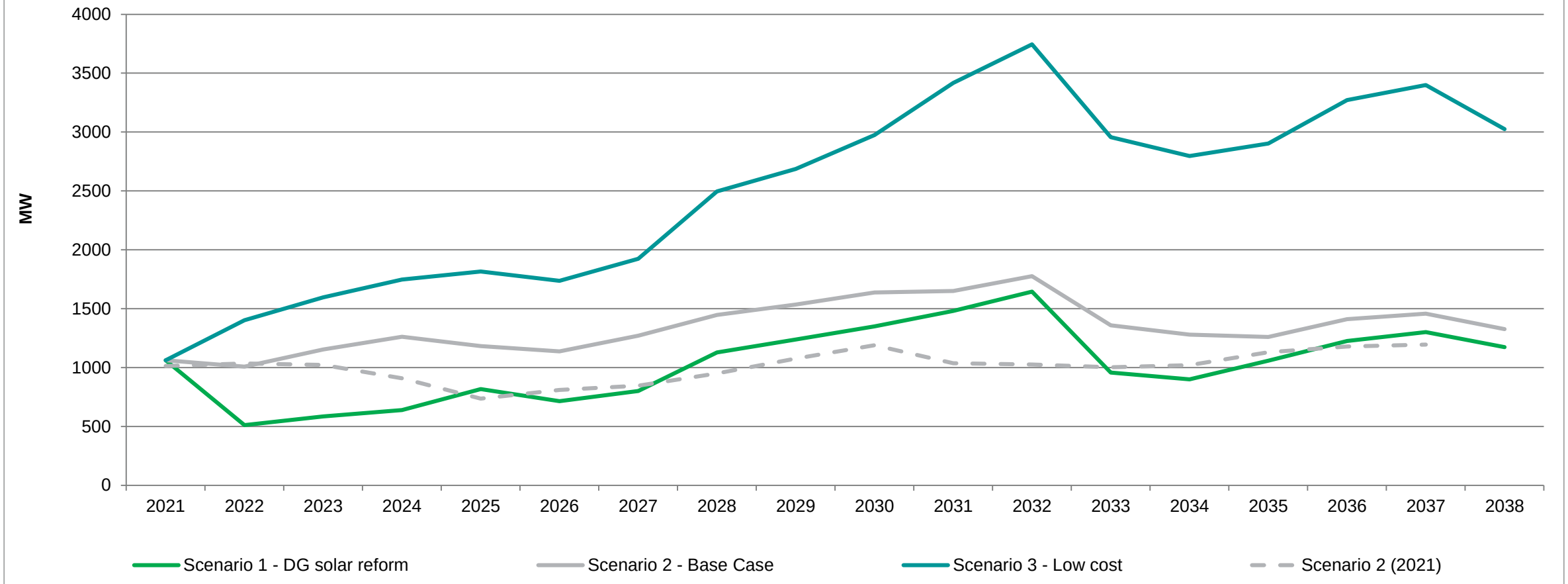


Notes: Utility-scale battery is a 50 MW / 200 MWh system. Residential is a 5 kW / 12 kWh system. ITC rate is assumed to be 30%
Source: IHS Markit

Solar and batteries forecast

Distribution/BTM solar PV capacity additions by scenario

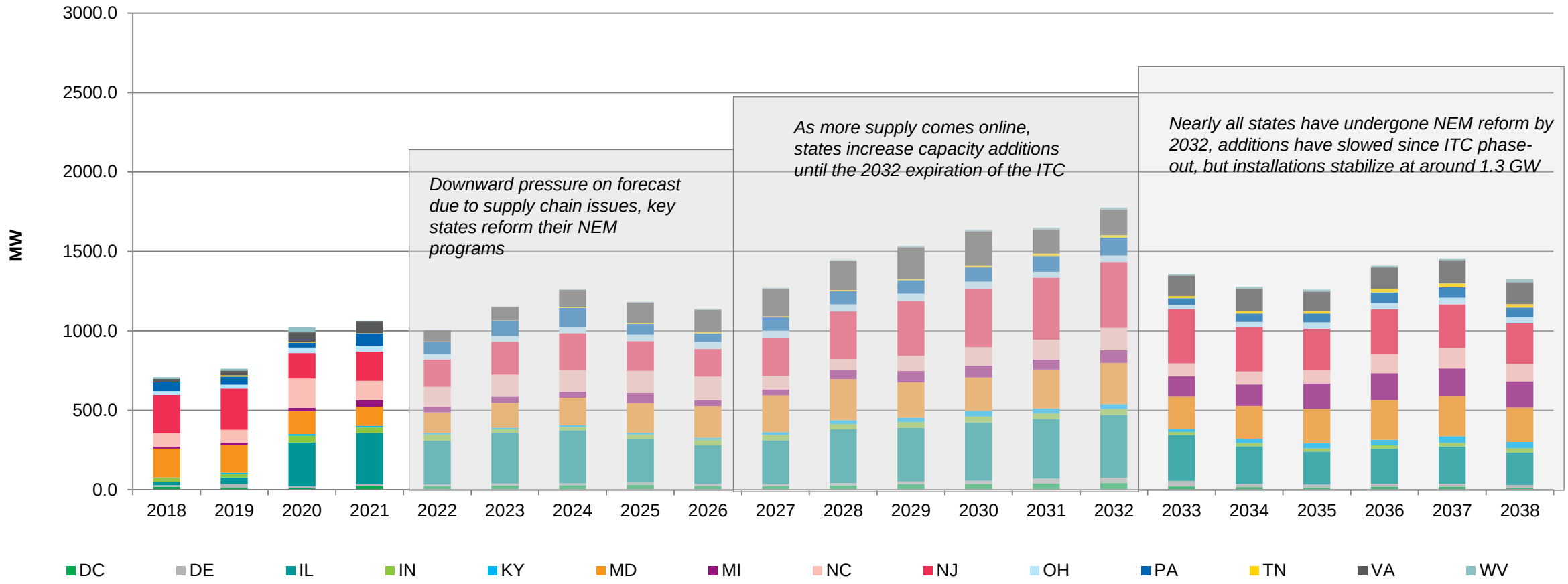
Solar forecasts by scenario, entire state



Source: IHS Markit

Distribution/BTM solar PV capacity additions
Scenario 2: NEM reform (base case)

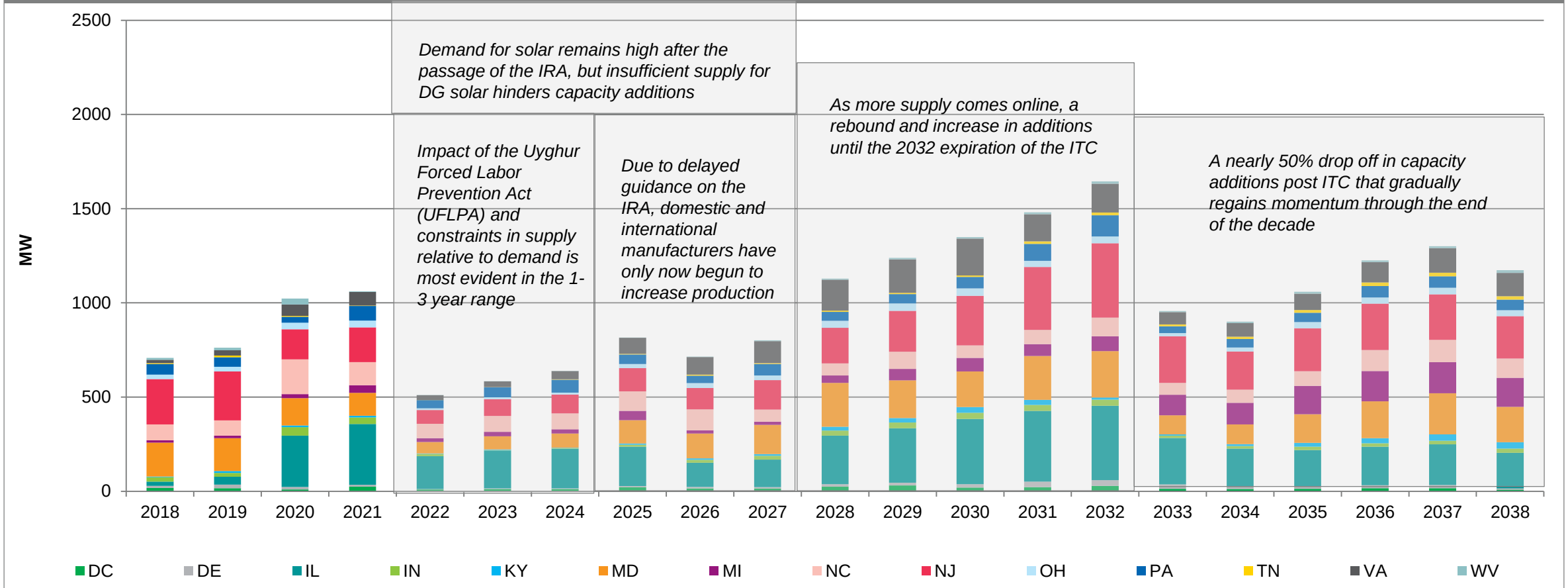
Distribution/BTM solar PV capacity additions—Scenario 2: "NEM reform" (base case), entire state



Source: IHS Markit

Distribution/BTM solar PV capacity additions
Scenario 1: DG solar reform

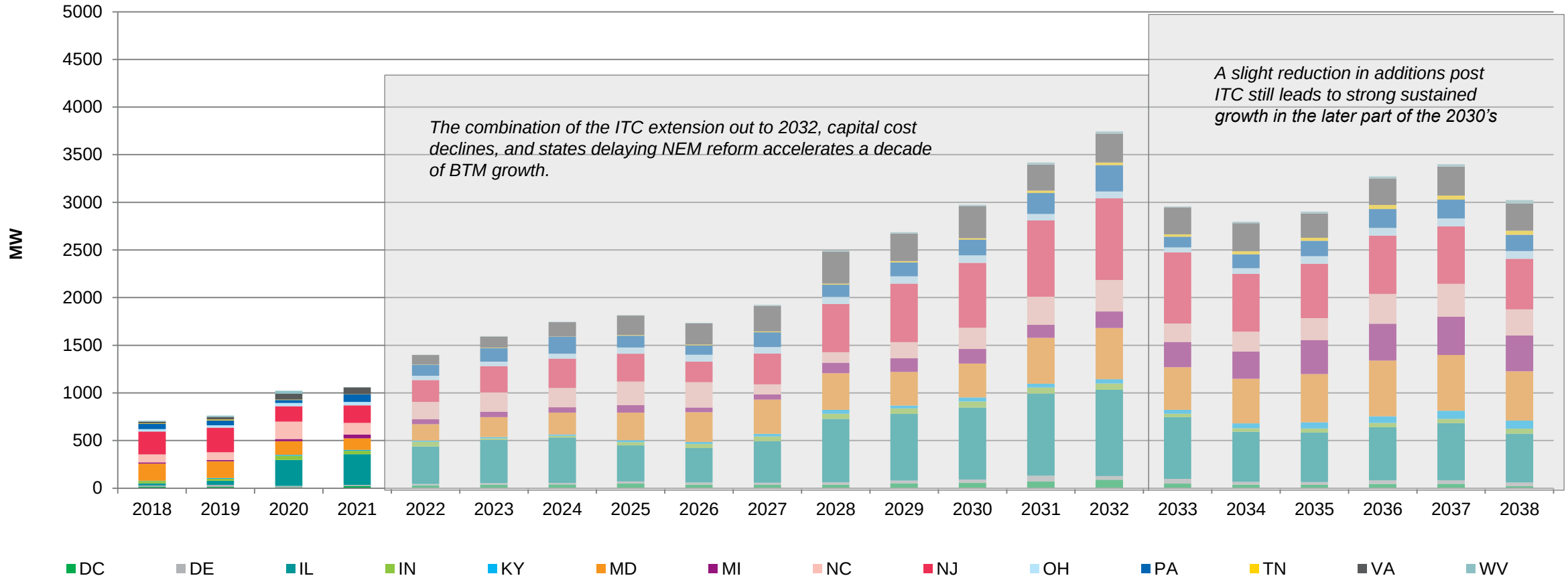
Distribution/BTM solar PV capacity additions—Scenario 1: "DG solar NEM reform", entire state



Source: IHS Markit

Distribution/BTM solar PV capacity additions
Scenario 3: Low-cost solar PV

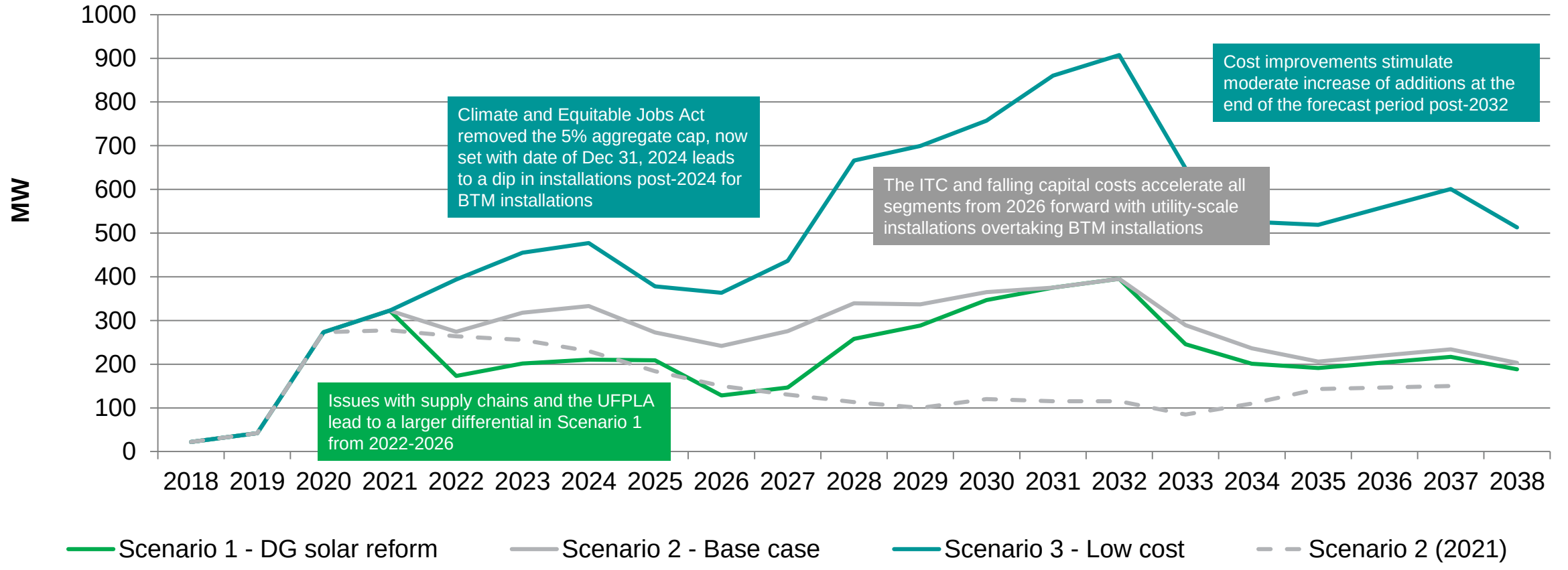
Distribution/BTM solar PV capacity additions—Scenario 3: "Low cost", entire state



Source: IHS Markit

Illinois solar PV distribution/BTM capacity additions by scenario

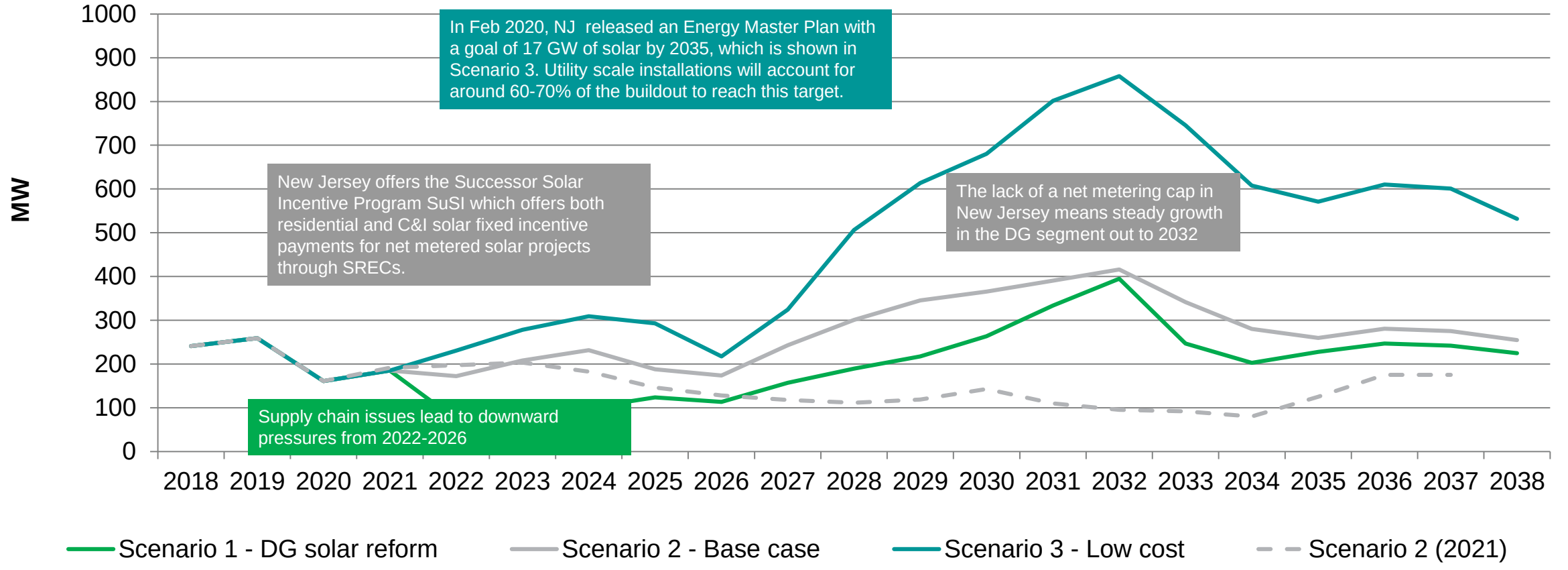
Illinois solar capacity additions by scenario



Source: IHS Markit

New Jersey solar PV distribution/BTM capacity additions by scenario

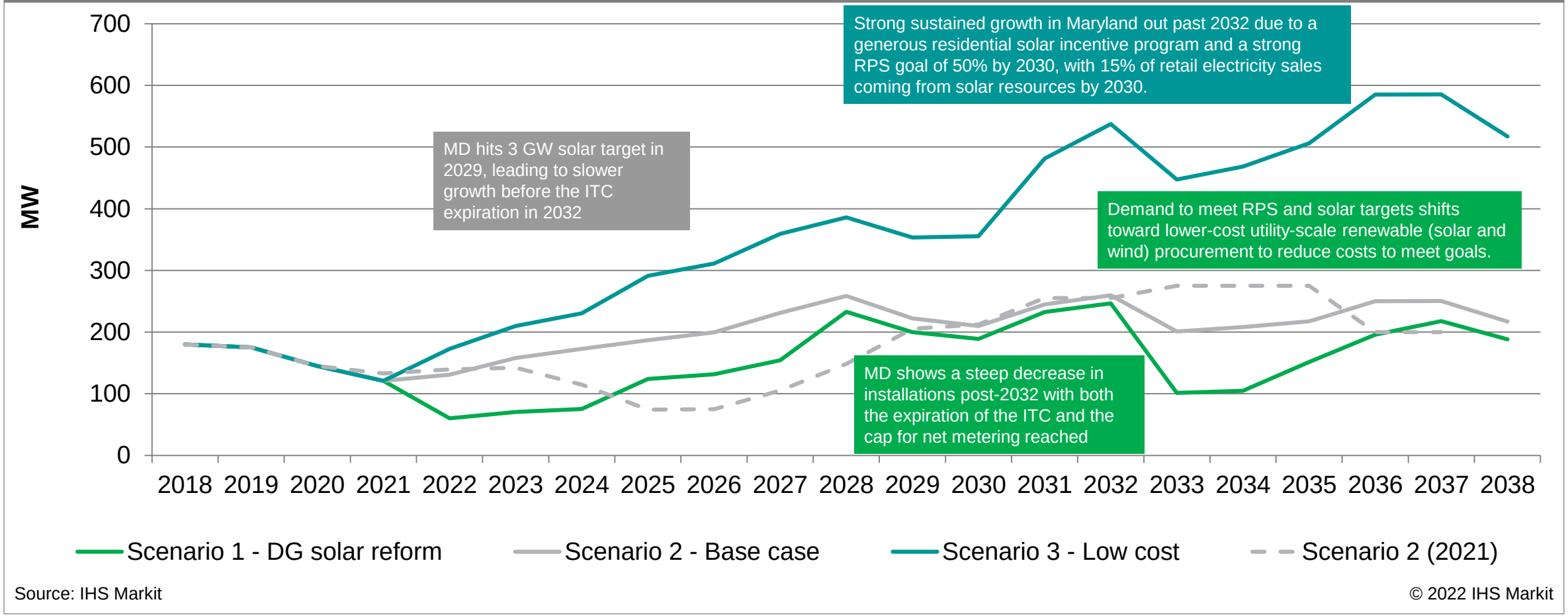
New Jersey solar capacity additions by scenario



Source: IHS Markit

Maryland solar PV distribution/BTM capacity additions by scenario

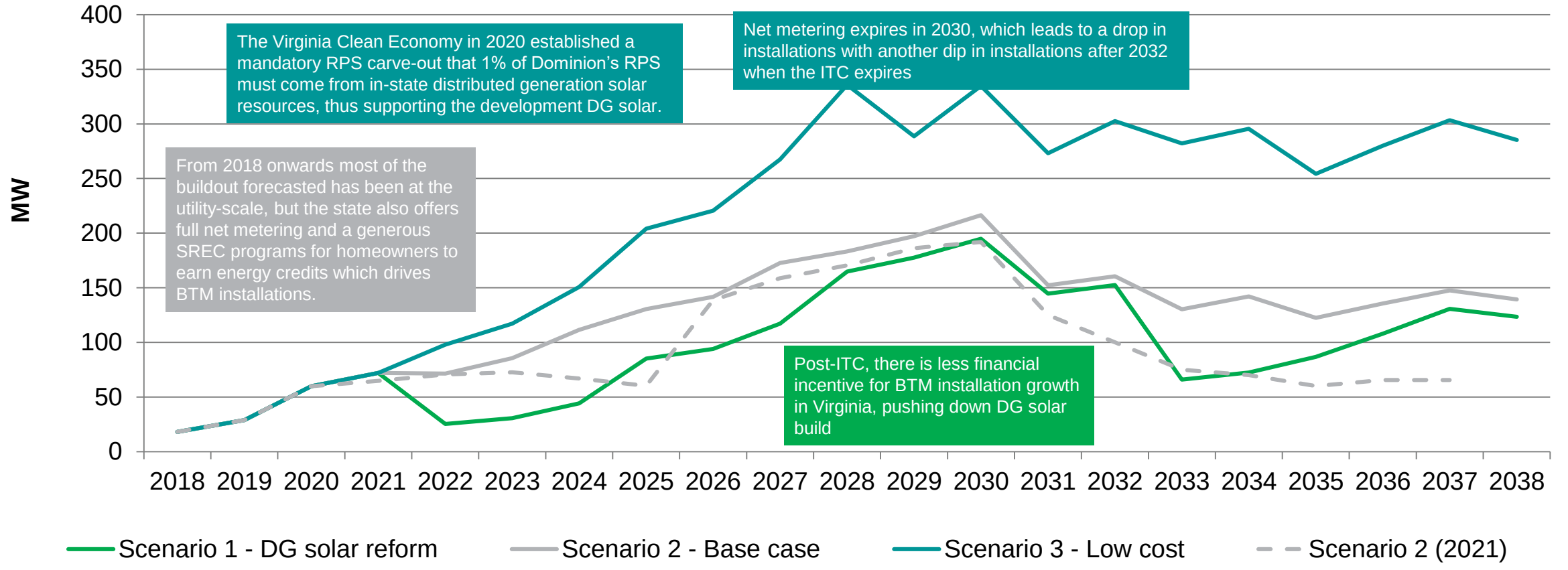
Maryland solar capacity additions by scenario



Source: IHS Markit

Virginia solar PV distribution/BTM capacity additions by scenario

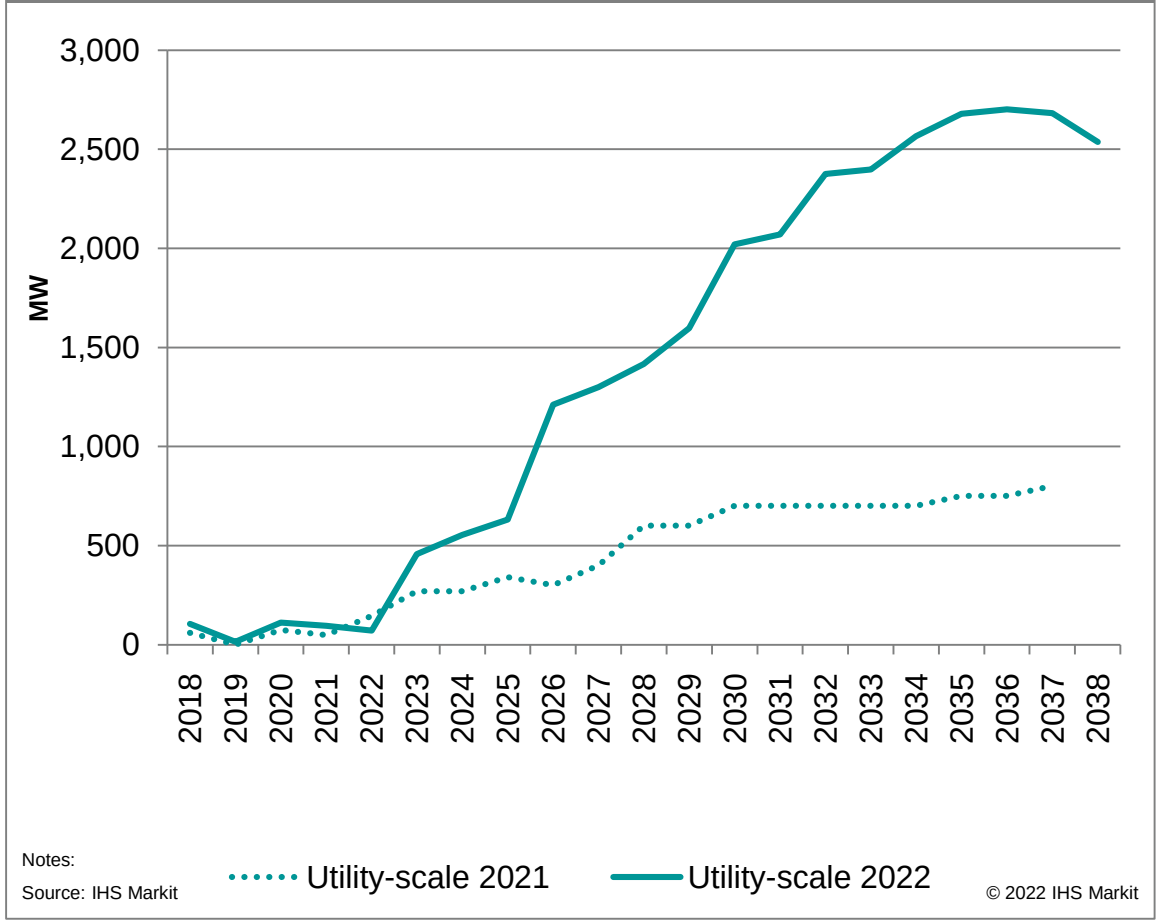
Virginia solar capacity additions by scenario



Source: IHS Markit

Battery outlook relative to last year

Utility-scale battery outlook comparison



Notes:

Source: IHS Markit

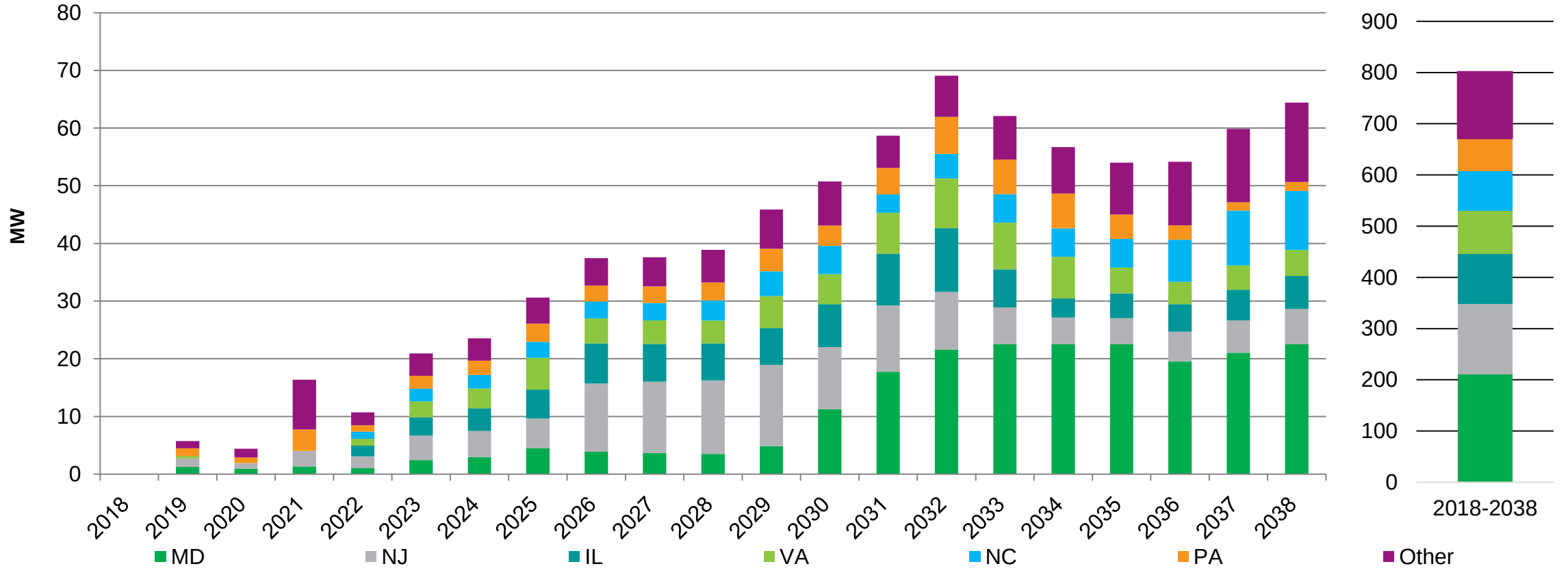
Residential and C&I battery outlook comparison

Notes:

Source: IHS Markit

Residential sector battery outlook

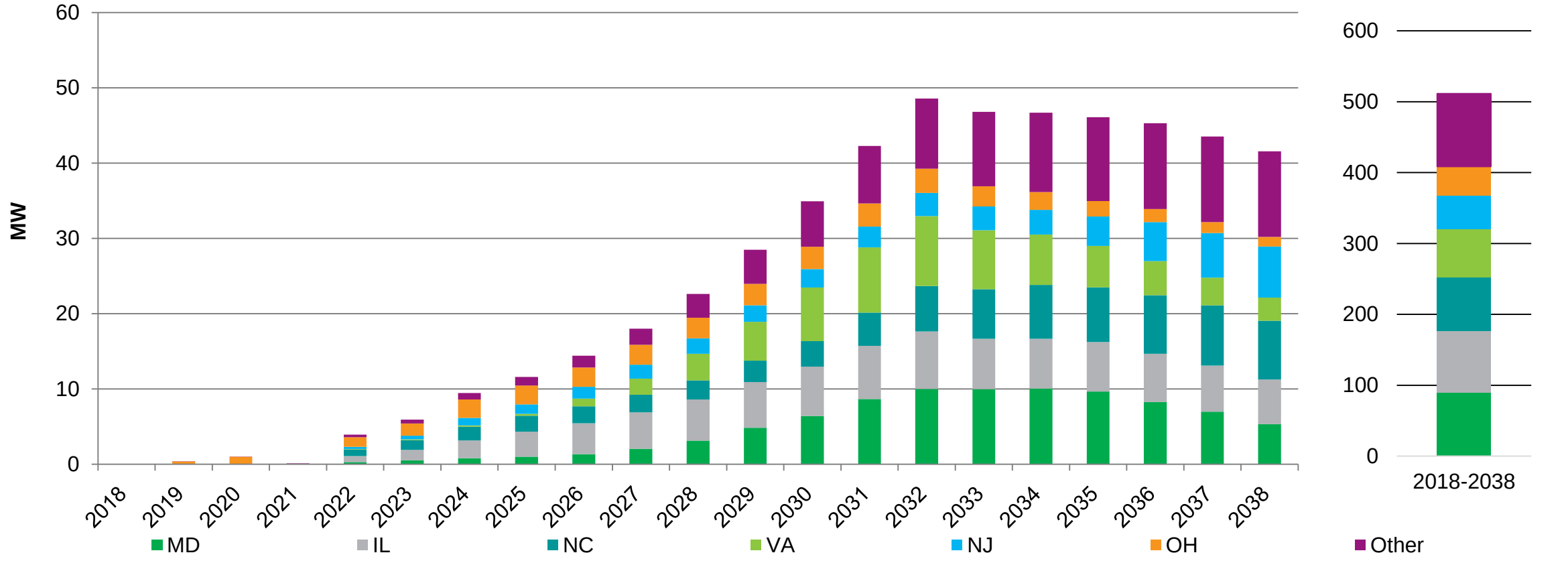
Annual residential battery additions (entire state)



Notes:
Source: IHS Markit

Commercial and industrial sector battery outlook

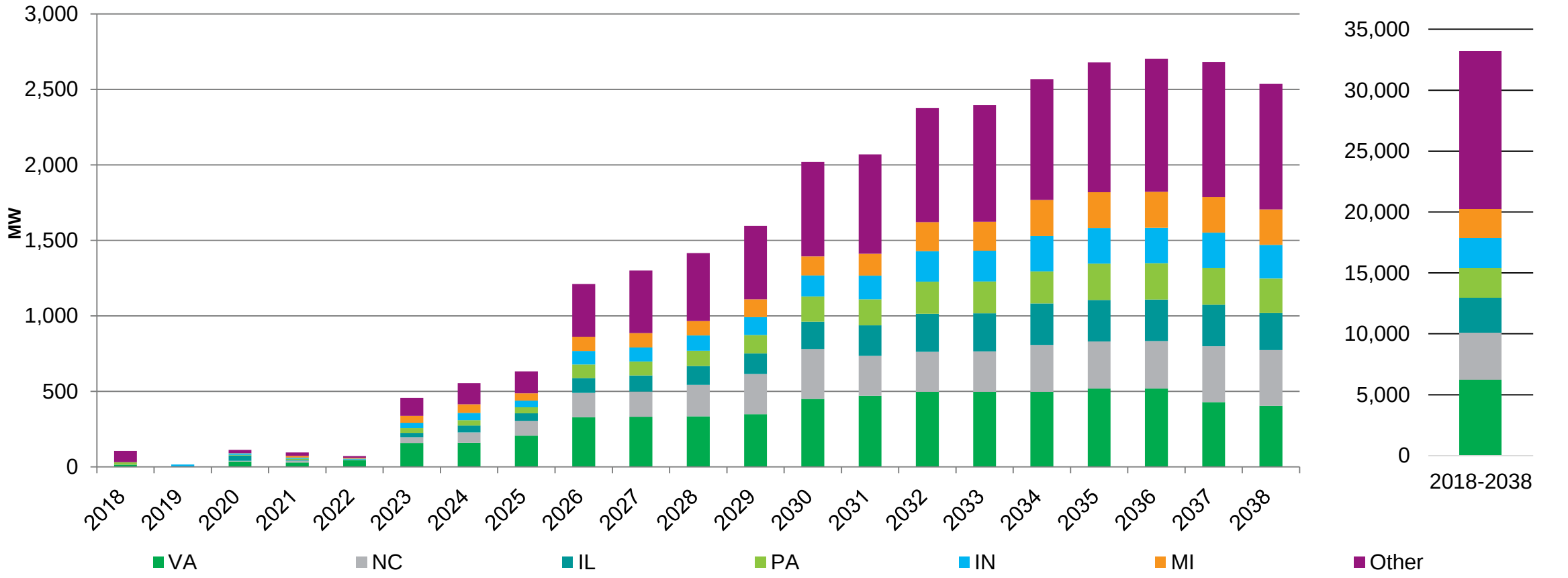
Annual C&I battery additions (entire state)



Notes:
Source: IHS Markit

Utility-scale battery outlook

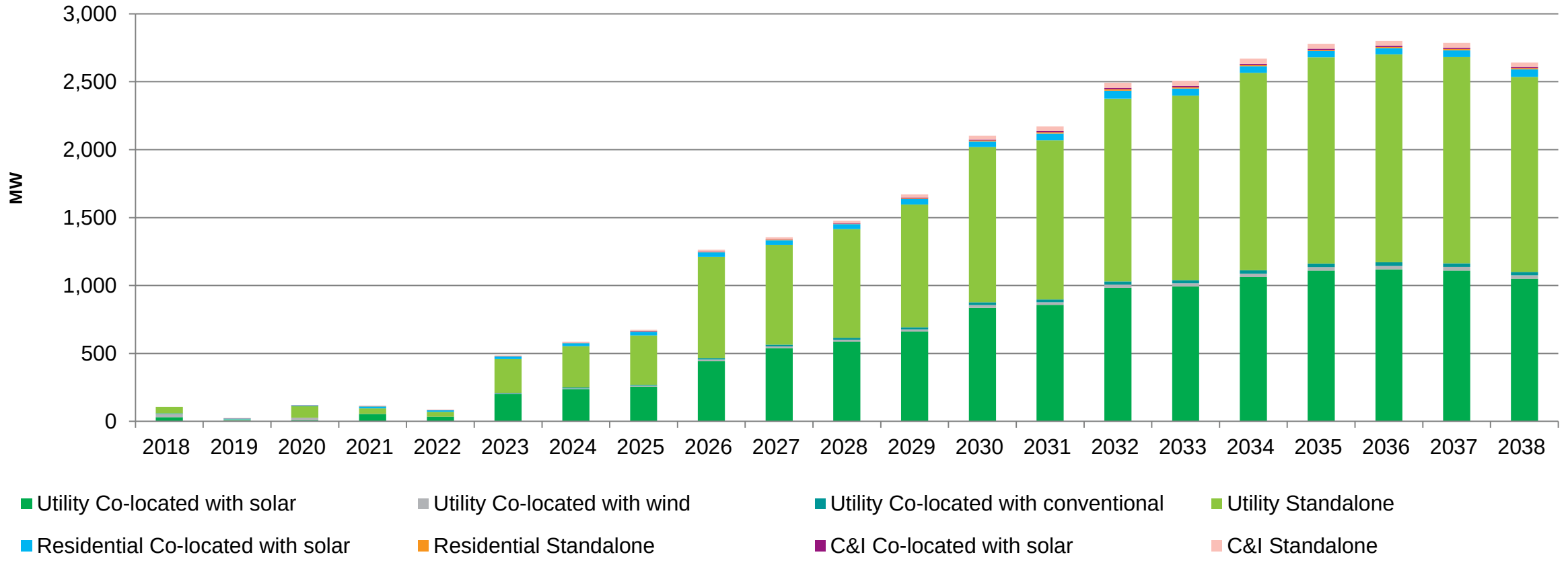
Annual utility-scale battery additions (entire state)



Notes:
Source: IHS Markit

PJM battery outlook by siting

Battery outlook by siting



Notes:
Source: IHS Markit

Conclusions for solar and battery forecasts

- **New federal tax credits will supercharge growth in distributed solar**
  - ITC extension + bonus provisions dramatically improves distributed solar economics, especially >2025
  - Our base case scenario is ~30% higher across the forecast period relative to last year's base case
  - Our bear case is higher than last year's base case
- **In the PJM region, four states will lead the charge – Maryland, New Jersey, Illinois, and Virginia**
  - Combined they account for nearly 70% of the forecast across the PJM region. Key legislation in these states such as the Climate and Equitable Jobs act in Illinois and the Virginia Clean Economy act in Virginia help stimulate growth across all segments.
- **NEM remains a critical policy driver—inevitable reforms to full retail rate NEM will slow, but not halt, growth DG solar**
  - Most key states are expected to reform their NEM policies in the 2022-2026 period as installed capacity hits legislative caps
  - However, as experience in other states demonstrates (e.g. California), reforms are likely to balance policy costs against growth incentives, which in our view means reduced export compensation, but only to a level that allows for continued growth.
  - NEM reforms are also likely to support distributed battery storage—common reforms such as TOU and asymmetrical rates create natural incentives for storage, and experience in other states suggests regulators/policymakers may couple those reforms with incentives for flexible load, including batteries.
- **Battery energy storage will also grow much faster in PJM with new federal tax credits (standalone ITC + bonuses)**
  - Utility-scale storage will dominate sector additions owing to high demand, better economics and an easier path to market. But resi and C&I storage adoption will also grow much faster than last year's outlook owing to improved economics (tax credits) and a higher DG solar forecast which drives battery adoption.