Behind-the-Meter Solar & Storage Forecast Summary

August 21, 2020

Submitted to:
Evergy

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I. Introduction

Evergy is seeking to gain additional insights on the adoption of Distributed Energy Resources (DER), and in particular behind-the-meter (BTM) solar and storage. While Evergy has access to selected regional deployment projections, such as those from the U.S. Energy Information Administration (EIA) and the Electric Power Research Institute (EPRI), management wants to understand the potential for deployment of technologies specifically within the utility's service territories. Therefore, this Forecast Summary aims to report on the potential for BTM solar and storage adoption within Evergy's service territories and when that adoption might occur. It is divided into two parts:

- **Technology Inventory:** ICF identified and analyzed the key BTM solar and storage technologies, including customer drivers and barriers, utility best practices, and forward-looking trends. These are summarized in Section II.

- **30-Year Forecast:** ICF conducted 30-year forecasts of three adoption Scenarios (Low, Mid, and High) for four technologies/technology combinations, each of which was performed for each of the four Evergy service territories and for three different customer classes (residential, commercial, and industrial) within them. This resulted in 144[1] discrete output combinations (e.g., high adoption of community solar + storage among residential customers in Kansas Metro) for each of the 30 years in question, which were then recombined in various ways to analyze the results.[2] These results are summarized in Section III.

II. Technology Inventory

This section summarizes key behind-the-meter solar and storage technologies, products, and programs. The purpose of this section is to provide Evergy with insights into the developing market for, and adoption of, BTM solar and storage, including key motivating factors. This information is intended to provide a perspective on what drives utilities, customers, developers, and other stakeholders to advocate for and/or undertake new distributed energy resources (DER) programs, pilots, tariffs, and rules.

Table 1 describes customer-sited behind-the-meter solutions, including solar photovoltaics (PV) systems and battery storage systems. Typical ownership options for BTM systems include third-party-owned, utility-owned, and customer-owned.

[1] 3 scenarios x 4 technologies x 4 service territories x 3 customer classes = 144 combinations
[2] Along with summaries of key results included in this document, ICF provided Evergy with the underlying models so that further adjustments to inputs and parameters could be made in the future.

Table 1: Customer-Sited Solutions

	Technology Description	Customer Drivers & Barriers	Best Practices	Forward-Looking Trends
BTM Solar PV	• Collocated with customer load • Generation is consumed on-site by individual customers before exporting to the grid • Formatted to limit grid export or export freely as a "net-metered" system • *Net metering:* billing mechanism to compensate customer at tariff-based rate for exported kWh	*Drivers:* • Electricity cost savings • Environmental benefits *Barriers:* • Upfront costs • Interconnection issues • Customer challenges (uncertainty in ownership, home value impact, etc.)	• Predictability, consistency, and transparency in policies, rates/financial incentives, and processes encourage adoption and development	• Emphasis on low-to-moderate-income customers • Net-metering successor tariffs • Incentives for on-site consumed generation
BTM Battery Storage	• Allow customers to store energy for use later • Lithium-ion technologies are most prevalent Uses: • Demand response to curb high energy costs and wholesale delivery charges during peak times • Back-up power • Demand and energy charge savings	*Drivers:* • Back-up power • Arbitrage • Peak-shaving • Wholesale market participation *Barriers:* • Upfront costs • Difficulty analyzing grid impacts • Load profile suitability • Safety & uncertainty	• Demand response programs should limit customer inconvenience • Incentives should be meaningful and reflect value of provided grid services	• Encourage energy use patterns through Time of Use (TOU) rates and demand charges • Residential customers installing storage as back-up power
BTM Solar PV + Storage	• Power produced by solar PV systems can be stored in a battery for later use • PV + storage systems often have a site controller to manage generation, storage, energy dispatch, and interconnection requirements • Programs are still in their infancy	*Largely the same as standalone solar PV & battery storage drivers/barriers.*	• Dictating specific hours that exported kWh will be compensated • Shifting on-peak hours dictated in TOU rates to later in the evening	• Large solar developers are marketing storage systems as add-ons to PV systems and as a mechanism to assist with EV charging • Customer interest is increasing; desire for back-up power and reduced electricity bills • Storage helps utilities meet ramp requirements in the evenings • Storage can be used to prevent solar PV export and minimize distribution impacts

Table 2 describes off-site solutions, including community and virtual net-metered (VNM) solar PV systems as well as battery storage systems. Typical ownership options for such systems include third-party-owned and utility-owned.

Table 2: Off-Site Solutions

	Technology Description	Customer Drivers & Barriers	Best Practices	Forward-Looking Trends
Community Solar	• Large, off-site, utility scale projects that allow a broad base of customers to "subscribe" to a portion of the solar array • Subscribers receive a credit based on their portion of the system or output on a monthly basis • Production is attributed to individual customer load "behind-the-meter" even though the system is off-site	*Drivers:* • Limited physical assets • Environmental • Electricity cost savings *Barriers:* • Customer communication • Subscription costs • Technical challenges • Interconnection	• Define success and goals before the design phase • Administrative reforms to improve interconnection queue • Updating interconnection requirements for community solar needs • Updating customer outreach strategies • Start small on capacity limits, grow gradually	• Utilities are implementing temporally sensitive rate structures, leading to the addition of storage to projects • Consolidated billing + requirements to provide credits for entire electric bill • Emphasis on low-to-moderate-income customers
Community Solar + Storage	• Batteries can be tied to a new or existing community solar array • Used to inject power onto the grid during peak times or as back-up power • Programs are still in their infancy	*Drivers:* • Avoiding upgrades or downsizing • Dispatchability and additional revenue streams • Backup power *Barriers:* • Learning curve • Interconnection • Compensation complexities	• Encourage solar PV generated during off-peak time to be exported to the grid during peak hours • Allow utility control or work closely with the local utility to optimize operations and revenue streams • Can be used as a resiliency asset	• Developers are beginning to pair solar + storage, or add storage to existing systems • Interconnection requirements innovation • Regulators looking to add storage to existing community solar programs • Incorporation into resiliency programs
Remote/Virtual Net-Metered Solar	• Large, off-site, utility-scale projects that allow customers to purchase a portion of the solar array • Production/credit is attributed to a customer's bill as a net-metering credit • Unlike community solar, remote/VNM programs are typically geared towards a single customer or small aggregation of customers, rather than a broader customer base	*Drivers:* • Electricity cost savings • Environmental • Limited physical assets • Logistics *Barriers:* • Low rates • Communication • Site control and account management	• Customers in multi-unit dwellings or with multi-building campuses generally benefit the most • Customers with multiple sub-metered, aggregated properties should receive a single bill • Third parties can provide technical assistance or guidance to customers throughout the Virtual Net-Metered (VNM) process	• States looking to allow some form of remote/virtual net-metering • Moving to make VNM programs more inclusive • Emphasis on low-to-moderate income customers • Programs started with focus on hard-to-reach segments of customers

III. Methodology Summary

1. Approach

ICF's approach to developing 30-year forecasts for the technologies, customer classes, and Evergy service territories described above included a multi-step, iterative process that resulted in forecasted values for annual and cumulative installed capacity. This process varied by technology type but included the following primary tasks:

- To build the baseline adoption curves, ICF reviewed Evergy data, provided both by Evergy and publicly available EIA datasets, and gathered and analyzed prior technology installation data from similar utilities across the United States. External market reference utilities were used to produce an array of potential future scenarios and to define upper and lower bounds for the forecasts. The targeted utilities were located in California, New York, Massachusetts, Colorado, Minnesota, Missouri, and Kansas (including Empire District Electric and Union Electric), based on specific technologies. While regulatory conditions and market forces do of course differ between jurisdictions, these reference utilities can still be helpful as proxies when exploring possible future outcomes.
- Forecasts for customer classes were adapted from the baseline adoption curves to reflect differences in average technology system sizes, relative costs, customer-derived economic benefits, and comparative payback periods.
- Technology cost baselines were developed using data from nationally recognized sources including NREL and Wood Mackenzie technology reports.
- Utility rates, average avoided costs, and net customer savings were based on both published Evergy tariffs and EIA annual operational reports.
- Modifications were made to forecasts by service territory and Scenario based on the impact of customer-centric project economics which included levelized cost of electricity metrics for BTM PV and payback years for storage-related models.
- When initial technology adoptions levels were very low or non-existent, estimates for capacity adders were included to build the baseline cumulative installed capacity until the annual growth rate adoption curves became meaningful. For example, in all territories there have been no documented BTM storage capacity deployments, so a fixed estimate was added in the early forecast years, rather than an annual percentage growth which could be unhelpful or misleading when deployments are very small or zero.[3]
- ICF further adjusted annual growth potential by reviewing the potential impact from Evergy service territory tariff structures,[4] existing adoption trends, and technology market maturity considerations.
- When developing the final forecasts, ICF first focused on the Mid Scenario as the starting point (i.e., the approximate market path forward), and then adjusted down for the Low Scenario (i.e., a depressed forecast) and up for the High Scenario (i.e., a reasonable best case).
- As higher penetration levels are experienced, a variety of mechanisms – formal or informal, intentional or unintentional – may act as mitigating factors and provide limits on continued growth. Therefore, to avoid unrealistic outputs, ICF included potential caps to

[3] There is no percentage growth rate that, when applied to 0 MW, can result in a larger number

[4] This included the expected shift to time-of-use (TOU) tariff structures for residential customers; commercial and industrial customers, by contrast, are expected to utilize non-TOU structures but to be more influenced by demand charges

the growth rates of certain technologies (e.g., PV) over time to reflect the potential evolution of the desire and opportunities for adoption by customer class.
- The key output for each forecast is an estimate of deployed capacity, both in terms of annual incremental additions as well as cumulative totals. From these values, ICF calculated the incremental load impact and estimates for number of installed systems by customer class.
- Inputs and assumptions for the initial decade (i.e., 2020-2030) are likely to track closest to current trends and market forecasts, with the two subsequent decades (i.e., 2030-2040 and 2040-2050) using the initial decade trends as the starting point for a more straight-line future forecast.

Please see Appendix A for a more thorough description of the forecasting methodology.

2. Parameters

There were four key parameters that determined the scope and scale of the 30-year forecasts: Scenarios, service territories, customer classes, and technologies/technology combinations.

2.1 Scenarios

ICF forecasted three Scenarios, each of which was further partitioned by the additional parameters below. The three Scenarios are described in Table 3.

Table 3: Scenario Definitions

Scenario	Description	Category	Input / Assumption
Low	Low adoption scenario that has a slow growth curve due to conservative technology cost estimates, low utility rates, and no new or extended programs or incentives. This estimated a likely floor on adoption and the total addressable opportunity.	Adoption Curve	Slow adoption curve
		Technology Cost	NREL ATB 2020 Conservative forecast
		Tariffs / Rates	EAAGS Scenario 6 (High Load, Low Gas, No CO2 Restrictions)
		Incentives	No new or extended incentives included
Mid	The forecast of likely or probable market growth of new capacity only. Intermediate adoption scenario that has a middle-of-the-road growth curve due to moderate technology cost estimates, average utility rates, and no new or extended programs or incentives. The Mid Scenario helped to determine differences between/among the service territories and customer classes.	Adoption Curve	Moderate adoption curve based on similar market trends nationwide
		Technology Cost	NREL ATB 2020 Moderate forecast
		Tariffs / Rates	EAAGS "Expected Value"
		Incentives	No new or extended incentives included
High	High adoption scenario that has a more aggressive growth curve due to faster-evolving technology cost estimates and higher utility rates, but also with no new or extended programs or incentives. Upward bounds on adoption and the total addressable opportunity estimated using best-in-class adoption rates from other utilities and jurisdictions. In concert with the Low Scenario, the High Scenario established a band of potential future outcomes.	Adoption Curve	Aggressive adoption curve, but capped below leading markets
		Technology Cost	NREL ATB 2020 Advanced forecast
		Tariffs / Rates	EAAGS Scenario 15 (Low Load, Mid Gas, with CO2 Restrictions)
		Incentives	No new or extended incentives included

2.2 Service Territories

The forecasts were conducted for each of the four Evergy service territories:

- Missouri Metro (MO – Metro)
- Missouri West (MO – West)
- Kansas Metro (KS – Metro)
- Kansas Central (KS – Central)

2.3 Customer Class

Three customer classes were separately forecast:

- Residential
- Commercial
- Industrial

2.4 Technologies

For the purpose of forecasting, some of the starting technologies/technology combinations described in Section II were consolidated or discarded. ICF made two such changes, with the approval of Evergy staff:

- Rather than having separate forecasts for Community Solar *and* Community Solar + Storage, the two were combined into the forecast for Community Solar + Storage.[5]
- No forecast for Remote/Virtual Net-Metered Solar was developed.[6]

This resulted in four technologies/technology combinations utilized for the forecast:

1. Behind-the-Meter Photovoltaic Solar
2. Behind-the-Meter Battery Energy Storage
3. Behind-the-Meter Photovoltaic Solar + Battery Energy Storage
4. Community Solar + Storage

[5] It is ICF's opinion that a rapidly increasing percentage of community solar projects are going to include storage, as seen with the latest new project announcements nationally due to the improving economics and combined benefits of the two technologies. Consequently, "standalone" community solar (i.e., without storage) will not be the primary model for asset development. Therefore, rather than having a Community Solar forecast that is bifurcated into two components where one decreases significantly within the first decade of the forecast, it provides a more complete picture to provide the more encompassing Community Solar + Storage forecast. The resulting forecast allows Evergy to see both models (i.e., with and without storage), but in an easier to utilize and more consolidated fashion.

[6] It is ICF's view that the remote/virtual net-metered solar model is unlikely to be utilized in significant volume in jurisdictions where community solar does not exist. (In instances where remote/virtual net-metered solar is already in place, and community solar is then introduced, the former model is often "grandfathered" in, and the two models therefore do occasionally exist side-by-side.) Evergy has had its Solar Subscription Program in effect since 2016, which is effectively a utility-owned community solar program. (Community solar activity to date in both KS and MO has been limited to utility-owned programs; there have not been any third-party-owned community solar projects to date.) Furthermore, Evergy does not have an existing remote/virtual net-metered solar tariff. Therefore, remote/virtual net-metered solar is highly unlikely to emerge as a model within Evergy's service territory, and ICF's analysis for this forecast yields a minimal expectation for this program type.

3. Metrics

The set of metrics used within each technology's scenario, service territory, and customer class breakdown are generally standardized, but there are a few exceptions based on the specific nature of solar compared to storage, and the complexities that arise when combining the two. The key metrics are:

- **Capacity**
    - The rated generating capacity of the systems installed within Evergy's service territories and measured in kW and MW. This is shown separately for PV and storage capacity for more detailed analysis and forecasting.
    - The cumulative generating capacity by technology is presented in the forecast models and charts below.

- **Energy Output and Net Energy Charging Impact**
    - The ***energy output*** metric is applicable to BTM solar PV and to community solar installations. This metric indicates the energy produced by these technologies during the forecast period and is measured in MWh.
    - As solar PV is an energy generating resource, the energy output from solar PV and community solar reduces the overall energy requirement for Evergy and its customers within each service territory.
    - The annual energy output by technology is presented in the forecast models and the charts below, based on the cumulative installed capacity.
    - The ***net energy charging impact*** metric is applicable to battery storage technologies. Batteries can both charge from and discharge energy to the grid, however, a fraction of the charging energy is lost during a battery's discharge cycle due to round-trip efficiency losses. The battery's discharging energy is lower than its charging energy. As a result, from the utility's perspective, a battery represents a net addition to existing load. The net energy charging impact is measured in MWh.
    - The annual net energy charging impact by technology is presented in the forecast models and the charts below, based on the cumulative installed capacity.
    - For BTM solar + storage and community solar + storage, ICF evaluated the combined energy impact of both the solar PV and battery storage components of the technologies.
        - For these technologies, ICF subtracted the net energy charging impact of the batteries from the solar PV energy output to obtain a net energy impact value (in MWh) from the simultaneous operation of both solar PV and battery storage.
        - As the solar PV energy output is always greater than the battery net energy charging impact on an annual basis within the forecasts, the result is a reduction in the load that must be served by Evergy.

- **Installations**
  - The number of systems (of all technology types) installed within Evergy's service territories over the forecast period.
  - This metric is cited in the forecast models and in the charts below on a cumulative basis.

IV. 30-Year Forecast

This section summarizes the modeling outputs, summarized on a consolidated basis by service territory and then organized by each of the four technologies/technology combinations.

1. Forecast Summary

Given the number of parameters involved (see Section III.2. above), and the resulting granularity of forecasted data, it is possible to lose a sense of how of the different technologies compare and work together; this section provides a high-level summary to provide that viewpoint.

The need for such a summary is particularly important given the potential for overlapping adoption forecasts between BTM technologies. Due to the methods used to build the forecasts, some of the installed capacity forecasted for BTM PV+Storage is also represented in the standalone BTM PV and BTM Storage forecasts. This summary includes all forecasted activity and makes an adjustment to avoid double-counting due to the overlap. Community Solar+Storage, as larger-scale assets than behind-the-meter, do not experience such an overlap, and therefore the numbers depicted in this section match those seen in the Community Solar+Storage summary section (Section IV.5.).

In order to simplify what is displayed below, three years out of the total thirty years were chosen as "snapshots." The years 2025, 2035, and 2050 were chosen to provide an expanding view of the future, with each interval between dates increasing: five years from today, then ten additional years, and finally an additional fifteen years. In other words, the first is near-term (five years away), the second is medium-term (fifteen years away), and the third is long-term (thirty years away). As seen in the graphs in the sections that follow this Forecast Summary, all thirty years were modeled, and the full set of forecasted outcomes is included in the underlying models (see Appendix B).

The tables below summarize forecasted cumulative installed kilowatt (kW) capacity for each analyzed technology at 2025, 2035, and 2050.

Table 4: Missouri Metro Forecast Summary (kW Capacity)

		Low		Mid		High	
		PV	Storage	PV	Storage	PV	Storage
2025	BTM PV	59,690		92,193		107,970	
	BTM Storage		348		1,818		2,720
	BTM PV + Storage	-	-	568	488	2,486	2,298
	Adjustment for BTM Forecast Overlap	-	-	(568)	(49)	(1,451)	(287)
	Community Solar + Storage	1,050	134	3,525	469	6,775	956
	Totals	**60,740**	**482**	**95,718**	**2,726**	**115,780**	**5,687**
2035	BTM PV	106,533		190,555		232,536	
	BTM Storage		4,260		27,898		80,834
	BTM PV + Storage	3,363	3,316	15,231	14,684	25,598	24,555
	Adjustment for BTM Forecast Overlap	(636)	(483)	(5,022)	(2,036)	(9,227)	(3,365)
	Community Solar + Storage	10,570	3,704	34,625	12,131	87,200	30,570
	Totals	**119,830**	**10,796**	**235,389**	**52,677**	**336,107**	**132,594**
2050	BTM PV	155,471		268,706		336,936	
	BTM Storage		6,525		60,714		190,476
	BTM PV + Storage	4,475	4,332	31,240	29,791	56,305	53,706
	Adjustment for BTM Forecast Overlap	(1,362)	(606)	(12,383)	(4,027)	(22,234)	(7,263)
	Community Solar + Storage	13,210	5,288	53,425	23,411	142,000	60,143
	Totals	**171,795**	**15,538**	**340,988**	**109,890**	**513,007**	**297,061**

Table 5: Missouri West Forecast Summary (kW Capacity)

		Low		Mid		High	
		PV	Storage	PV	Storage	PV	Storage
2025	BTM PV	77,341		100,640		115,097	
	BTM Storage		348		1,776		2,720
	BTM PV + Storage	-	-	600	515	1,690	1,487
	Adjustment for BTM Forecast Overlap	-	-	(600)	(52)	(1,465)	(161)
	Community Solar + Storage	1,300	165	3,725	484	7,125	994
	Totals	**78,641**	**513**	**104,365**	**2,724**	**122,447**	**5,040**
2035	BTM PV	128,291		106,290		261,728	
	BTM Storage		4,074		26,474		78,954
	BTM PV + Storage	429	369	7,866	7,252	24,856	23,688
	Adjustment for BTM Forecast Overlap	(429)	(37)	(4,711)	(900)	(9,948)	(3,197)
	Community Solar + Storage	10,920	3,773	36,675	12,840	96,425	33,896
	Totals	**139,211**	**8,179**	**146,120**	**45,666**	**373,061**	**133,341**
2050	BTM PV	187,304		172,516		406,836	
	BTM Storage		6,527		61,100		201,985
	BTM PV + Storage	1,402	1,205	19,864	17,975	57,812	54,438
	Adjustment for BTM Forecast Overlap	(1,402)	(120)	(14,055)	(2,120)	(27,338)	(7,137)
	Community Solar + Storage	13,770	5,483	58,175	25,740	156,825	66,458
	Totals	**201,074**	**13,094**	**236,500**	**102,695**	**594,135**	**315,744**

Table 6: Kansas Metro Forecast Summary (kW Capacity)

		Low		Mid		High	
		PV	Storage	PV	Storage	PV	Storage
2025	BTM PV	14,220		26,537		35,856	
	BTM Storage		332		1,755		2,600
	BTM PV + Storage	-	-	836	810	5,634	5,566
	Adjustment for BTM Forecast Overlap	-	-	(251)	(113)	(999)	(814)
	Community Solar + Storage	1,050	134	3,625	484	6,550	923
	Totals	**15,270**	**465**	**30,747**	**2,935**	**47,041**	**8,274**
2035	BTM PV	43,506		83,537		109,956	
	BTM Storage		2,532		13,681		38,994
	BTM PV + Storage	214	184	19,930	19,635	57,082	56,488
	Adjustment for BTM Forecast Overlap	(214)	(18)	(3,879)	(2,855)	(9,501)	(8,292)
	Community Solar + Storage	10,480	3,670	35,625	12,484	86,500	30,375
	Totals	**53,986**	**6,368**	**135,213**	**42,944**	**244,037**	**117,565**
2050	BTM PV	101,850		201,037		262,706	
	BTM Storage		4,630		39,869		128,726
	BTM PV + Storage	1,100	945	54,169	52,480	162,401	159,161
	Adjustment for BTM Forecast Overlap	(1,100)	(95)	(16,213)	(7,357)	(36,940)	(22,886)
	Community Solar + Storage	13,120	5,254	55,025	24,124	140,700	59,588
	Totals	**114,970**	**10,735**	**294,018**	**109,116**	**528,867**	**324,589**

Table 7: Kansas Central Forecast Summary (kW Capacity)

		Low		Mid		High	
		PV	Storage	PV	Storage	PV	Storage
2025	BTM PV	30,394		43,129		52,457	
	BTM Storage		-		3,040		10,308
	BTM PV + Storage	-	-	2,145	2,110	5,786	5,696
	Adjustment for BTM Forecast Overlap	-	-	(435)	(306)	(1,151)	(827)
	Community Solar + Storage	1,030	131	3,438	456	6,663	939
	Totals	**31,424**	**131**	**48,277**	**5,300**	**63,754**	**16,116**
2035	BTM PV	77,824		114,255		144,606	
	BTM Storage		-		3,525		34,397
	BTM PV + Storage	3,467	3,431	22,626	22,273	59,221	58,509
	Adjustment for BTM Forecast Overlap	(573)	(504)	(4,517)	(3,233)	(10,473)	(8,559)
	Community Solar + Storage	8,640	2,984	33,288	11,649	83,863	29,372
	Totals	**89,357**	**5,912**	**165,651**	**34,214**	**277,218**	**113,719**
2050	BTM PV	175,281		254,255		325,106	
	BTM Storage		-		5,726		74,896
	BTM PV + Storage	7,001	6,819	63,075	61,141	171,016	167,305
	Adjustment for BTM Forecast Overlap	(1,864)	(967)	(18,664)	(8,581)	(40,811)	(23,964)
	Community Solar + Storage	10,860	4,316	51,488	22,569	136,763	57,939
	Totals	**191,278**	**10,168**	**350,153**	**80,855**	**592,074**	**276,176**

2. Behind-the-Meter Solar Photovoltaics

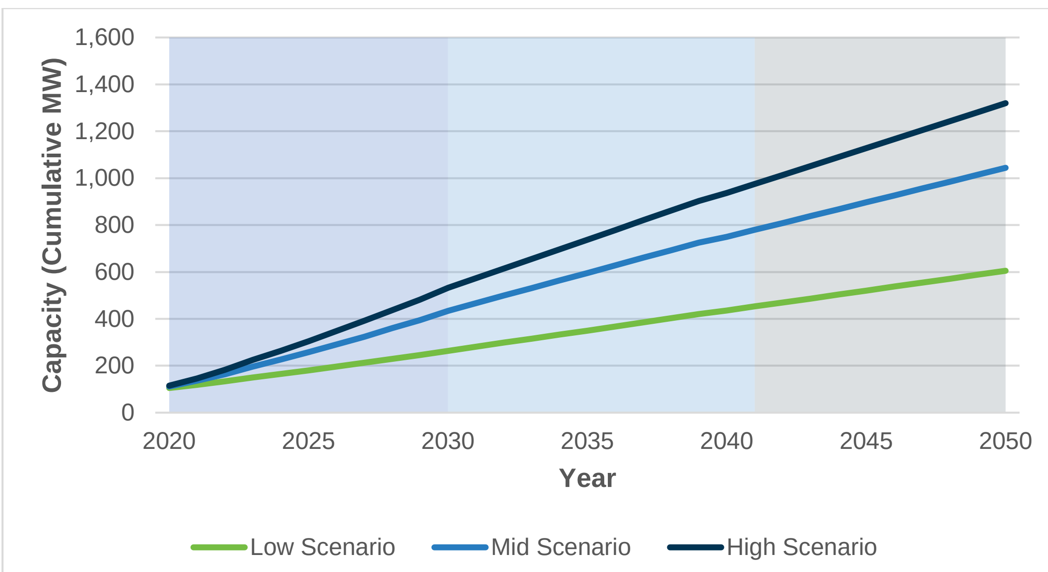
The three sections below summarize results across Scenarios, service territories, and customer classes for photovoltaic solar. Please see Appendix B for more information about the underlying model, which includes the full set of forecasted data.

2.1 Scenario Summary

Observations and Drivers for Forecast Outputs

Overall, ICF is not forecasting significant new BTM solar PV activity in 2020 due to the current economic and societal impacts of the COVID-19 pandemic. However, there are still strong economics across most customer segments that provide continued upward annual growth for all three Scenarios. ICF forecasted growth across the three Scenarios: starting with the initial decade (2020-2030), compound annual growth rates for capacity were 9.63% in the Low Scenario, 14.58% in the Mid Scenario, and 16.55% in the High Scenario (Figure 1). This growth was capped primarily by assumptions for maximum annual installation volumes due to market development constraints, interconnection queue management, and technical factors. Even with the forecasted growth, the cumulative BTM solar PV capacity – reaching a maximum of nearly 1,320 MW in 2050 in the High Scenario – is well within long-term Renewable Portfolio Standard (RPS) targets in Missouri, with a similar result in Kansas, indicating that this technology forecast will remain achievable across all three Scenarios.[7]

Figure 1: BTM Photovoltaic Solar – Evergy-wide Capacity (Cumulative MW) Projection by Scenario, 2020-2050



[7] ICF recognizes that the forecast exceeds the customer-owned generation limits prescribed within Evergy tariffs. Evergy's NEM tariffs stipulate that the installed NEM PV capacity in any territory cannot exceed more than 1% of the previous year's single hour peak load for that territory. However, it is ICF's opinion that caps on deployment of customer-owned resources are likely to be raised or waived as adoption increases, as they have been in other jurisdictions.

Figure 2: BTM Photovoltaic Solar – Evergy-wide Energy Output (Annual MWh) Projection by Scenario, 2020-2050

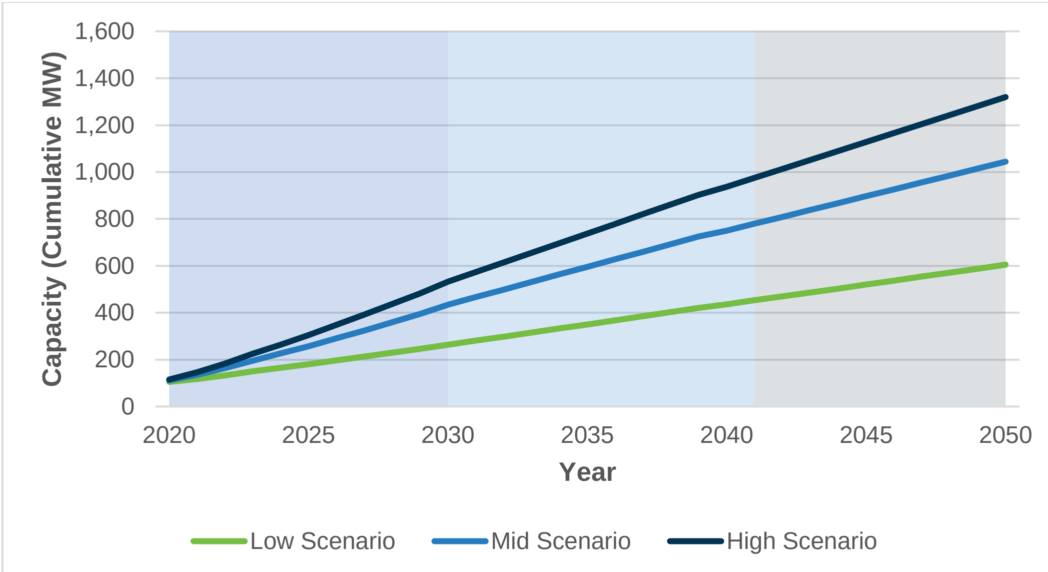
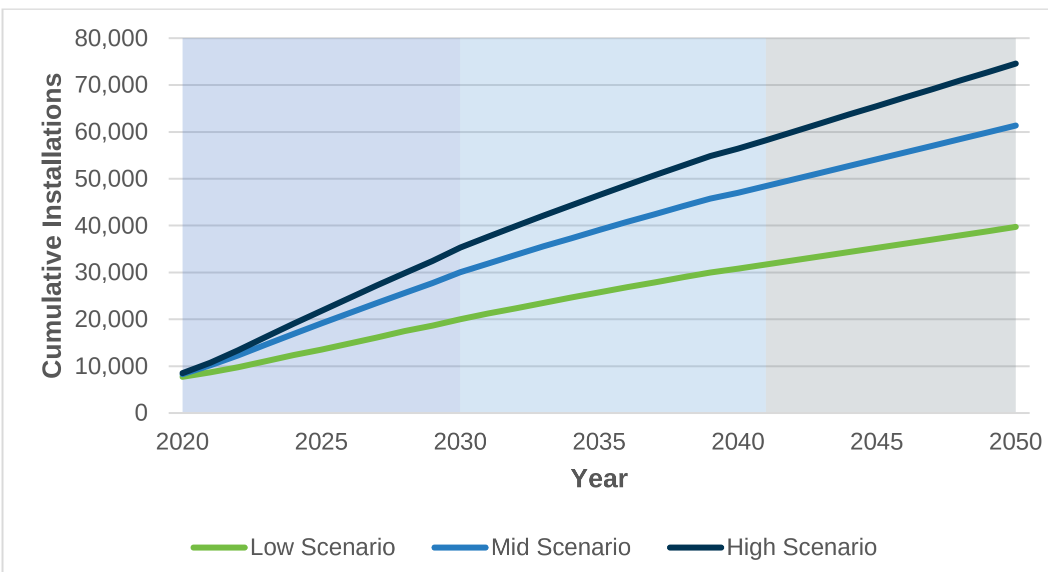


Figure 3: BTM Photovoltaic Solar – Evergy-wide Number of Cumulative Installations Projection by Scenario, 2020-2050



2.2 Service Territory Summary

Observations and Drivers for Forecast Outputs[8]

In the Missouri service territories, there is strong potential for growth in the residential and commercial sectors where incentives have proven helpful but are slated to end, which is reflected in the forecast. In Kansas, the residential and commercial sectors also have great potential, but industrial is not likely to see growth due to the tariff structure and low energy costs.

The Missouri service territories start the forecast period with not immaterial cumulative BTM solar PV capacity in place in 2020: 37.8 MW in Missouri Metro and 52.6 MW in Missouri West in the Mid Scenario. Even from those respectable starting numbers, the markets are projected to grow, and particularly in the initial decade (2020-2030): an average of 15.06% annually in Missouri Metro and 11.90% annually in Missouri West during that period; see Figure 4. However, that growth is forecasted to slow a fair amount during the subsequent decade (2030-2040), during which Missouri Metro is projected to grow 3.85% annually (on average) and Missouri West is projected to grow 4.92% annually (on average). This is typical as newer technologies reach maturity. The model also indicates further drop-off in growth rates for the final decade (2040-2050), although that is so far into the future – particularly with still-developing technologies – that putting too fine a point on the specific numbers could be misleading.

By contrast, the Kansas service territories start out much more modestly: 6.2 MW of cumulative BTM solar PV capacity in Kansas Metro in 2020 in the Mid Scenario, and 14.8 MW in Kansas Central that same year in its Mid Scenario (see Figure 4). That also, however, means that there is significantly more “headroom” for growth, and the projections bear that out: Mid Scenario annual compound growth rates of 22.63% in Kansas Metro and 17.04% in Kansas Central over the initial decade (2020-2030). These growth rates, while higher than those in Missouri due to starting off at lower penetration levels, do follow a similar curve over the forecasted period, falling to 9.00% and 7.79% (respectively) during the second decade (2030-2040). The same caveats about the final decade noted above with regard to Missouri apply in Kansas as well: while growth is projected to continue, it is forecasted to do so at slower rates than in the preceding decades.

[8] ICF understands that Evergy forecasts solar energy generation from customer-owned assets using solar PV data from the EIA for the West North Central Census division as one of the inputs. (The West North Central census division consists of North and South Dakota, Nebraska, Iowa, Minnesota, Kansas, and Missouri.) ICF’s forecast differs from the EIA’s projections for a few reasons. ICF’s solar PV forecast relies on more granular assumptions on solar energy production as well as economic factors that would influence customer decision-making. For example, ICF simulated hourly annual solar PV output profiles for representative installations in the Kansas City region using the NREL PVWatts tool. Such simulations provide more accuracy by incorporating local weather and solar irradiation data. The output profiles also assisted in the calculation of the levelized cost of energy (LCOE) from customer-sited solar PV. Analyzing the solar PV LCOE in conjunction with the avoided costs of energy purchases (based on Evergy retail tariffs) allowed ICF to determine the financial attractiveness of solar PV to various customer classes. Such an approach simplifies and mimics the steps a prospective customer might take before making a solar PV purchasing decision. The incorporation of these techniques and baseline market adoption curves result in solar PV projections that differ from those published by the EIA while taking into account important local considerations.

Figure 4: BTM Photovoltaic Solar – Mid Scenario Capacity (Cumulative MW) Projection by Service Territory, 2020-2050

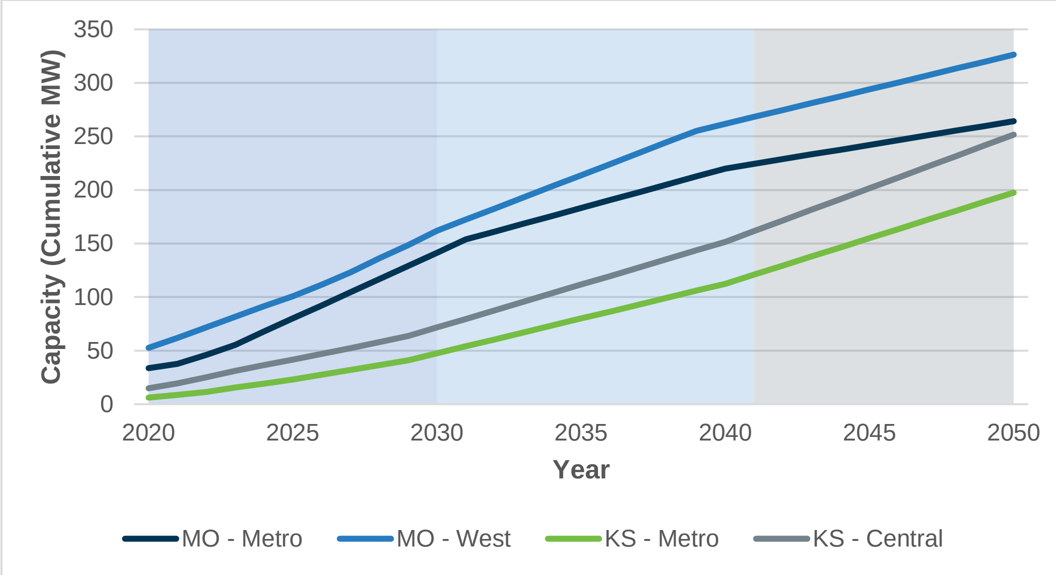


Figure 5: BTM Photovoltaic Solar – Mid Scenario Energy Output (Annual MWh) Projection by Service Territory, 2020-2050

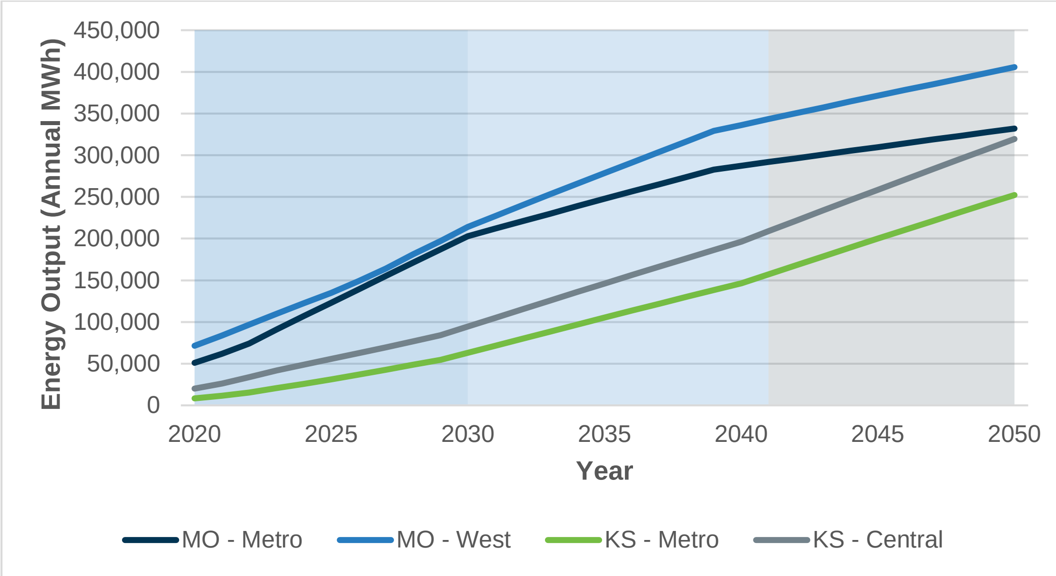
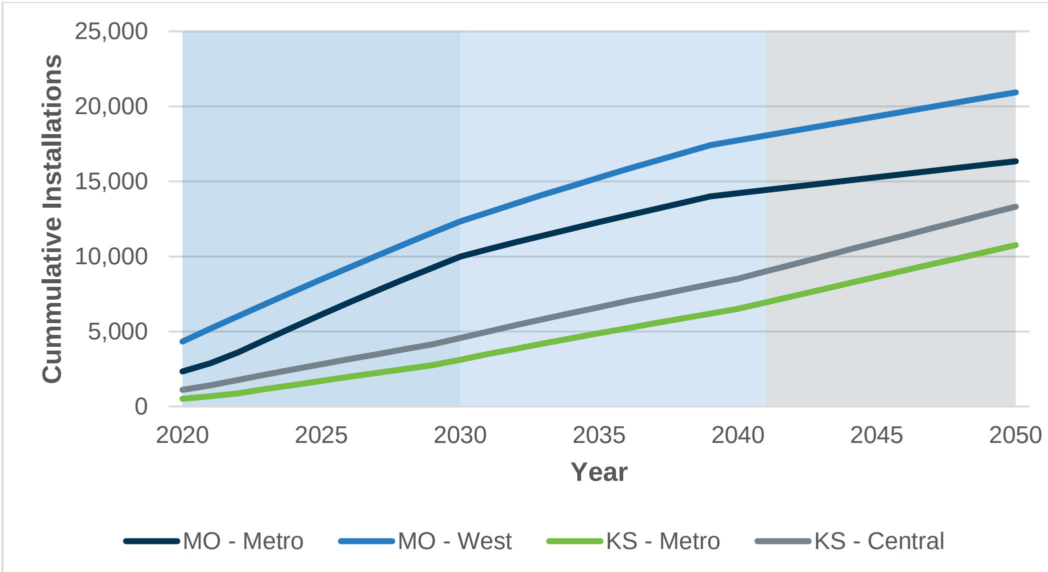


Figure 6: BTM Photovoltaic Solar – Mid Scenario Number of Cumulative Installations Projection by Service Territory, 2020-2050



2.3 Customer Class Summary

Observations and Drivers for Forecast Outputs

Residential BTM solar PV growth will remain robust, based on the strong growth to date across Evergy's territories.[9] Commercial adoption will expand due to decreasing costs and increased awareness of the opportunities for net savings. The industrial segment has potential but in certain territories, the avoided costs are very low, making the economic case weak; therefore, the forecasts remain quite low in those areas.

While residential installations and commercial installations are projected to grow at similar rates (13.78% and 12.49% annually, respectively; see Figure 9[10]) over the initial decade (2020-2030) in the Mid Scenarios, the divergent project sizes mean that the much smaller number of commercial installations will largely keep pace with the much larger number of residential installations in terms of MW capacity and MWh output. So while there are projected to be more than 15 times as many residential installations as commercial installations in 2030 in the Mid Scenario (see Figure 9), cumulative commercial MW capacity is forecasted to only trail cumulative residential MW capacity by approximately 9% in that year (see Figure 7).

[9] The forecast takes into account rebates and tax credits, which have helped spur that growth, and their eventual discontinuance. For Missouri, rebates were assumed to remain in place through 2023 for all customer classes. There are currently no rebates in Kansas, and the forecast assumes that that remains the case going forward. The Federal Investment Tax Credit is included for residential customers through 2021 and for commercial and industrial customers for the duration of the forecast per the latest rules.

[10] Please note that due to relative scales, it can be difficult to discern the number of commercial and industrial installations in Figure 9. However, in the Mid Scenario depicted, commercial installations are projected to rise from a starting number of 557 in 2020 to 2,857 in 2040 (a compound annual growth rate of 8.51%), and industrial installations are projected to grow from 3 in 2020 to 144 in 2040 (a compound annual growth rate of 21.08%).

Figure 7: BTM Photovoltaic Solar – Mid Scenario Evergy-wide Capacity (Cumulative MW) Projection by Customer Class, 2020-2050

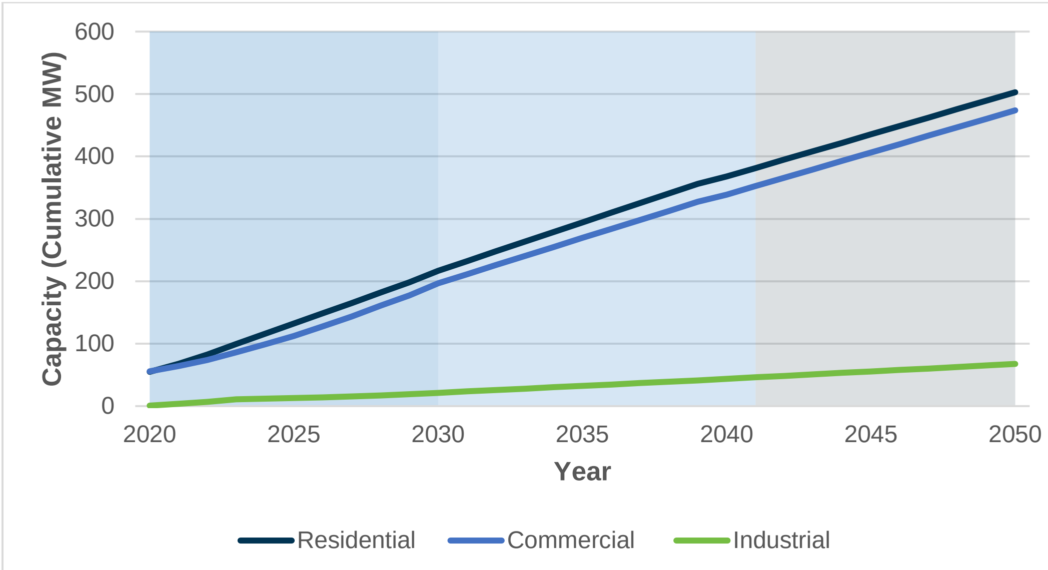


Figure 8: BTM Photovoltaic Solar – Mid Scenario Evergy-wide Energy Output (Annual MWh) Projection by Customer Class, 2020-2050

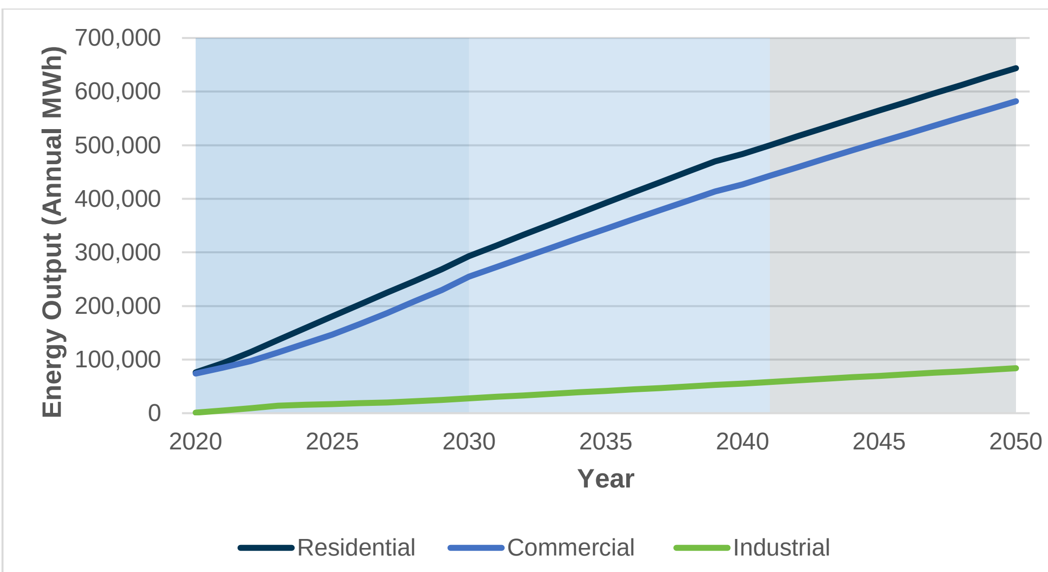
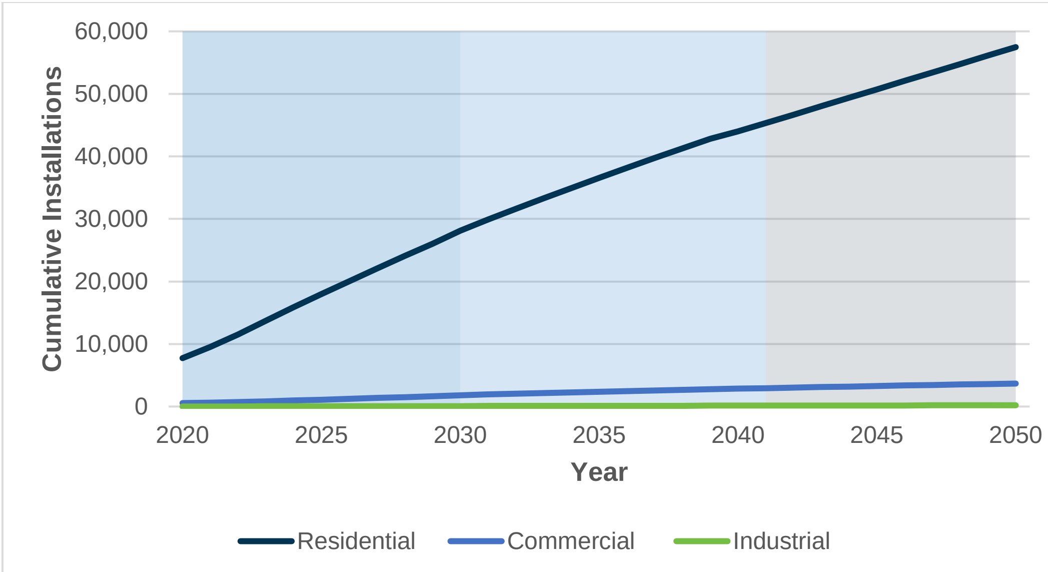


Figure 9: BTM Photovoltaic Solar – Mid Scenario Evergy-wide Number of Cumulative Installations Projection by Customer Class, 2020-2050



3. Behind-the-Meter Battery Energy Storage

The three sections below summarize results across Scenarios, service territories, and customer classes for battery energy storage. ICF assumed a battery storage duration of four hours for each of the customer classes – residential, commercial, and industrial. Please see Appendix B for more information about the underlying model, which includes the full set of forecasted data.

3.1 Scenario Summary

<u>Observations and Drivers for Forecast Outputs</u>

There are significant contrasts between the Scenario outputs for BTM storage, which reflects the technology's relative nascence and the different directions that market adoption could take in the coming years. While BTM storage adoption is, to ICF and Evergy's best knowledge, non-existent today within Evergy's service territory – and reflected as thus in all three Scenarios, ICF believes that there can be a strong economic case for adopting BTM storage in the residential sector, depending on the estimated technology investment payback period. The difference between peak and super off-peak rates presents an attractive arbitrage opportunity for residential customers on time-of-use (TOU) rates.

The assumptions for the Low Scenario are based on relatively long payback periods and slow market acceptance of storage as a resilience solution. In the High Scenario, the assumed technology costs and project payback periods provide much higher financial incentives, combined with broader interest in solutions for both resiliency and net cost savings. By 2040, there are projected to be nearly 44,000 cumulative BTM storage installations (see Figure 12) and 389.5 cumulative MW in the High Scenario (see Figure 10), versus approximately 1,740 installations and 13.2 MW in the Low Scenario.[11] The gaps between the Mid and the Low

[11] Due to relative scales, it can be difficult to discern the levels for the Low Scenario in Figures 10, 11, and 12. However, the projected levels for the Low Scenario are not zero: In Figure 10, the Low Scenario reaches 7.3 MW of capacity in 2030 and 13.2 MW in 2040; in Figure 11, it reaches 2,305 MWh of net

Scenarios, and between the Mid and the High Scenarios, while obviously not as extensive as that between the Low and High Scenarios, are still substantial.

Figure 10: BTM Battery Energy Storage – Evergy-wide Capacity (Cumulative MW) Projection by Scenario, 2020-2050

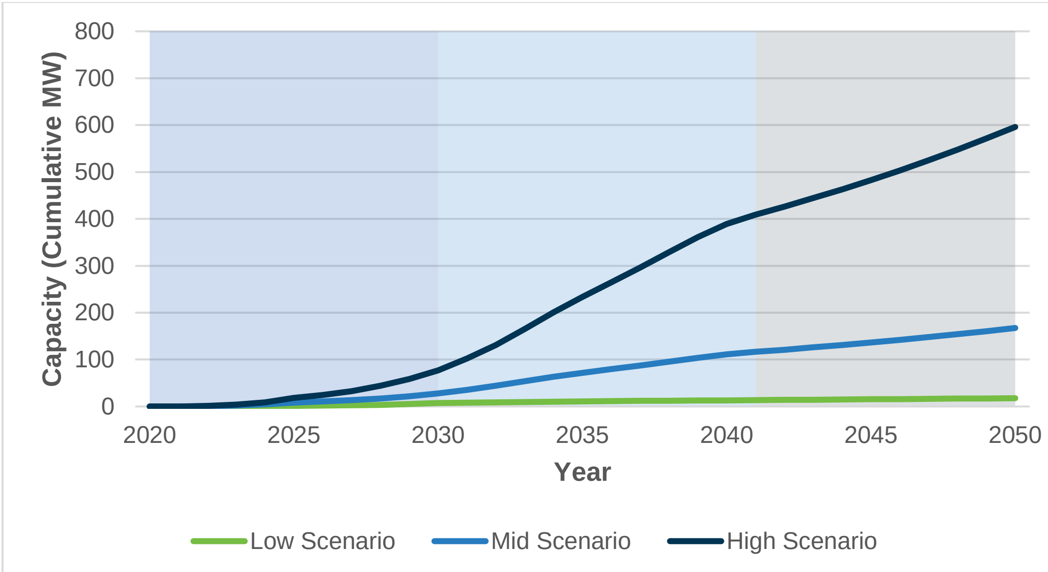
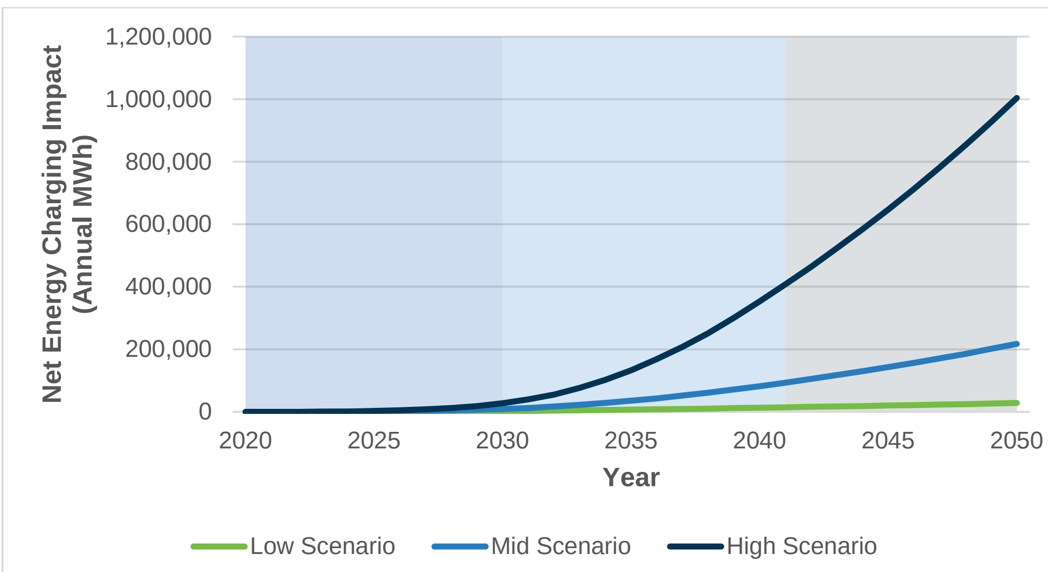
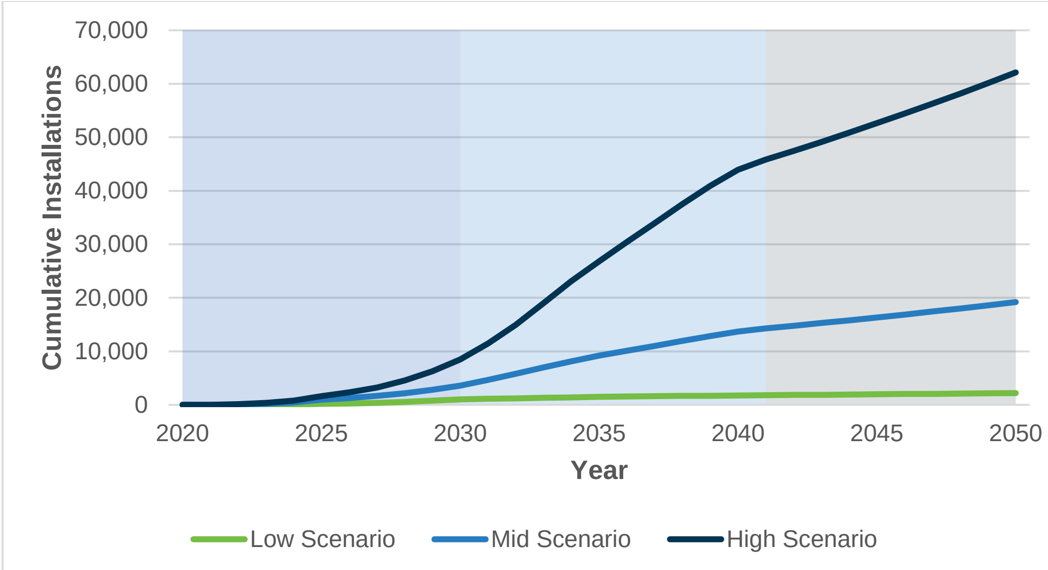


Figure 11: BTM Battery Energy Storage – Evergy-wide Net Energy Charging Impact (Annual MWh) Projection by Scenario, 2020-2050



energy charging impact in 2030 and 13,180 MWh in 2040; and in Figure 12, it reaches 1,023 installations in 2030 and 1,743 in 2040.

Figure 12: BTM Battery Energy Storage – Evergy-wide Number of Cumulative Installations Projection by Scenario, 2020-2050



3.2 Service Territory Summary

Observations and Drivers for Forecast Outputs

Three out of the four Evergy service territories are projected to experience similar – and substantial – BTM storage growth over the first two decades of the forecast period (2020-2040). This is largely due to similar expectations for project-level economics and decreasing technology costs. The Kansas Central territory, where the tariffs have both lower overall power costs and lower potential for savings from a customer's perspective, is expected to have a lower adoption rate. In their Mid Scenarios, Missouri Metro, Missouri West, and Kansas Metro are forecasted to have compound annual capacity (MW) growth rates of 38.95%, 38.31%, and 33.32%, respectively.[12] By contrast, Kansas Central projections are lagging, at "only" 13.42% in its Mid Scenario.

[12] These rates are actually calculated on the period 2022-2040, since 2022 is the year where each of the service territories is projected to have its first installed BTM storage projects; calculating from 2020 would result in infinite/undefined growth rates since they would start from zero installations.

Figure 13: BTM Battery Energy Storage – Mid Scenario Capacity (Cumulative MW) Projection by Service Territory, 2020-2050

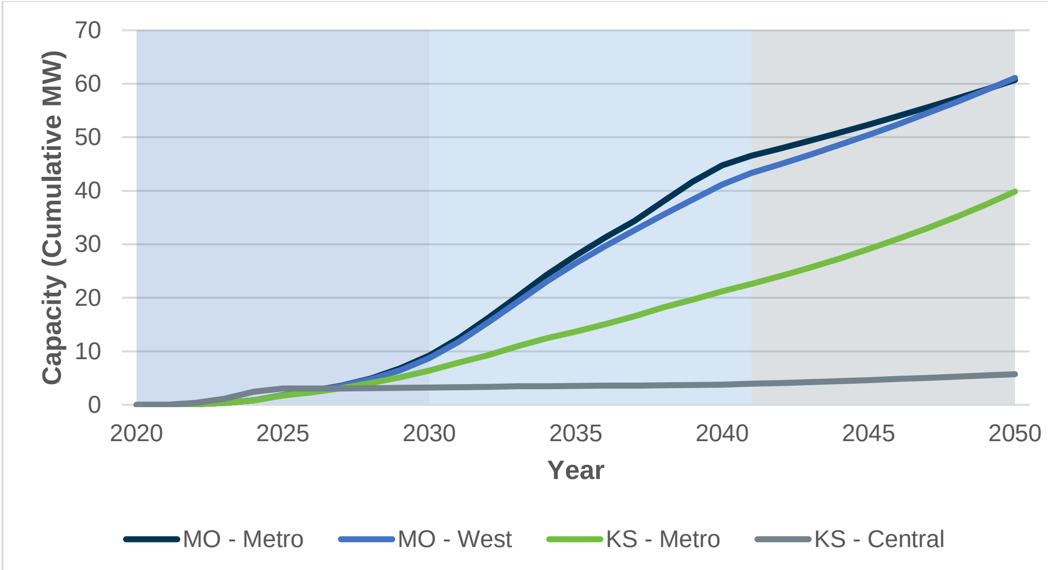


Figure 14: BTM Battery Energy Storage – Mid Scenario Net Energy Charging Impact (Annual MWh) Projection by Service Territory, 2020-2050

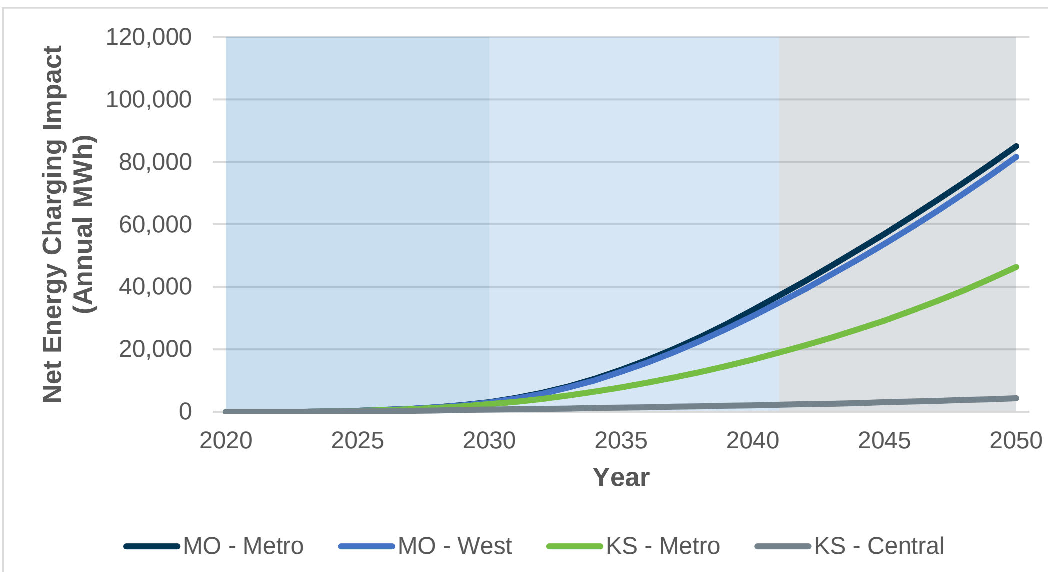
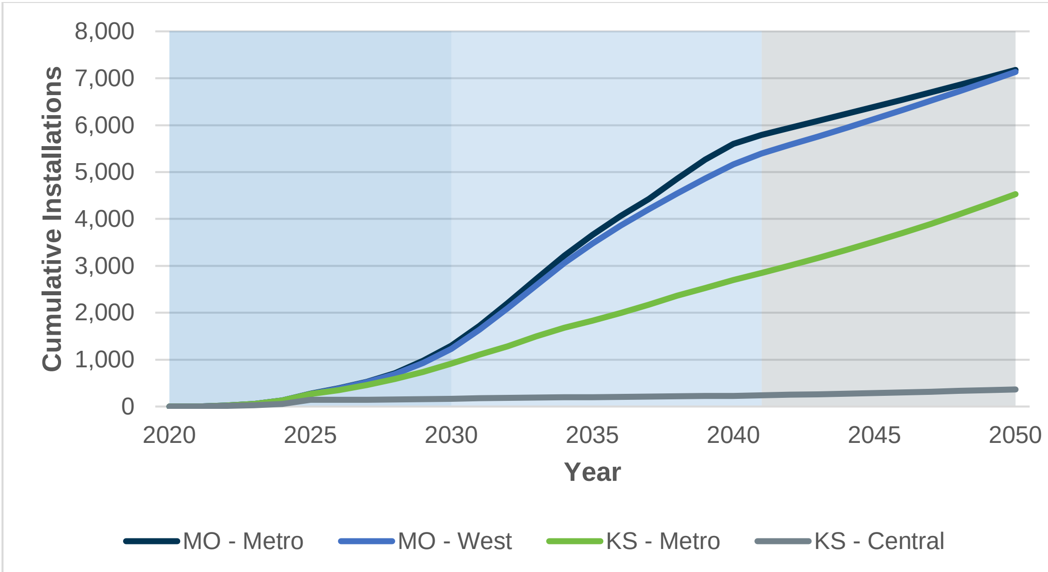


Figure 15: BTM Battery Energy Storage – Mid Scenario Number of Cumulative Installations Projection by Service Territory, 2020-2050



3.3 Customer Class Summary

<u>Observations and Drivers for Forecast Outputs</u>

There is projected to be a wide divergence between customers classes, with commercial and industrial customers on one side and residential customers on the other. This is based largely on the different use cases from the customer's perspective and different tariff structures. For example, where there are time-of-use rates that have a high ratio of peak-to-off-peak, there is strong potential for rapid paybacks, as seen in the residential sectors in most territories. However, in the commercial and industrial sectors, the value proposition primarily relies on avoided demand charges which are not sufficiently high in most markets to yield an attractive return – especially for cost-sensitive non-residential customers.[13]

None of the customer classes has any BTM storage projects installed in 2020 and 2021, and commercial and industrial are forecasted in their Mid Scenarios to reach one project each in 2022. From there, the number of installations are projected to grow through 2040 at a healthy 10.48% and 11.36% annually, respectively – but topping out at just 9 and 4 projects by the end of the 2040.[14] The residential Mid Scenario, however, jumps up to 66 installations in 2022, and then grows at a robust 34.47% annually through 2040, reaching more than 13,500 cumulative installations then; see Figure 18.

[13] Due to relative scales, it can be difficult to discern the levels for commercial and industrial customers in Figures 16, 17, and 18. However, the projected forecasts for these customer classes are not zero: By 2024, commercial customers are projected to reach 8 installations totaling nearly 1.0 MW, and industrial customers are projected to reach 4 installations totaling 1.3 MW – in both cases levels that do not substantially change until the final decade of the model.

[14] While the commercial and industrial growth rates are similar, the number of installations varies significantly due to the assumed system size: 100 kW for commercial systems and 300 kW for industrial systems.

Figure 16: BTM Battery Energy Storage – Mid Scenario Evergy-wide Capacity (Cumulative MW) Projection by Customer Class, 2020-2050

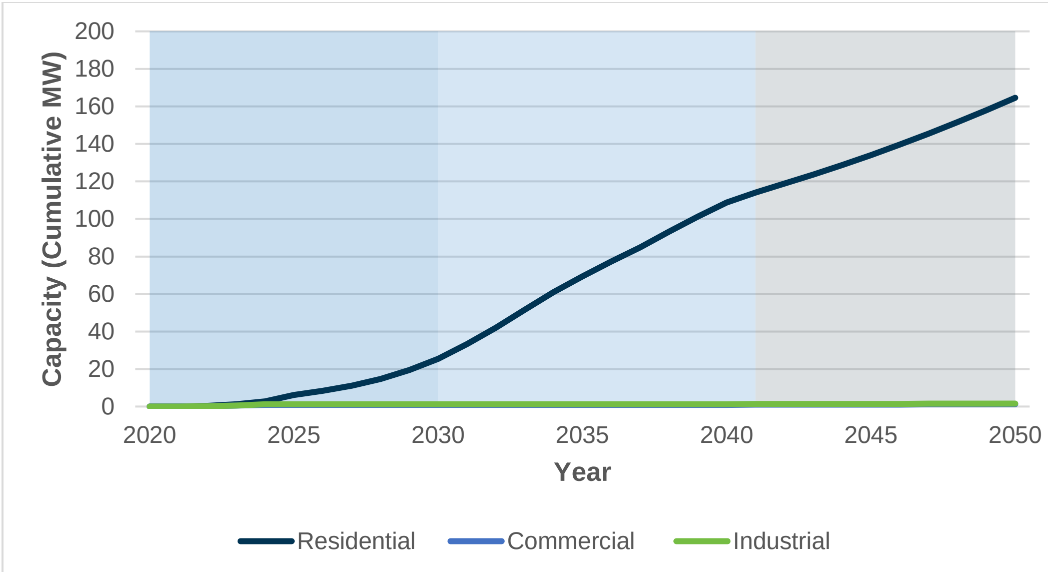


Figure 17: BTM Battery Energy Storage – Mid Scenario Evergy-wide Net Energy Charging Impact (Annual MWh) Projection by Customer Class, 2020-2050

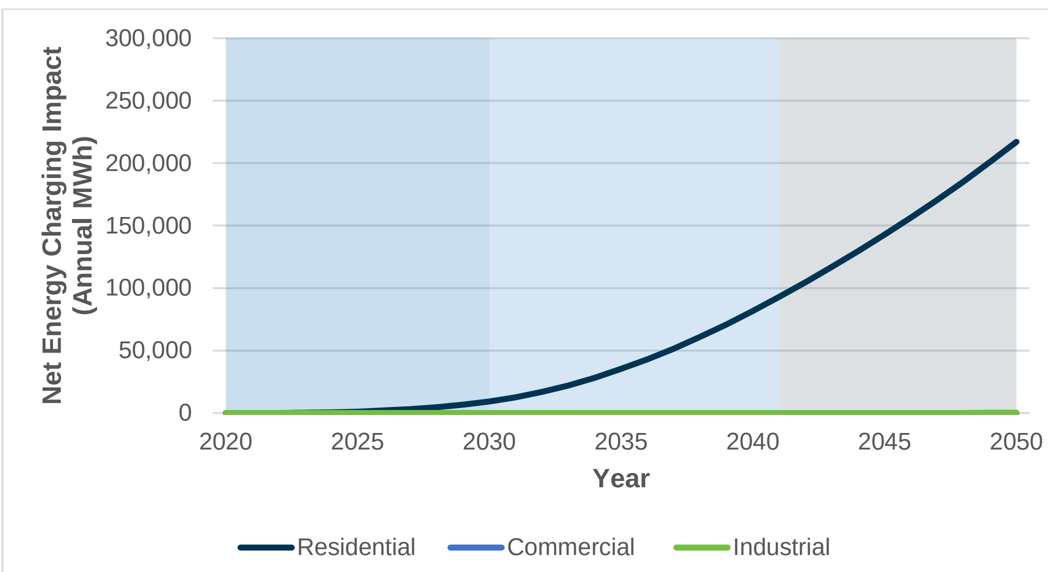
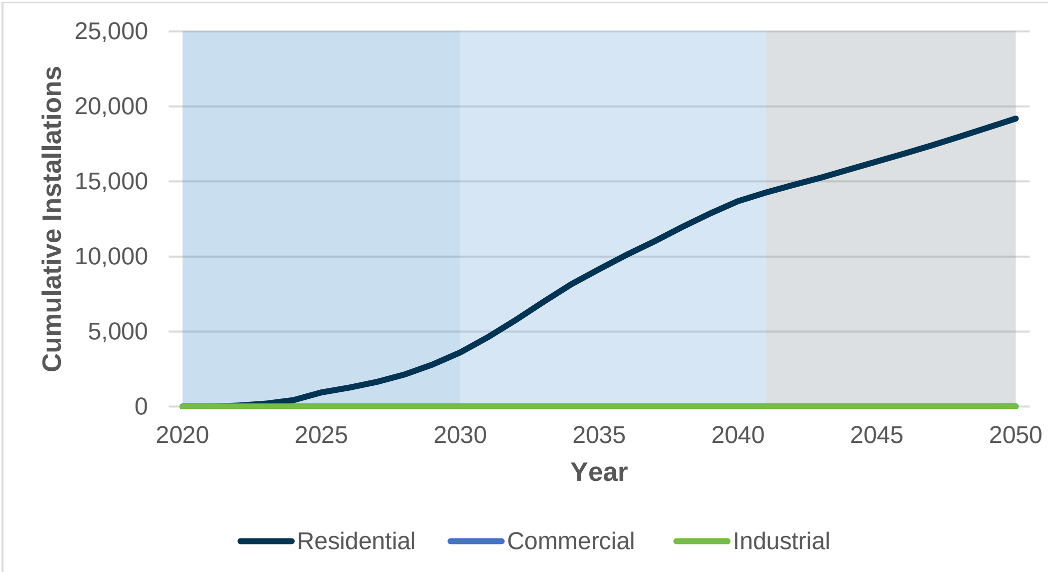


Figure 18: BTM Battery Energy Storage – Mid Scenario Evergy-wide Number of Cumulative Installations Projection by Customer Class, 2020-2050



4. Behind-the-Meter Solar Photovoltaics + Battery Energy Storage

The three sections below summarize results across Scenarios, service territories, and customer classes for photovoltaic solar + battery energy storage. Please note that cumulative capacity is displayed individually for the PV and storage forecasts because they have distinct operational characteristics and are unlikely to have a compounding impact on the grid. While they are combined behind the meter from a functional perspective, they should be considered and evaluated as components that tend to act somewhat independently. However, total annual net energy impact represents PV and storage combined to be comparable across all technologies and to assess the overall load changes for this technology solution.

ICF assumed a constant solar PV-to-storage capacity (kW) ratio of 0.86 for residential customers, 0.40 for commercial customers, and 0.75 for industrial customers for the duration of the forecast period. The solar and storage capacities used are consistent with those used in the standalone PV and storage forecasts summarized above. ICF assumed a battery storage duration of four hours for each customer class. Please see Appendix B for more information about the underlying model, which includes the full set of forecasted data.

4.1 Scenario Summary

Observations and Drivers for Forecast Outputs

As might be expected when considering the combination of two technologies that are still in their early stages (particularly storage), the forecasted solar + storage Scenarios diverge considerably depending on a number of market factors that could ultimately influence adoption rates. In the Low Scenario, Evergy is not forecasted to see its first BTM solar + storage project until 2027, a year in which the Mid Scenario is projected to reach 434 installations and the High Scenario 985 installations (see Figure 22). This is primarily due to anticipated slow adoption across all sectors and the lagging effects of the COVID-19 pandemic. On the other hand, the High Scenario is based on a much more rapid adoption curve for the residential sector as customers begin to add storage as a default with new PV installations, and in the commercial sector as the combined project economics and added tax benefits decrease overall payback periods. By the end of the initial forecasted decade (i.e., 2030), the Mid Scenario is projected to have nearly fourteen times the annual net energy impact from BTM solar + storage than in the Low Scenario (42,151 MWh, compared to 3,019 MWh), and the High Scenario is projected to have more than twice the Mid Scenario (92,611 MWh, compared to 42,151 MWh) (see Figure 21).

Figure 19: BTM Solar + Storage – Evergy-wide Solar Capacity (Cumulative MW) Projection by Scenario, 2020-2050

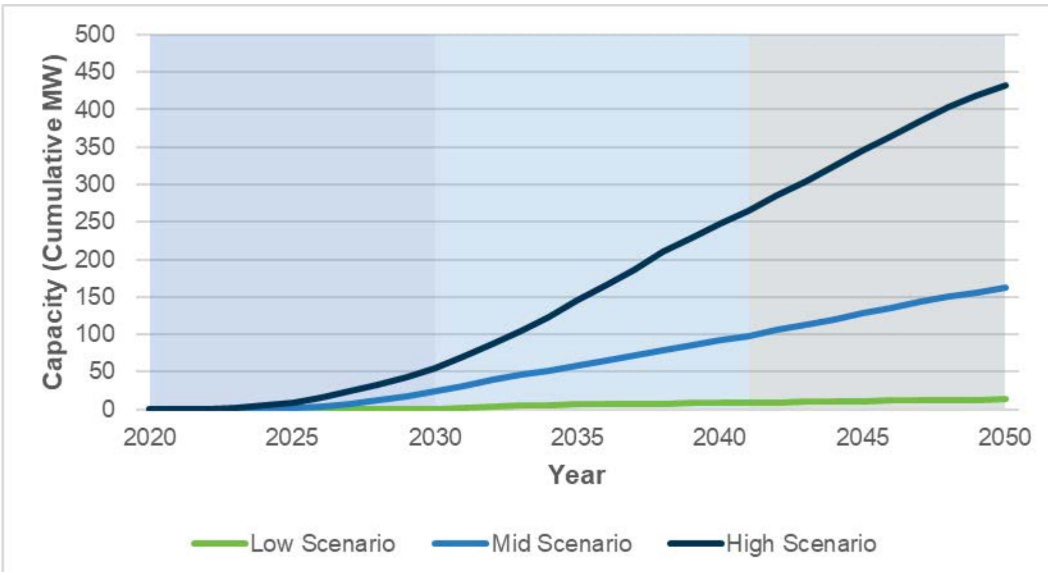


Figure 20: BTM Solar + Storage – Evergy-wide Storage Capacity (Cumulative MW) Projection by Scenario, 2020-2050

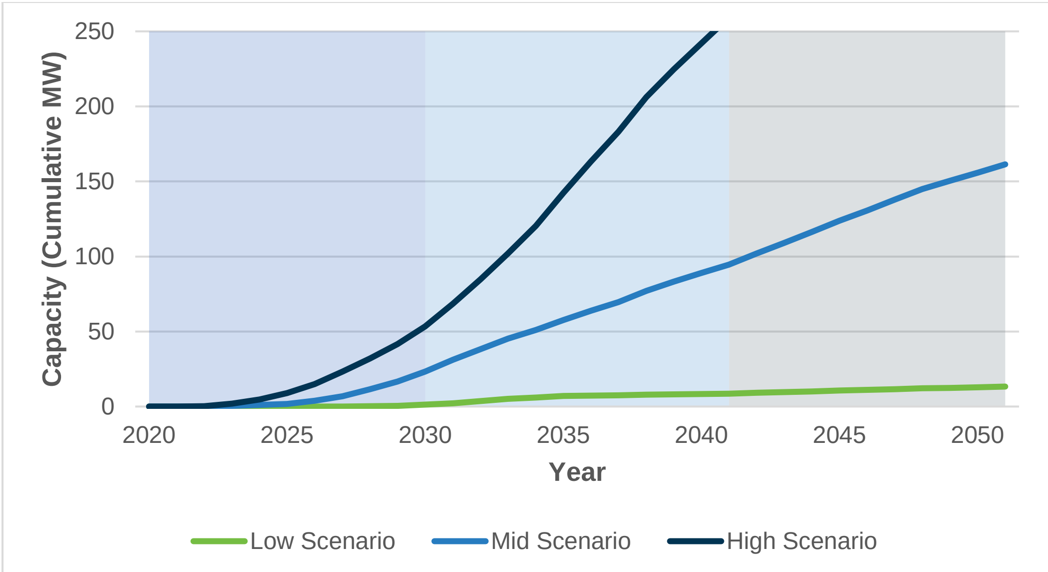


Figure 21: BTM Solar + Storage – Evergy-wide Net Energy Impact (Annual MWh) Projection by Scenario, 2020-2050

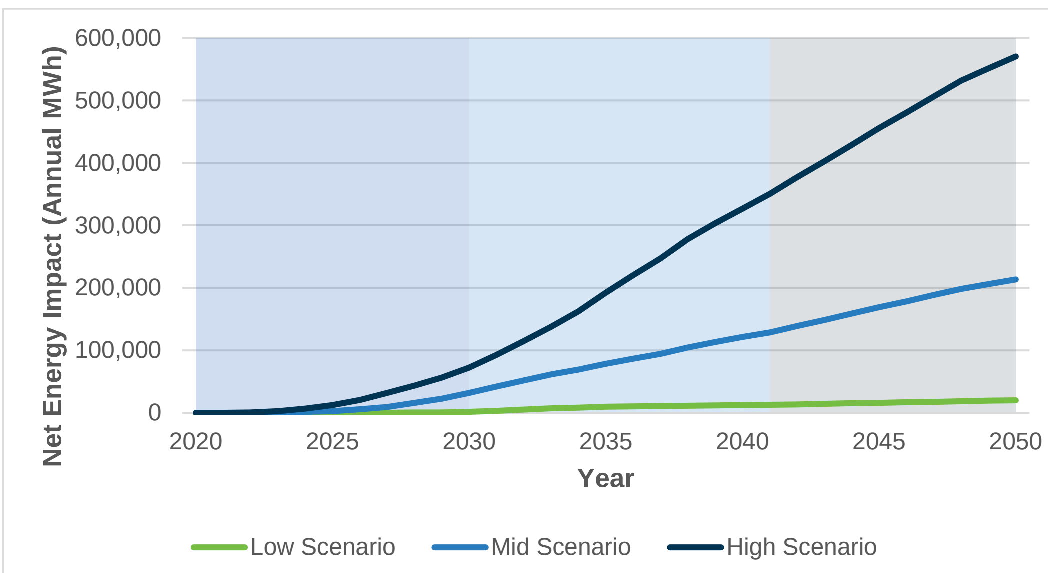
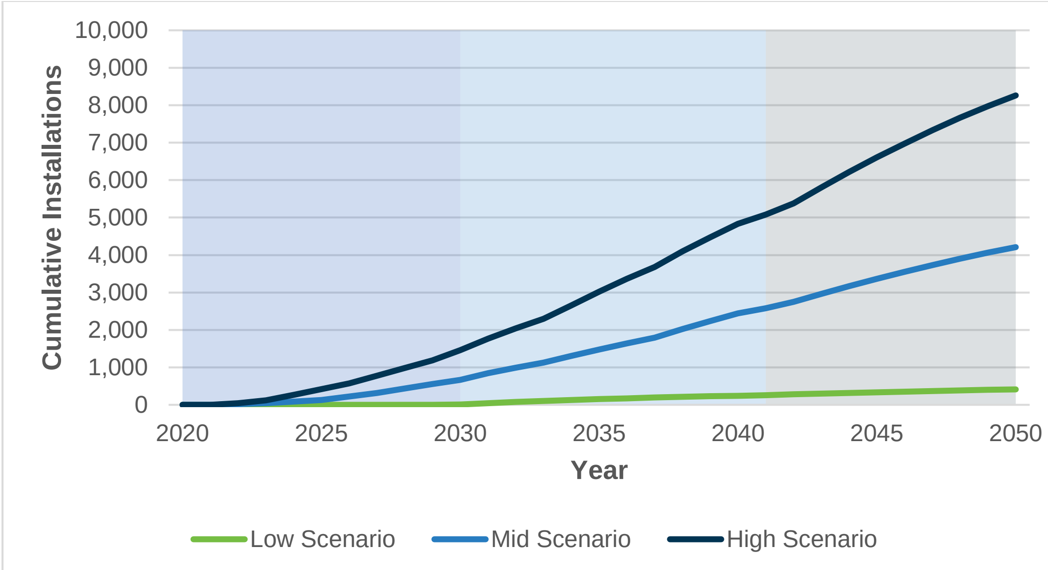


Figure 22: BTM Solar + Storage – Evergy-wide Number of Cumulative Installations Projection by Scenario, 2020-2050



4.2 Service Territory Summary

Observations and Drivers for Forecast Outputs[15]

The four Evergy service territories are forecasted to have somewhat similar growth in BTM solar+storage. The assumptions are based on the expectation that over time each territory will support this combined solution as a way to help mitigate some of the uncertainty of BTM PV standalone systems in ways that leverage the learnings across all Evergy service territories. In the Mid Scenario, both Missouri Metro and Missouri West are projected to hit 100+ installations in 2026, a level that the two Kansas territories are projected to reach two (Kansas Central) or three (Kansas Metro) years later (see Figure 26). By 2040, all four territories are forecasted in their Mid Scenarios to have between 500 and 750 installations and to have achieved compound annual growth in the 25-35% range.[16] While Missouri West is projected to have the largest number of installations of any service territory by 2040, it is also projected to have the lowest cumulative MW capacities (both solar and storage), due to a higher concentration of residential installations and the resulting smaller average project size. By contrast, Kansas Metro is projected to have nearly 30% fewer installations than Missouri West in 2040, but 2.5 times the solar capacity and 2.7 times the storage capacity due to a disproportionate number of commercial and industrial installations.

[15] Please note that the capacity charts (Figures 23 and 24) and the net energy impact chart (Figure 25) indicate somewhat abrupt flattening of the growth curves for Missouri Metro after initial upsurges. This is not due to a predicted fall-off in demand for BTM solar+storage in that service territory, but rather due to forecasting methodology: given the lack of existing BTM storage installations, ICF used a “capacity adder” in the early years before switching to annual growth rates, and the point of that change causes a shift in adoption trajectory. Please see the Approach section above or Appendix A for more detail on the capacity adder methodology.

[16] These growth rates are calculated for the period 2021-2040, since there are no forecasted BTM solar+storage installations in 2020 and using 2020 as a base year would yield undefined mathematical results.

Figure 23: BTM Solar + Storage – Mid Scenario Solar Capacity (Cumulative MW) Projection by Service Territory, 2020-2050

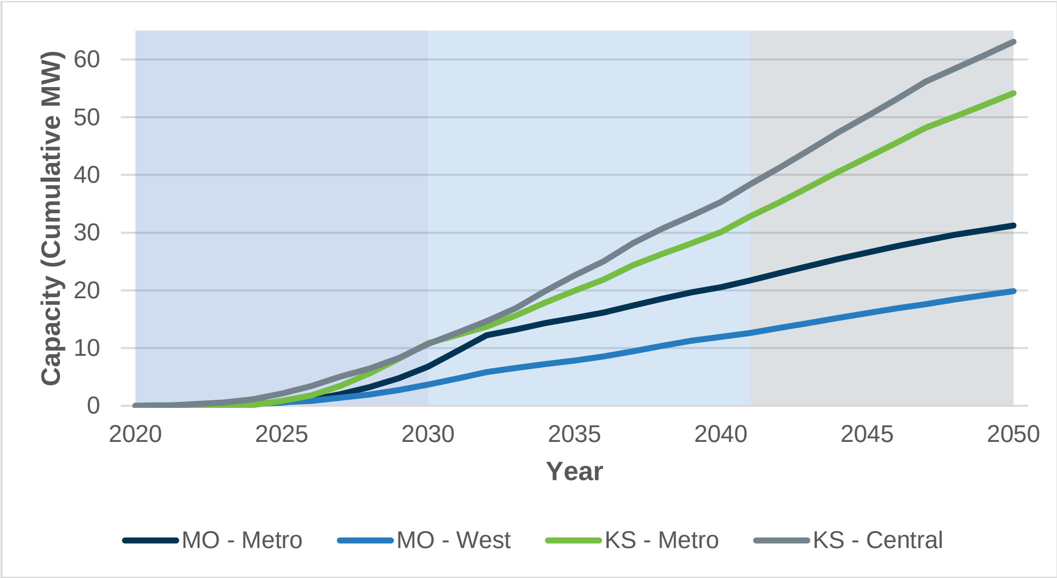


Figure 24: BTM Solar + Storage – Mid Scenario Storage Capacity (Cumulative MW) Projection by Service Territory, 2020-2050

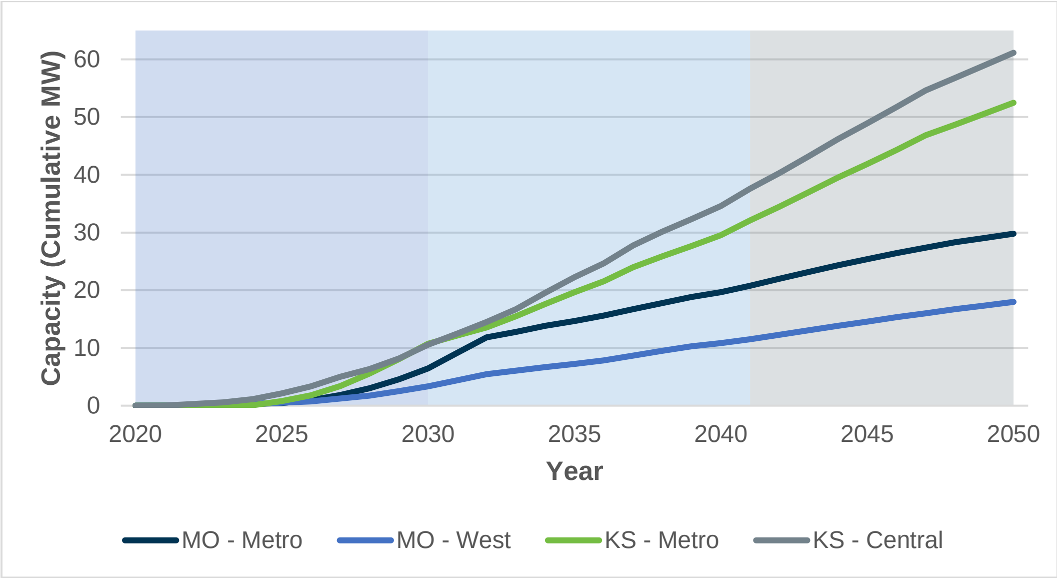


Figure 25: BTM Solar + Storage – Mid Scenario Net Energy Impact (Annual MWh) Projection by Service Territory, 2020-2050

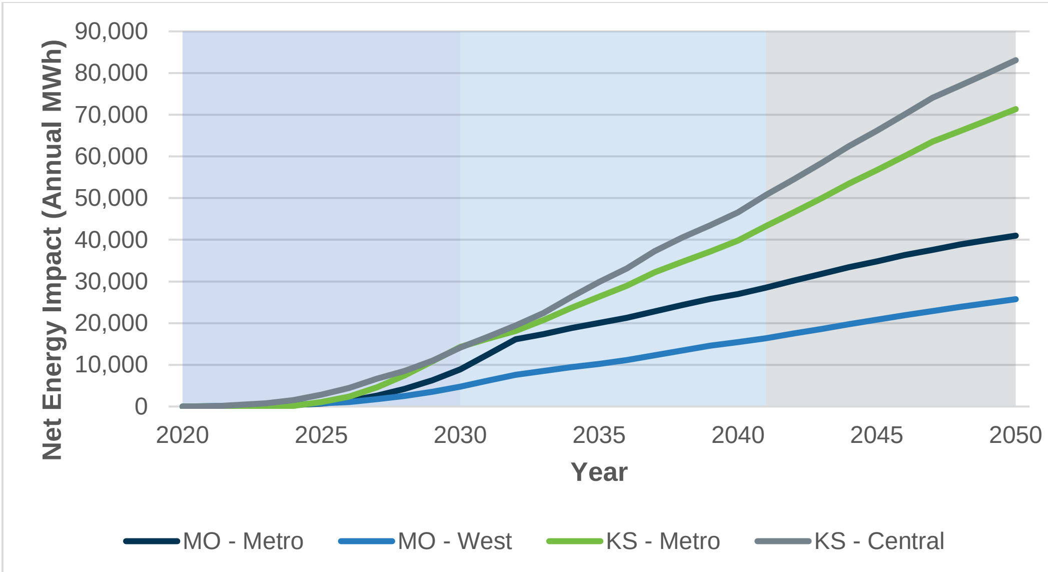
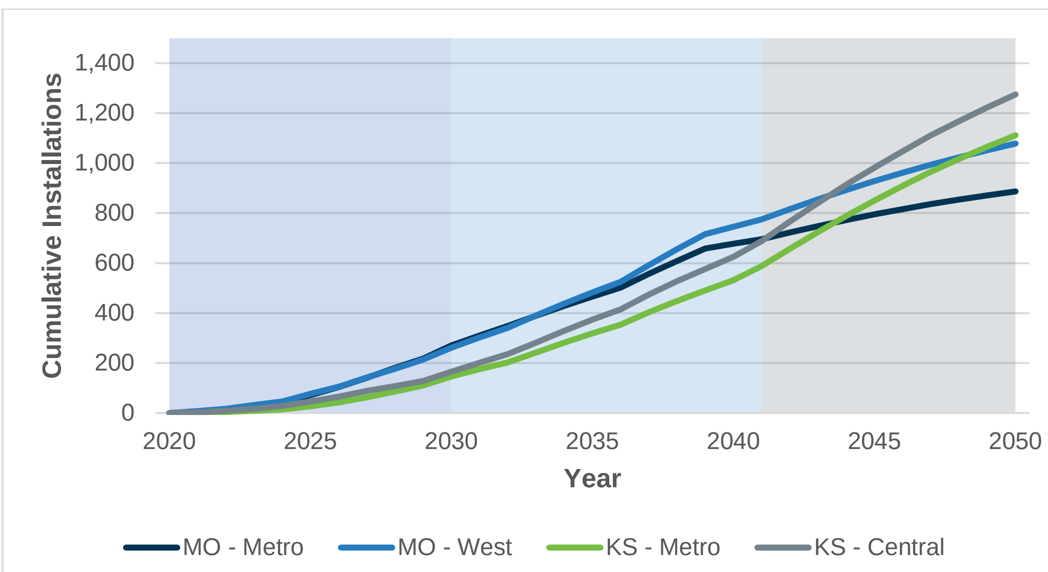


Figure 26: BTM Solar + Storage – Mid Scenario Number of Cumulative Installations Projection by Service Territory, 2020-2050



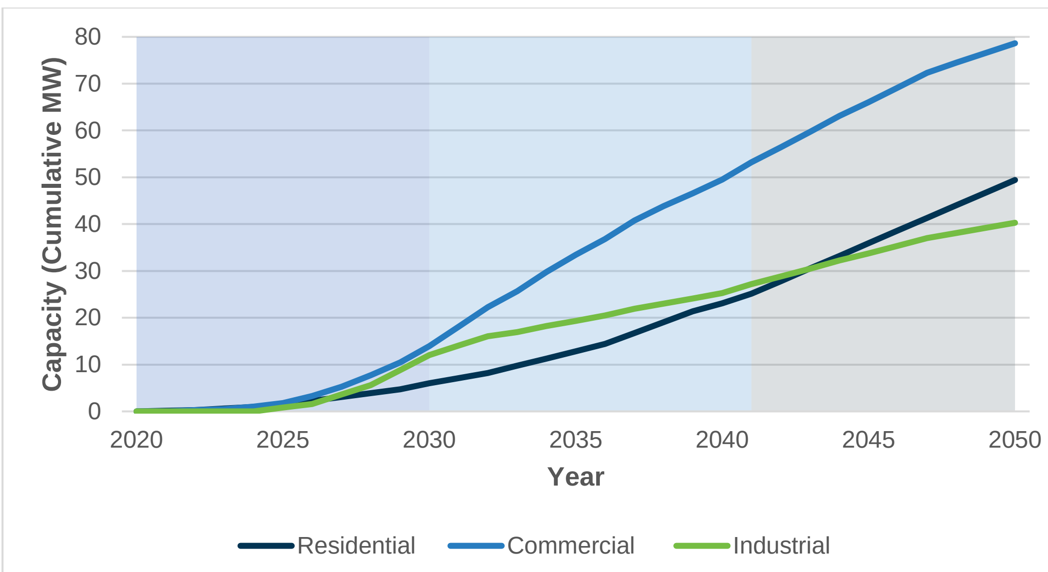
4.3 Customer Class Summary

Observations and Drivers for Forecast Outputs

Between 2020 and 2040,[17] the three customer classes are forecasted to experience similar growth rates for BTM solar + storage: in the Mid Scenario, an annual average of 28.84% for residential customers, 31.52% for commercial customers, and 23.41% for industrial customers. Among residential customers, the primary driver of growth is likely to be increased "attachment rates" – where adopters of BTM PV opt to "attach" storage to their new or existing solar installations. Commercial customers will likely be driven by increased benefits over time. Industrial customers, however, are predicted to lag adoption by Commercial customers based on estimated project payback period challenges and a smaller overall market size.

Additionally, the similar growth rates belie underlying differences in the number of installations and their sizes. In 2040 in the Mid Scenario, there are projected to be 57 industrial installations, with each one averaging nearly 600 MWh of net energy impact (i.e., PV output minus battery output); that is contrasted with 2,189 residential installations averaging approximately 13.5 MWh (see Figures 29 and 30). Commercial projections fall in between on both metrics.

Figure 27: BTM Solar + Storage – Mid Scenario Evergy-wide Solar Capacity (Cumulative MW) Projection by Customer Class, 2020-2050



[17] To avoid undefined mathematical results, the starting year for calculating these growth rates was not 2020 but instead the first year forecasted to have an installation for each customer class: 2021 for residential, 2022 for commercial, and 2025 for industrial.

Figure 28: BTM Solar + Storage – Mid Scenario Evergy-wide Storage Capacity (Cumulative MW) Projection by Customer Class, 2020-2050

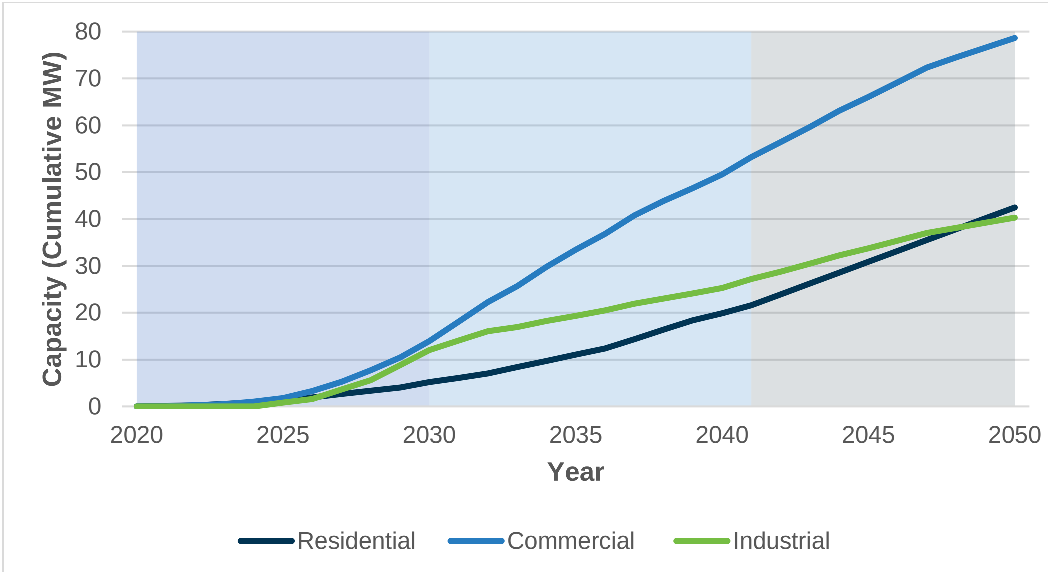


Figure 29: BTM Solar + Storage – Mid Scenario Evergy-wide Net Energy Impact (Annual MWh) Projection by Customer Class, 2020-2050

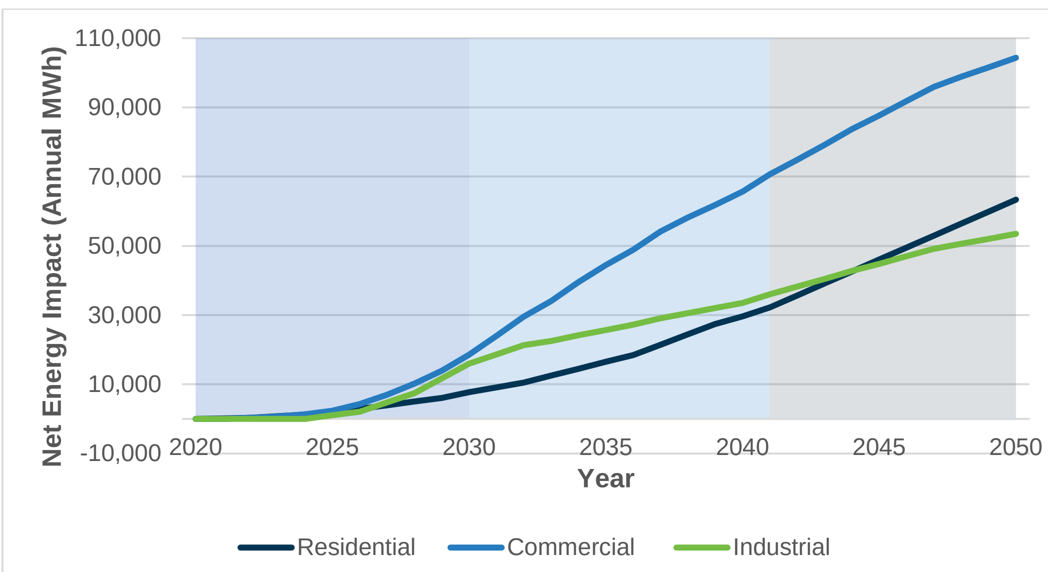
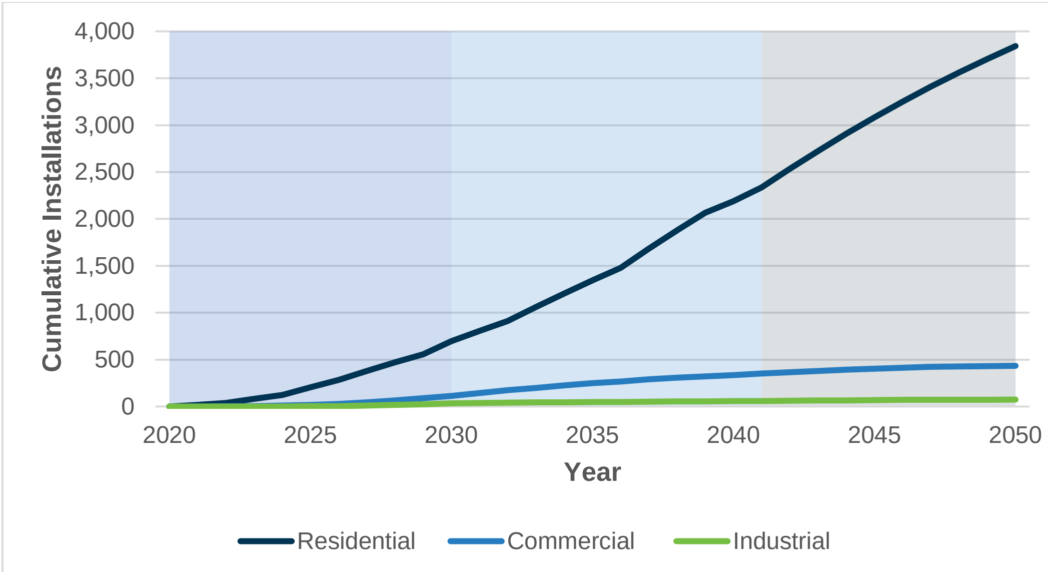


Figure 30: BTM Solar + Storage – Mid Scenario Evergy-wide Number of Cumulative Installations Projection by Customer Class, 2020-2050



5. Community Solar + Storage

The three sections below summarize results across Scenarios, service territories, and customer classes for community solar + storage. Please see Appendix B for more information about the underlying model, which includes the full set of forecasted data.

5.1 Scenario Summary

Observations and Drivers for Forecast Outputs

While there are currently a handful of Evergy-owned[18] community solar projects in development within Evergy's service territories, they are not projected to be operational until 2021.[19] Additionally, these installations will be solar-only (at least initially), and the first storage capacity associated with community solar is projected to be paired with PV in 2023 (Figure 32). This phasing assumption has been used across all three Scenarios, although the scale and speed of adoption differ based on the various pathways to development that Evergy may pursue. Through 2040, the Low Scenario is projected to result in 19 installations (a compound annual growth rate of 25.51%), the Mid Scenario 78 installations (32.28%), and the High Scenario 197 installations (45.10%) (see Figure 34).[20] This growth is expected to occur in a "stepwise" pattern (as seen in the Figures below), due to the inherent aggregated nature of community solar+storage and the long lead times associated with that; installations might not happen every year, but each new one could introduce a substantial amount of capacity. The final decade of forecasts indicates a plateauing: the Low Scenario is estimated to reach its maximum number of

[18] Currently, third-party- or customer-owned community solar is not allowed within Evergy's service territories
[19] Based on subscription data provided by Evergy
[20] The growth rates in parentheses are calculated from a base year of 2021 – the first year forecasted to have community solar projects installed – in order to avoid undefined mathematical results.

installations in 2037, the Mid Scenario in 2039, and the High Scenario in 2040. This is based on an expectation that other Evergy programs, tariffs, and the overall achievement of RPS targets may reduce the demand for community solar and similar offerings, while storage and solar developments would likely continue.

Figure 31: Community Solar + Storage – Evergy-wide Solar Capacity (Cumulative MW) Projection by Scenario, 2020-2050

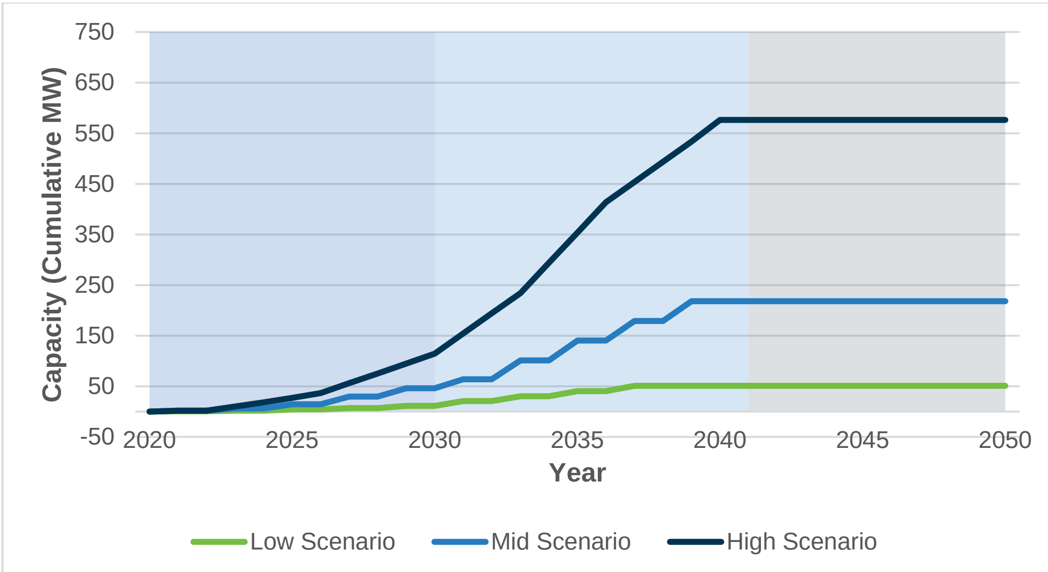


Figure 32: Community Solar + Storage – Evergy-wide Storage Capacity (Cumulative MW) Projection by Scenario, 2020-2050

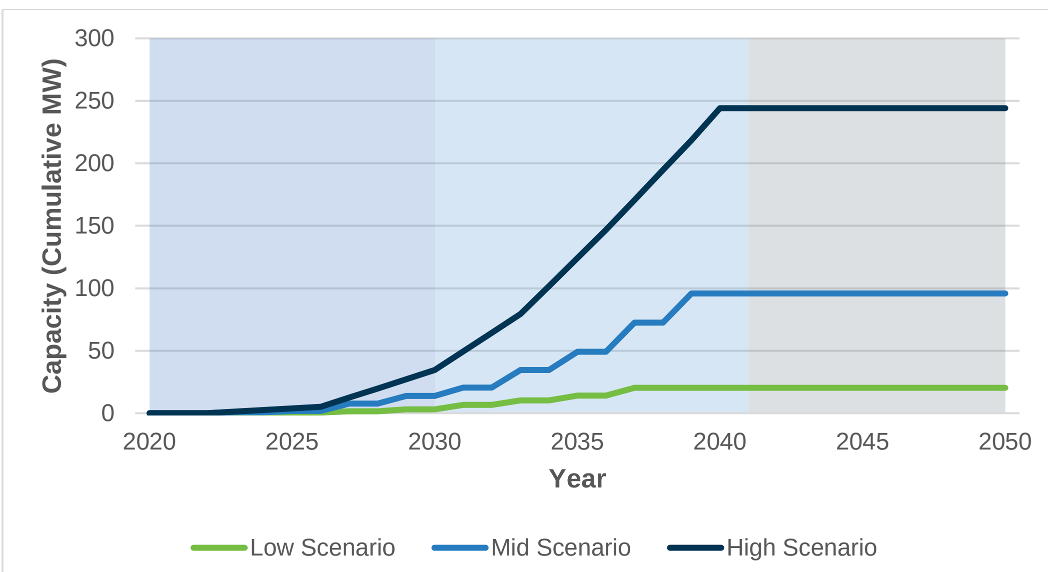


Figure 33: Community Solar + Storage – Evergy-wide Net Energy Impact (Annual MWh) Projection by Scenario, 2020-2050

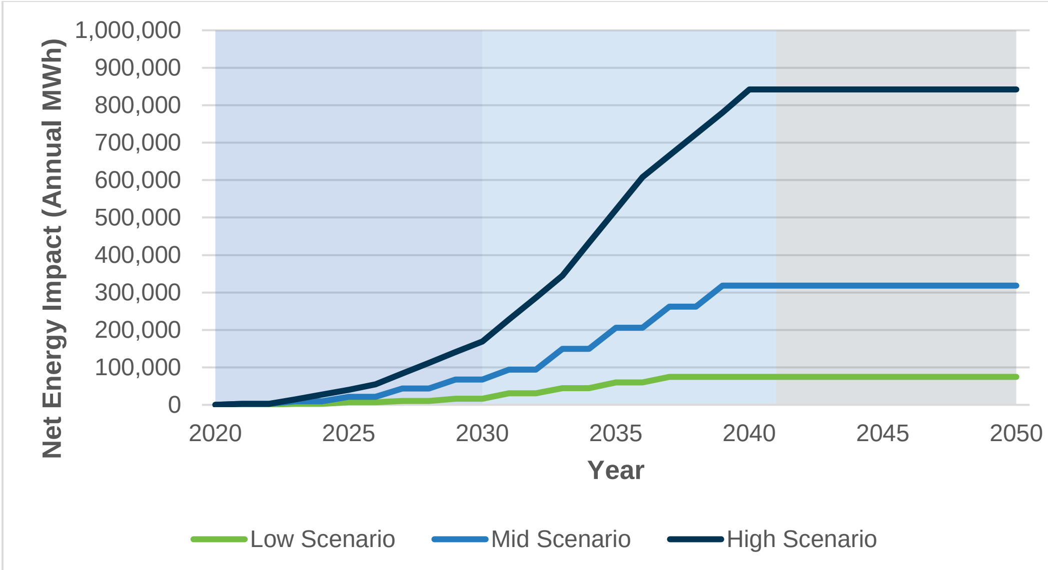
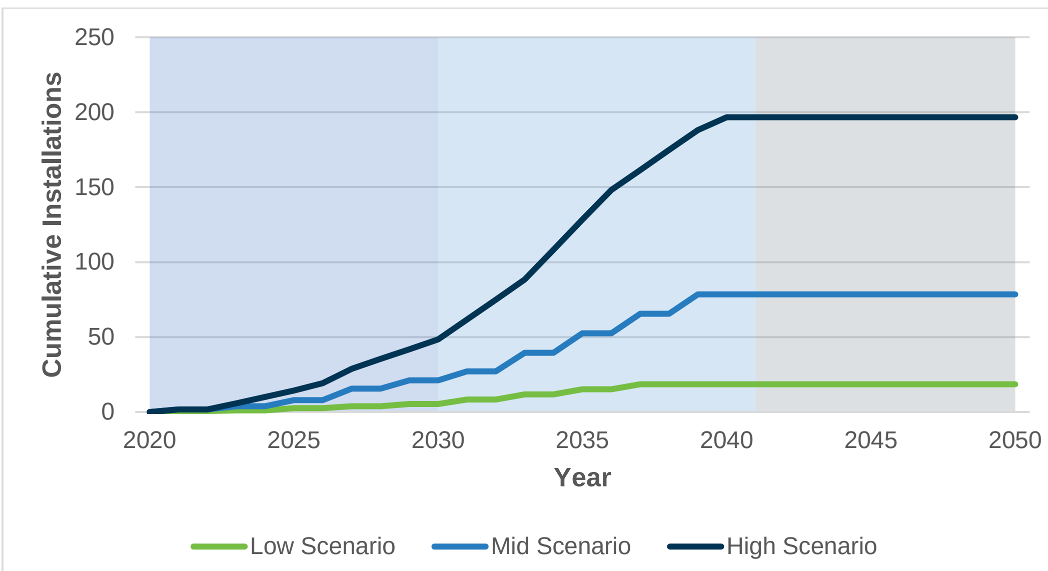


Figure 34: Community Solar + Storage – Evergy-wide Number of Cumulative Installations Projection by Scenario, 2020-2050



5.2 Service Territory Summary

<u>Observations and Drivers for Forecast Outputs</u>

Of the four technology/technology combination forecasts, the one for community solar+storage varies the least by service territory. As can be seen in Figures 35-38 (all depicting the Mid Scenario), the four service territories are projected to largely adopt community solar+storage in lockstep. As time progresses, Missouri West is projected to have the most installations, capacity, and net energy impact, and Kansas Central the fewest/least, but the differences are very small.

Figure 35: Community Solar + Storage – Mid Scenario Solar Capacity (Cumulative MW) Projection by Service Territory, 2020-2050

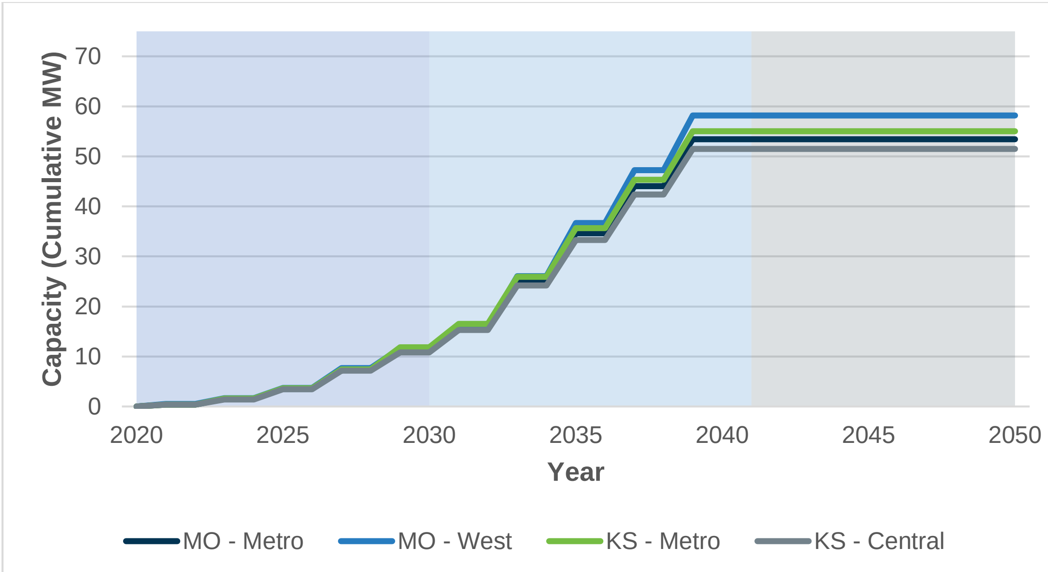


Figure 36: Community Solar + Storage – Mid Scenario Storage Capacity (Cumulative MW) Projection by Service Territory, 2020-2050

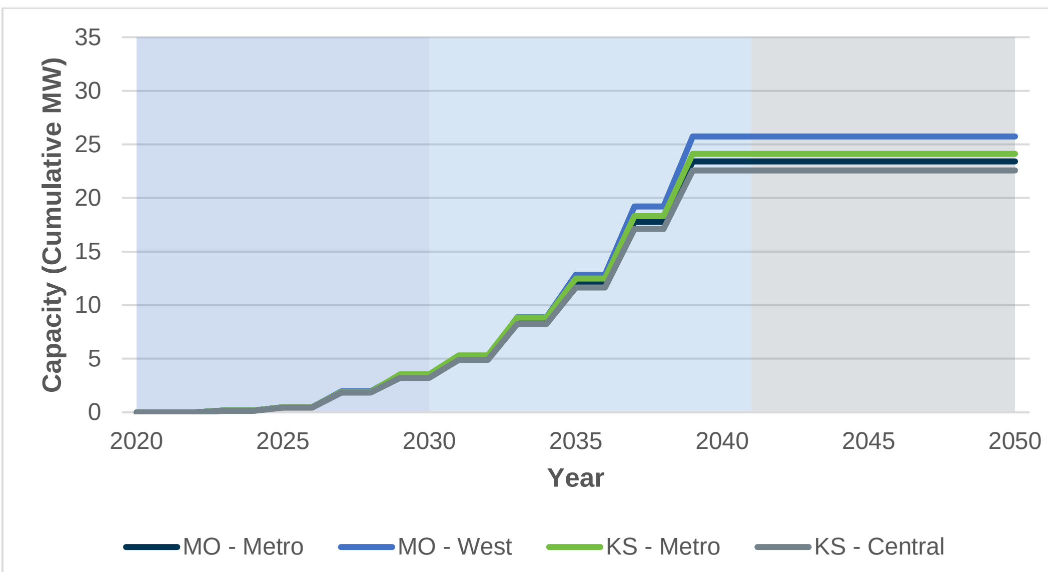


Figure 37: Community Solar + Storage – Mid Scenario Net Energy Impact (Annual MWh) Projection by Service Territory, 2020-2050

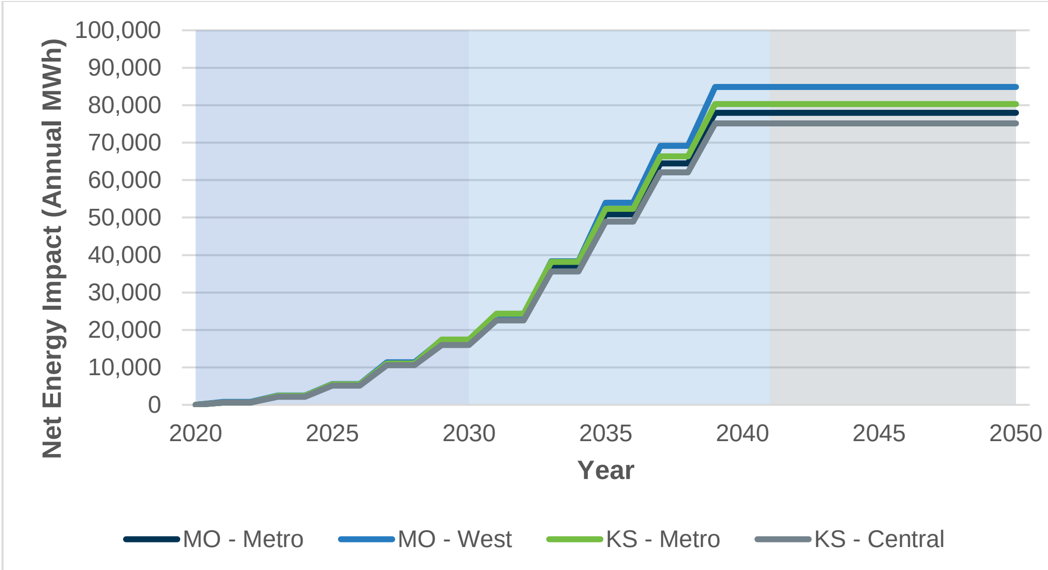
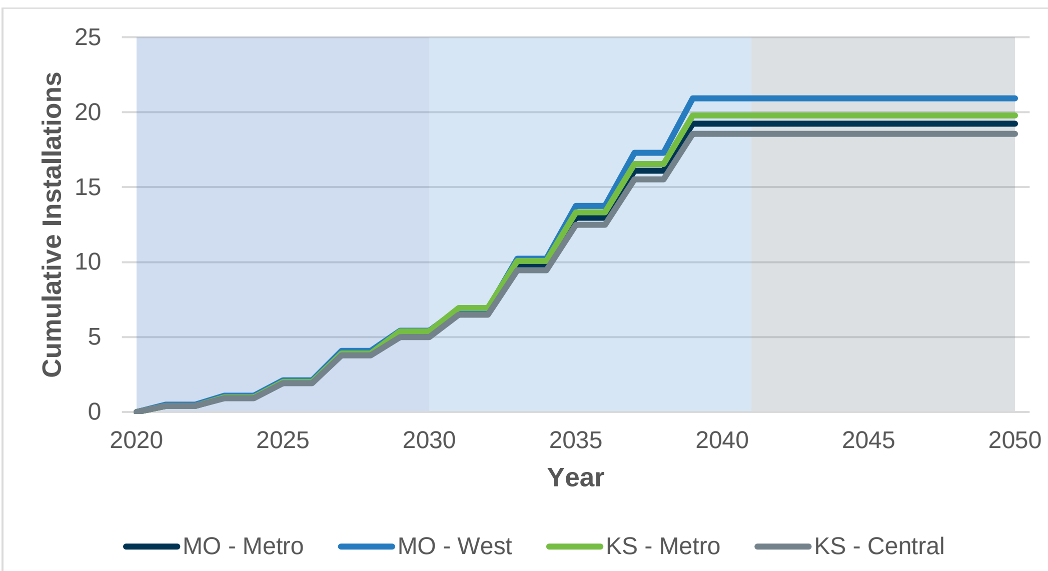


Figure 38: Community Solar + Storage – Mid Scenario Number of Cumulative Installations Projection by Service Territory, 2020-2050

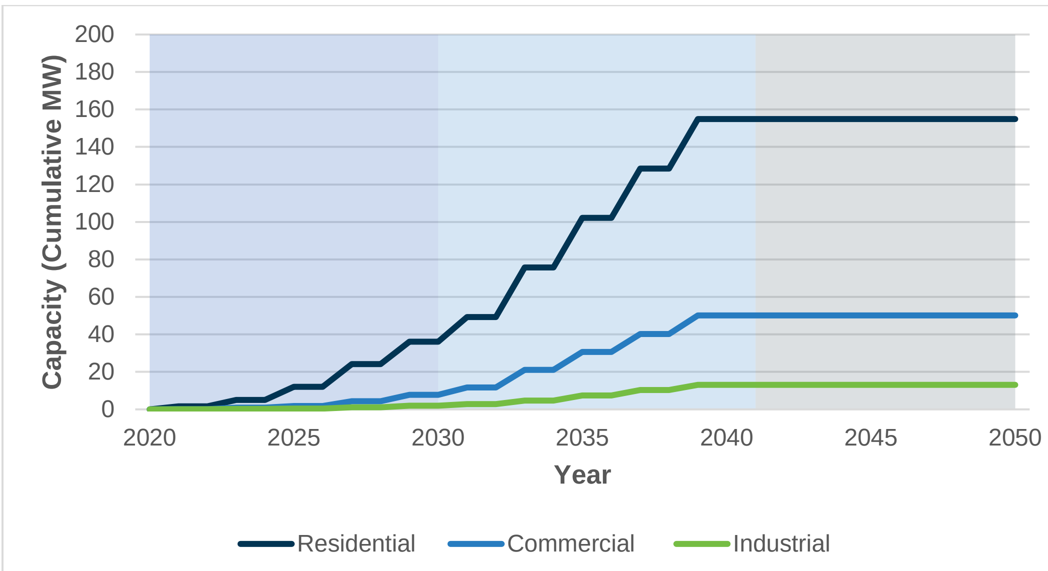


5.3 Customer Class Summary

Observations and Drivers for Forecast Outputs

Because of the small utility-scale development approach of community solar – grid-connected but not behind a customer meter – individual installations are not associated with any particular customer class. Instead, different customers from varying classes offtake from shared projects based on their subscriptions to each individual project. Hence, this section only features one chart: the cumulative solar capacity by customer class for the Mid Scenario (Figure 39), which depicts the MW equivalent that each class is forecasted to be subscribed to from the community solar+storage projects each year. Residential customers are projected to be by far the largest class of subscribers, off-taking nearly 80% of the community solar capacity in 2030 and more than 70% of the community solar capacity in 2040. Commercial subscribers are forecasted to offtake 17% of community solar capacity in 2030 and nearly 23% of community solar capacity in 2040, with industrial subscribers making up the (small) remainder in both cases.[21] The forecast considers typical subscription trends, but these relative ratios among customer classes can be influenced by the structure of the program and project development approach that Evergy develops as part of its overall community solar strategy.

Figure 39: Community Solar + Storage – Mid Scenario Evergy-wide Solar Capacity (Cumulative MW) Projection by Customer Class, 2020-2050



[21] Industrial customers are more likely to seek service under the Direct Renewable Participation Service Tariff or the Renewable Energy Rider, where loads of their size might be served more economically via wind energy.

Appendix A: Supplemental Methodology Detail

Behind-the-Meter Solar Photovoltaics

ICF forecasted the future adoption of behind-the-meter solar PV for residential, commercial, and industrial customers in Evergy's service territory for three adoption Scenarios – Low, Mid, and High. Data on installed and existing solar capacity in Evergy's service territory in the various customer classes formed the basis for the forecast. ICF's forecast factored capital costs, operations and maintenance (O&M) costs and information on current rebates and incentives. In addition, ICF examined BTM PV adoption trends in mature U.S. markets to modulate and inform the future growth of solar PV.

Figure 40. BTM Solar PV Annual Growth Rate Calculation

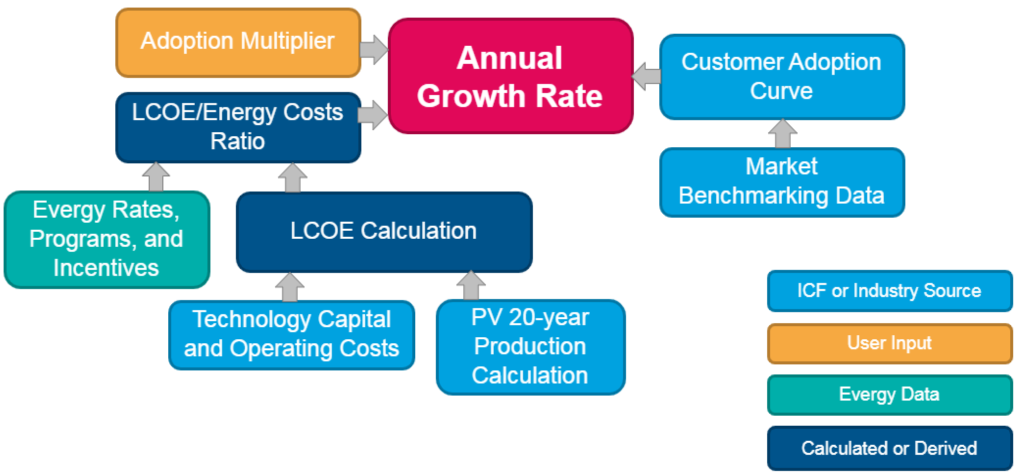
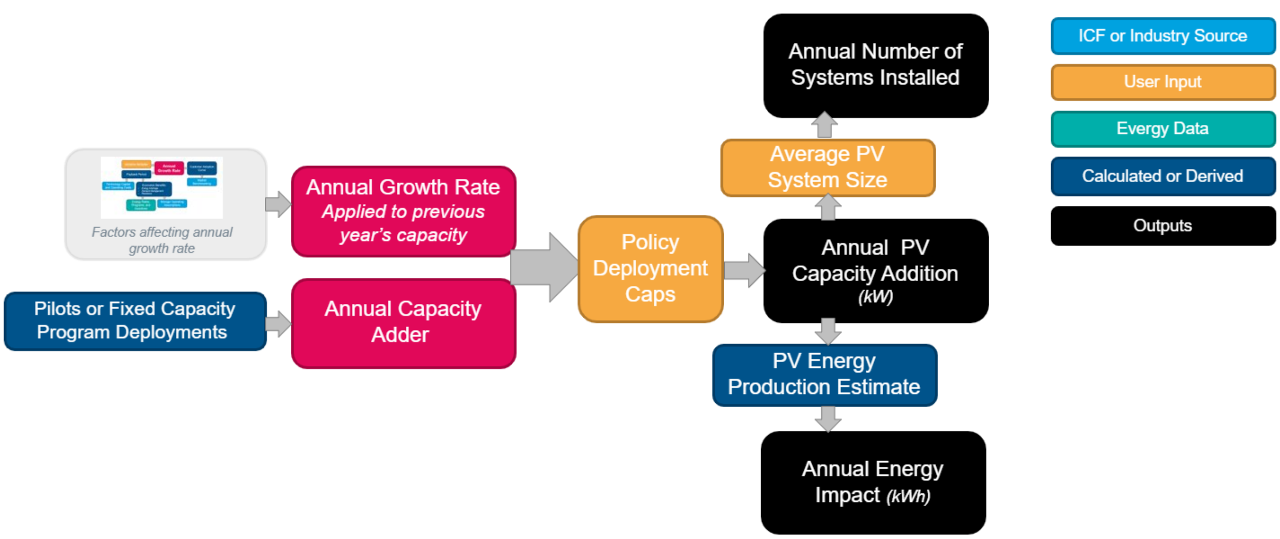


Figure 41. BTM Solar PV Model Schematic



Key assumptions, inputs, and calculations that impacted the various forecasted Scenarios are listed below by topical area.

Solar PV Economics

- Avoided costs – ICF developed estimates for avoided electricity costs for each customer class from the customers' perspectives based both on the published tariffs and on average utility costs per EIA data. These avoided costs ramp up over time using Evergy's EAAGS rate data and forecasts for an average annual revenue requirement increase on a per-scenario basis. ICF's Low and High forecast Scenarios used the lowest and highest EEAGS retail rates respectively which Evergy modeled for its 2020 integrated resource plan (IRP). ICF's Mid Scenario forecast used the expected value EEAGS retail rates. Time-of-Use (TOU) avoided costs for residential customers were used by developing a set of estimated hourly PV production (8760) values and mapping these to the currently available TOU rates. As a simplifying assumption, the annual values generated by the PV output were treated as if net metering was available for all customers.
- Solar production was developed using NREL data and tools (including PVWatts) for a representative system in Evergy territory. Solar production was then reduced by 0.5% per year to account for typical PV system degradation losses over time. This annualized data was used to calculate the average cost for solar power in comparison to avoided costs. The production values did not vary by Scenario.
- Technology costs were based on long-term forecasts for installed solar pricing, by customer class, and included average operations and maintenance (O&M) cost estimates. The NREL 2020 Annual Technology Baseline (ATB) was the source for these costs. Total project lifetime costs were estimated based on gross technology costs, less incentives, and less applicable investment tax credits, plus estimates for 20 years of O&M. As a simplifying assumption, depreciation benefits were not factored in. These values differed based on Scenario, with the Low Scenario using the highest published cost estimates over time and the High Scenario using the lowest cost estimates.
- Levelized Cost of Electricity (LCOE) was calculated using the total technology costs divided by the solar PV production over a 20-year lifetime. This is a conservative approach because the systems are likely to have value for more than twenty years.
- Incentives are included in the forecasts based on the current programs that are offered by Evergy but were not extended beyond their existing end dates.

Solar PV Growth Rates

- Baseline adoption curves were developed using both external trends from selected utilities, including Southern California, New York, and Missouri (Empire District Electric and Union Electric). These formed the inputs to generating a time- and market-adjusted annual growth rate that was then modified as described below.
- Modifications to the baseline adoption curves were made by territory to reflect an estimation of the current market readiness and existing adoption trends in each state (Missouri and Kansas).
- Modifications to the baseline adoption curves were made by Scenario to reflect the reduced potential in the Low Scenario and upper potential in the High Scenario.
- Finally, modifications to the baseline adoption curves were made by customer class that reflect the different economic benefit potential on decision-making processes for residential, commercial, and industrial classes.

- In the final determination for growth rates that were applied to the annual forecasts, the ratio of LCOE to avoided cost was determined and used as a final adjustment to the adoption baseline, where the lower LCOE-to-avoided-cost ratio (net savings potential for customers) resulted in higher growth rates, and decreased growth rates for lower savings potential.
- Where solar adoption has been very low or non-existent, capacity adders were applied in the early years of the forecast to reflect the initial ramp-up of solar PV installations within the territory and customer class. In subsequent years, the growth rates take over and drive the forecast. The capacity adders were used for the industrial sector where prior solar deployment had not been recorded as of 2019.
- To avoid “exponential growth” over the 30-year forecast period, and to reflect the patterns for longer-term deployment of solar and new technologies, policy caps to the deployment were used that limited the upper bound of each year’s capacity growth. These were developed based on existing annual load by Evergy service territory and compared to current RPS targets to ensure that the forecasts were reasonable and comparable to other markets around the country in total deployments.

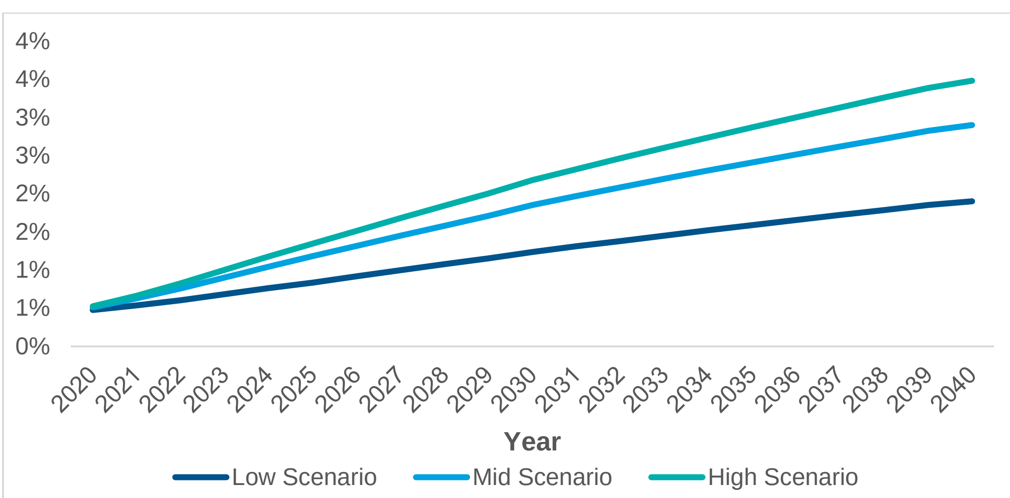
Conversions to Load Impact and Installation Volume

- Calculations for the net load impact to the grid have been developed and provided in the forecast outputs based on the average annual solar output for representative system sizes, with an annual degradation of 0.5% applied to prior year output. The intended use is to estimate the net reduction in overall load served by the grid from the deployed solar capacity in each Scenario.
- Installation volume estimates are provided in the forecast outputs based on total deployed capacity divided by average system sizes by customer class. The intended use is to understand the potential volume of interconnection activity annually and the number of systems over time that will be connected to the grid.

PV Penetration Data

- Evergy provided ICF with customer growth forecasts for the 2020 – 2040 period for each jurisdiction and customer class. The chart below displays the number of PV systems installed by all customers (residential, commercial, industrial) in Evergy’s entire service territory as a fraction of Evergy’s total customer base.

Figure 42: BTM Solar PV - Total Evergy PV Installations as a Fraction of All Evergy Customers



Behind-the-Meter Battery Energy Storage

ICF forecasted the future adoption of behind-the-meter battery energy storage for residential, commercial, and industrial customers in Evergy's service territory for three adoption Scenarios – Low, Mid, and High. As there are currently no BTM storage installations in Evergy's service territory, ICF used the concept of "capacity adders" to forecast storage adoption in the short-term (the 2020-2025 timeframe). ICF established the value of these capacity adders by studying storage adoption in other U.S. states: Texas, Colorado, and Nevada. ICF chose the states based on their similarity to Kansas and Missouri with respect to factors such as geographical location, electric retail rates, and the regulatory environment. ICF's forecast factored capital costs, operations and maintenance (O&M) costs, and information on rebates and incentives. In addition, ICF examined BTM storage adoption trends in mature U.S. markets (such as California and Hawaii) to modulate and inform the forecast.

Figure 43. BTM Storage Annual Growth Rate Calculation

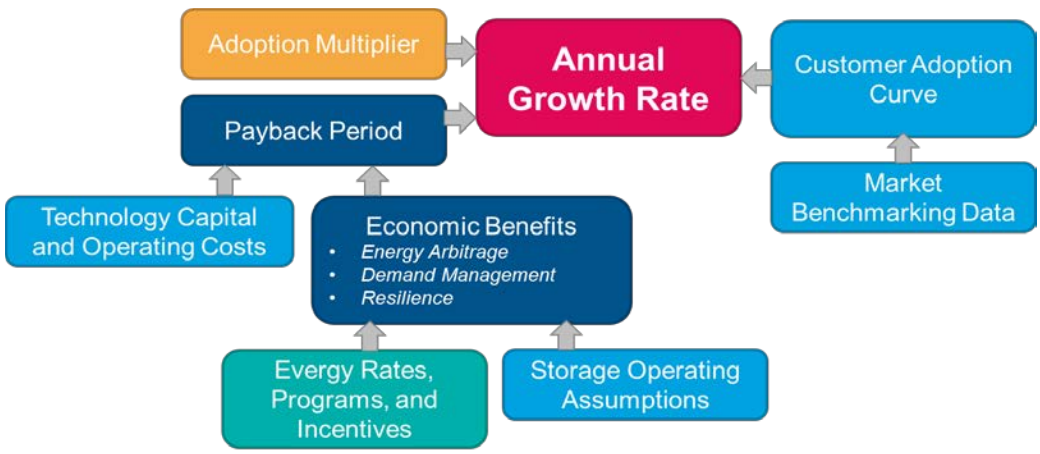
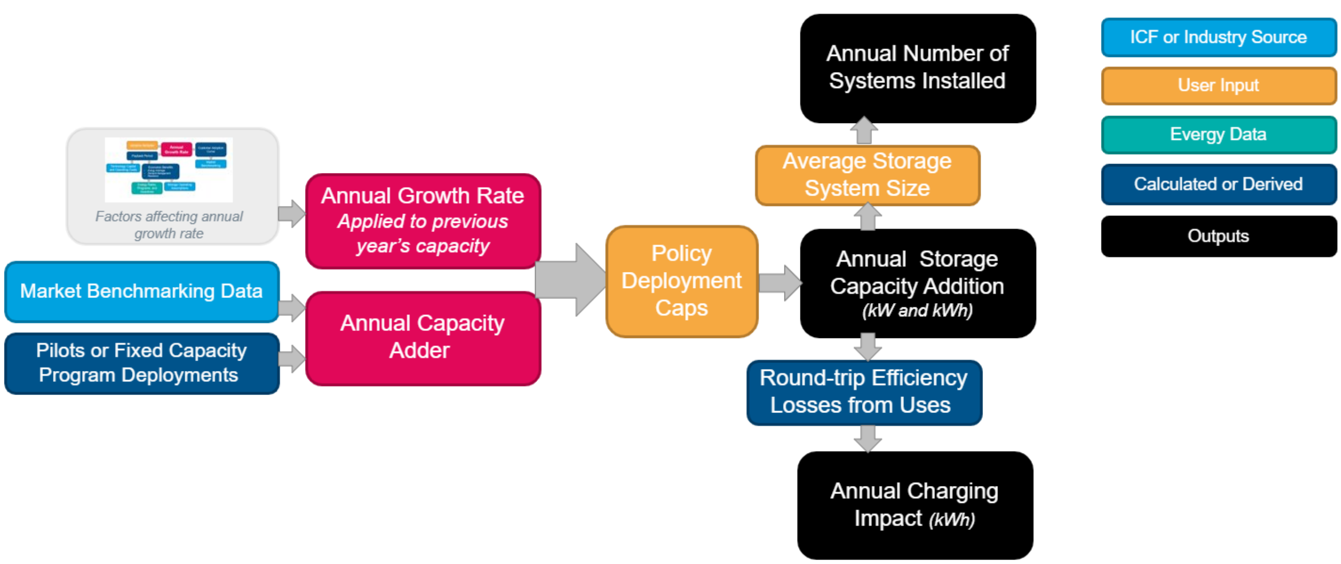


Figure 44. BTM Storage Model Schematic



Key assumptions, inputs, and calculations that impact the various forecasted scenarios are listed below by topical area.

Storage Economics

- ICF developed estimates for value streams from storage by customer class that included resiliency/back-up power, TOU arbitrage, and reductions of demand charges based on tariff structures and technology costs.
- Use cases for BTM Storage were based primarily on resiliency/back-up power and TOU arbitrage for residential customers, demand charge reduction and resiliency/back-up power for commercial customers and demand charge reduction alone for industrial customers. This approach estimated not only the net savings/value created for the customer but also the annual load impact (increase) for Evergy and the associated reduction in customer value.
- Technology costs for each of the Scenarios over the forecast period were based on data from the Wood MacKenzie Q3 2018 energy storage monitor and O&M costs were based on NREL 2020 ATB forecasts.
- Payback periods were calculated based on the technology costs, divided by the net savings/value. These varied dramatically across the various service territories and customer classes due primarily to the different tariff structures and rates.

Storage Growth Rates

- BTM Storage is an emergent market and has a much shorter and less robust adoption history nationally compared to BTM PV. That meant that ICF could not rely on a wide variety of external market examples. However, baseline adoption curves were developed taking a conservative approach to potential adoption adapted from the limited examples available.
- The baseline growth rates were modified by service territory to reflect estimated market readiness for this technology and existing tariff structures that may encourage or impede growth.
- Modifications to the baseline were also made based on each planned Scenario.
- Modifications were made by customer class based on their projected payback periods that established a more elastic curve for residential and incorporated more price sensitivity for the commercial and industrial customer classes.
- Capacity adders were used in the early years of each forecast because applying growth rates would not provide meaningful market forecasts. This creates some artificial, but minor, inflection points in the annual forecasts that are artifacts of the transition from fixed annual forecast growth to percentage growth.
- Policy/program caps were not used for BTM storage primarily due to the conservative forecast and low initial adoption rate estimates.

Conversions to Load Impact and Installation Volume

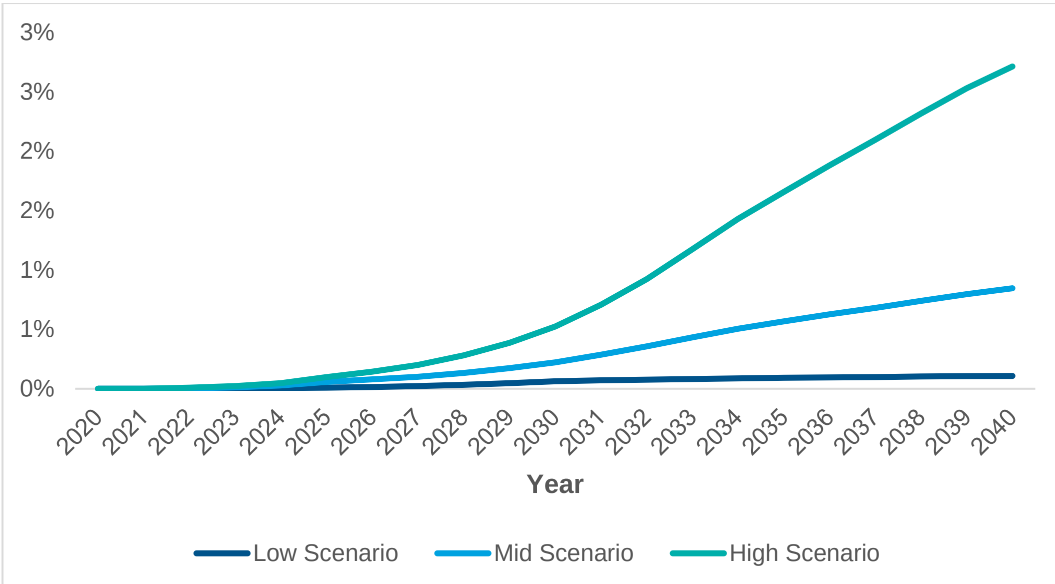
- Calculations for the net load impact to the grid have been developed and provided in the forecast outputs based on the BTM Storage system sizes and charge/discharge cycles by customer use case. For storage (as opposed to solar) the net impact is an increase in load for this technology due to a roundtrip efficiency of approximately 90% and one-sided charging cycles after grid outages. ICF assumed an annual storage energy capacity degradation of 3% for all customer classes, while recognizing that this number depends heavily on the number of daily battery cycles, the depth of discharge, environmental conditions and other factors.
- The number of installed BTM Storage systems were based on the annual aggregated capacity estimates divided by average system sizes by customer class to provide the

potential volume of interconnection activity annually and the number of systems over time that will be connected to the grid.

Storage Penetration Data

- Evergy provided ICF with customer growth forecasts for the 2020 – 2040 period by jurisdiction and customer class. The chart below displays the number of storage systems installed by all customers (residential, commercial, industrial) in Evergy's entire service territory as a fraction of Evergy's total customer base.

Figure 45: BTM Energy Storage - Total Evergy Storage Installations as a Fraction of All Evergy Customers



Behind-the-Meter Solar Photovoltaics + Battery Energy Storage

ICF forecasted the future adoption of behind-the-meter PV and battery energy storage for residential, commercial, and industrial customers in Evergy's service territory for three adoption Scenarios – Low, Mid, and High. For the residential sector, ICF used the concept of "attachment rates" to estimate the storage capacity co-installed with BTM residential PV systems. For commercial and industrial customers, ICF first calculated the payback period for both solar PV and battery storage systems individually. ICF then calculated a combined payback period for PV and storage assets by weighting the capital costs and payback period for the individual solar PV and battery storage assets for each year within the forecast period. ICF's forecast factored capital costs, operations and maintenance (O&M) costs, and information on rebates and incentives. In addition, ICF examined BTM PV and storage adoption trends in mature U.S. markets (such as California and Hawaii) to modulate and inform the forecast.

Figure 46. BTM PV + Storage Annual Growth Rate Calculation – C&I Customers Only

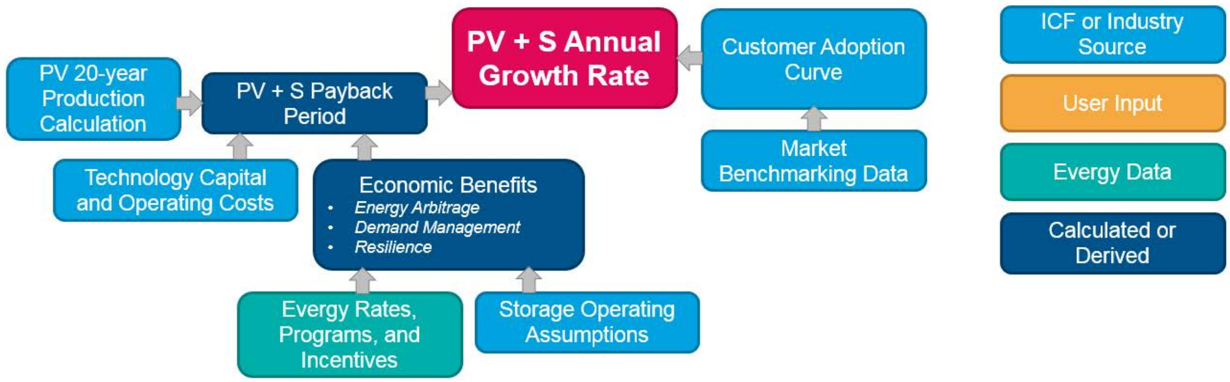
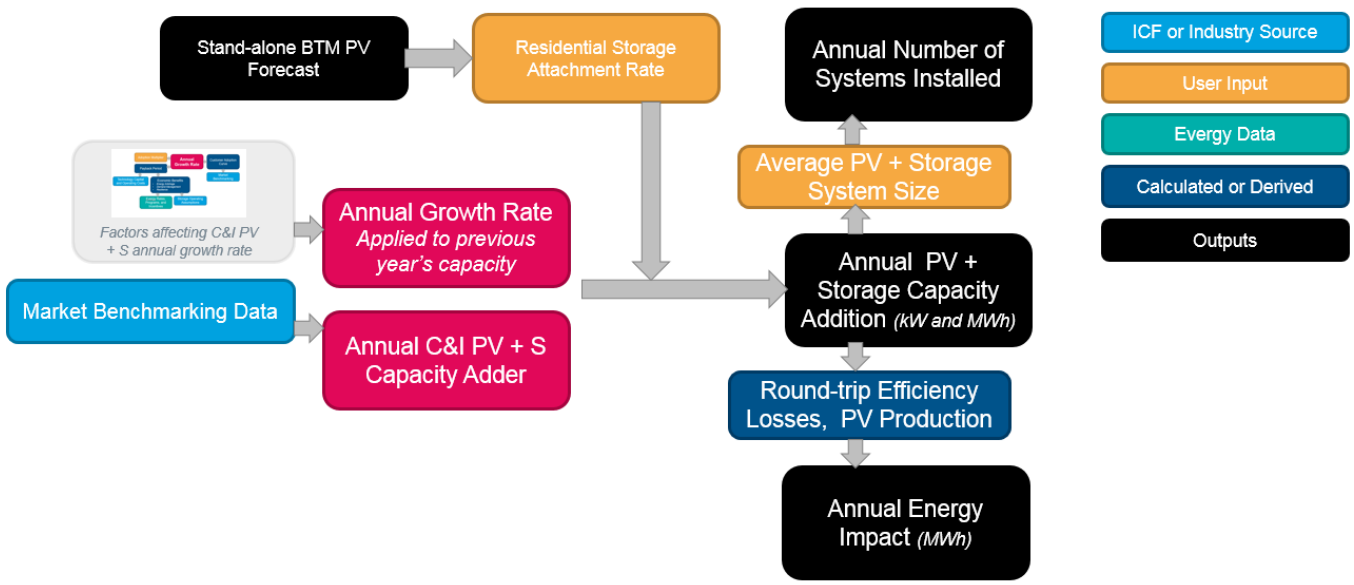


Figure 47. BTM PV + Storage Model Schematic



Key assumptions, inputs, and calculations that impact the various forecasted scenarios are listed below by topical area.

PV + Storage Economics

- ICF developed estimates for value streams from the storage component of PV + storage systems for commercial and industrial customers. The value streams considered included resiliency/back-up power and reductions of demand charges based on tariff structures and technology costs. No value streams were considered for residential customers as the storage attachment rates are the primary drivers of storage capacity co-installed with residential PV systems.
- Use cases for BTM PV + Storage were based on demand charge reduction and resiliency/back-up power for commercial customers and demand charge reduction alone for industrial customers. For residential customers, we assumed that a customer would completely charge and discharge their battery at least once per week. This approach

estimated not only the net savings/value created for the customer but also the annual load impact (increase) for Evergy and the associated reduction in customer value.

- Technology capital costs for each of the Scenarios over the forecast period were based on data from the Wood MacKenzie Q3 2018 energy storage monitor for battery energy storage and the NREL 2020 ATB for solar PV. O&M costs for both technologies were based on NREL 2020 ATB forecasts.
- The forecast accounted for existing installation incentives available to customers in Missouri only. We note that only Missouri currently offers customers standalone solar PV incentives and neither Missouri nor Kansas offer standalone storage incentives. ICF did account for the Federal Investment Tax Credit (ITC), which is offered to customers that install co-located solar PV and storage systems.
- ICF calculated a combined, weighted payback period for BTM PV + Storage installations for commercial and industrial customers. The payback periods were calculated based on the technology costs, after any incentives, divided by the net savings/value. The combined payback period calculation also factored in cost efficiency factors to account for the synergies of co-locating PV and storage, such as reduced installation, labor and electrical costs. The payback periods varied across the various service territories and customer classes due primarily to the different tariff structures and rates.

PV + Storage Growth Rates

- BTM PV + Storage is a very nascent market and has a much shorter and less robust adoption history nationally compared to standalone BTM solar PV and BTM storage. That meant that ICF could not rely on a wide variety of external market examples. However, baseline adoption curves were developed for commercial and industrial customers taking a conservative approach to potential adoption adapted from the very limited examples available.
- The baseline growth rates were modified by service territory to reflect estimated market readiness for this technology and existing tariff structures that may encourage or impede growth.
- Adjustments to the baseline adoption curves were also made based on each planned Scenario. These modifications were made for commercial and industrial customers based on the combined projected payback periods, incorporating more price sensitivity for these classes.
- Capacity adders were used in the first half of each forecast for commercial and industrial customers because applying growth rates would not provide meaningful results. This creates some artificial, but minor, inflection points in the annual forecasts that are artifacts of the transition from fixed annual forecast growth to percentage growth.
- The residential PV + storage forecast employed the concept of “attachment rates”. The attachment rate denotes the number of standalone PV installations in a year that are also coupled with a battery storage system. The installation of residential PV + storage systems is a very recent phenomenon, primarily driven by the need for backup power. Residential PV + storage systems have started to become prevalent in California and Hawaii, where the risk of outages due to wildfires and sever weather is especially acute. As these drivers are less applicable to Evergy’s service territory, residential PV + storage adoption in Missouri and Kansas is more likely to be based on economic considerations. Accordingly, ICF took a very conservative view on the attachment rates for residential PV and storage.

Conversions to Load Impact and Installation Volume

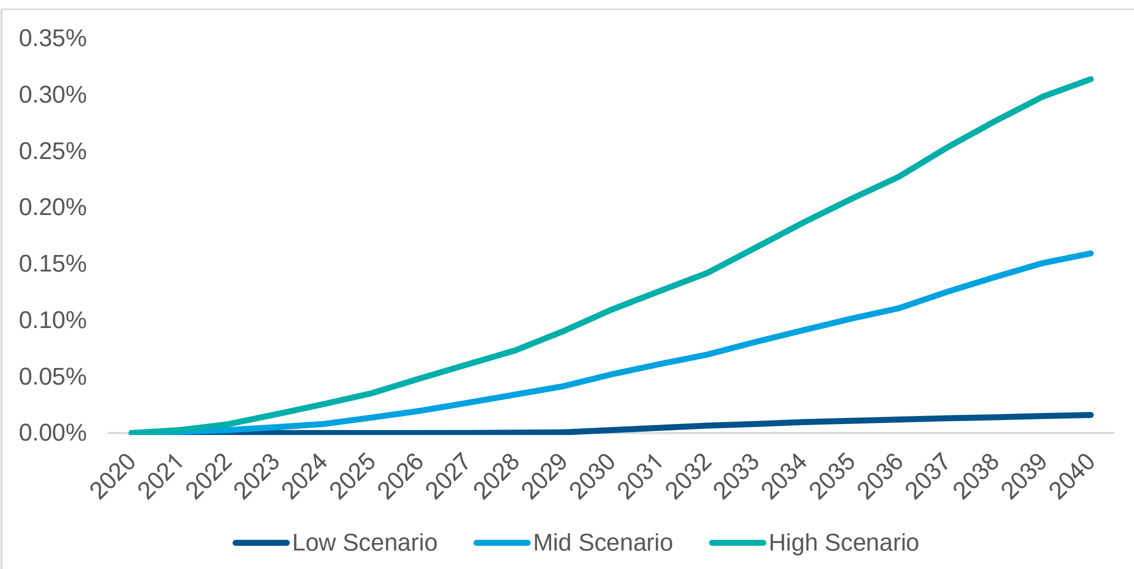
- Calculations for the net load impact to the grid have been developed and provided in the forecast outputs based on the BTM PV + Storage system sizes and charge/discharge cycles for storage by customer use case.

  - For solar PV, forecast outputs are based on the average annual solar output for representative system sizes, with an annual degradation of 0.5% applied to the prior year output. The energy output from solar PV results in a net decrease in customer load from Evergy's perspective.
  - For storage (as opposed to solar) the net impact to Evergy is an increase in load for this technology due to a roundtrip efficiency of approximately 90% and one-sided charging cycles after grid outages.
  - Based on the chosen use cases, dispatch strategies and resource outputs, energy production from solar PV is always found to be greater than the energy draw from the grid by battery storage. As a result, the net energy impact of BTM PV + Storage from Evergy's perspective is a decrease in load.
- The number of installed BTM PV + Storage systems were based on the annual aggregated PV capacity estimates divided by average PV system sizes by customer class (as each PV system is only equipped with one battery storage system) to provide the potential volume of interconnection activity annually and the number of systems over time that will be connected to the grid.

PV + Storage Penetration Data

- Evergy provided ICF with customer growth forecasts for the 2020 – 2040 period by jurisdiction and customer class. The chart below displays the number of PV + storage systems installed by all customers (residential, commercial, industrial) in Evergy's entire service territory as a fraction of Evergy's total customer base.

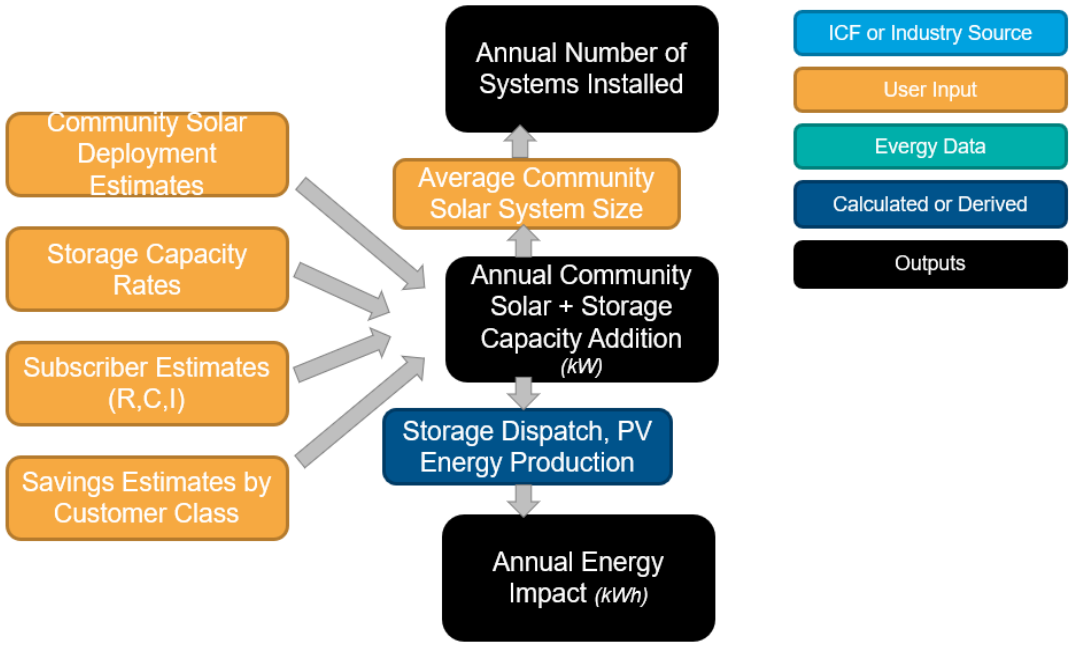
Figure 48: BTM PV + Energy Storage - Total Evergy PV + Storage Installations as a Fraction of All Evergy Customers



Community Solar + Storage

Unlike the BTM models, the Community Solar + Storage model does not rely on an economic analysis. Instead, ICF used adoption curves and storage attachment statistics from mature markets (Colorado, Minnesota, New York) to inform its own analysis. ICF also used data from these mature markets to estimate the PV capacity that participants within each customer class would subscribe to.

Figure 49. Community Solar Model Schematic



Key assumptions, inputs, and calculations that impact the various forecasted scenarios are listed below by topical area.

Community Solar + Storage Economics

- One of the primary drivers for adoption of Community Solar by customer class is their potential for savings (or added cost) from their existing utility bills. In the fastest growing utility territories, customers can save in the range of 15% on their supply charges in 2020. The forward-looking estimates for cost savings in Evergy territories range between an increase of 20% (based on current program offer for Evergy customers in 2020) to a decrease of 20% over the long-term forecast time horizon, with variations based on customer class due to their different tariffs.
- Total project costs for the development of Community Solar projects are expected to be competitive with alternative sources of power in the short term and trend lower over the mid-term – driving the potential for customer savings. This includes the addition of storage with the added value for dispatchability to serve grid needs and related value streams. For the purposes of this forecast, the overall project cost trends are expected to deliver net savings to customers using either a utility-owned model or third-party-owned model for project development.

Community Solar Growth Rates

- ICF understands that the deployment of community solar and storage in Evergy's service territory has been very limited. Evergy recently launched a Solar Subscription Program that is similar to other utility-owned community solar programs. Customers can subscribe to a portion of a solar PV array in the Kansas City area through the utility. The program has not yet reached its subscription target; construction of the solar array will begin once the program has been 90% subscribed. In addition, community solar is a relatively new concept. As a result, ICF could not rely on adoption curves in comparative markets to inform the forecast. ICF used the concept of annual "capacity adders" to project-driven future community solar growth and "storage frequency rates" to calculate the number of community solar installations that would also be equipped with storage.

- Within each state (Missouri and Kansas), ICF made assumptions on the proportion of the annual Community Solar and Storage installed capacity that would be subscribed to by residential, commercial and industrial customers. Residential customers are judged to subscribe to a larger portion of a system's capacity based on national adoption trends to date and their higher retail rates, relative to commercial and industrial customer classes.
- ICF made assumptions for each Evergy jurisdiction and customer class by scenario (Low, Mid, and High) regarding the potential bill savings that a customer could realize. These estimates are based on observations from peer markets such as Colorado, Minnesota, New York and Massachusetts. The forecast uses an estimate of potential customer bill savings in the short- to mid-term of 5% to 10% with that savings increasing over time up to a maximum potential of 20% for residential customers.

Conversions to Load Impact and Installation Volume

- Calculations for the net load impact to the grid have been developed and provided in the forecast outputs based on the Community Solar and Storage system sizes and charge/discharge cycles for storage.
    - For community solar, forecast outputs are based on the average annual solar output for representative small utility scale system sizes. The energy output from community solar results in a net decrease in customer load from Evergy's perspective.
    - For storage (as opposed to solar) the net impact to Evergy is an increase in load for this technology due to a roundtrip efficiency of approximately 90% and one-sided charging cycles after grid outages. ICF's model assumes that storage attached to a community solar array charges and discharges once per day.
    - Based on the chosen dispatch strategies and resource outputs, energy production from community solar is always found to be greater than the energy draw from the grid by battery storage. As a result, the net energy impact of Community Solar and Storage from Evergy's perspective is a decrease in load.
- The number of installed Community Solar and Storage systems were based on the annual aggregated PV capacity estimates divided by average Community Solar system sizes (as each Community Solar system is only equipped with one battery storage system) to provide the potential volume of interconnection activity annually and the number of systems over time that will be connected to the grid.

Approach to Consolidating Forecasts

ICF's approach to developing the BTM PV forecast and BTM Storage forecast was to develop them as their own independent estimation of the potential scenarios looking forward. The approach for BTM PV + Storage was similar, but the actual forecasted numbers overlap with the two standalone technologies to a certain extent due to the project-centric focus on adoption. Therefore, there are certain adjustments that needed to be made when combining the overall totals for all technologies – and specifically the BTM PV, BTM Storage, and BTM PV + Storage forecasts.

For the residential portion of the BTM PV + Storage forecast, ICF used an "attachment rate" for storage based on the BTM PV forecasted outputs. Therefore, the residential PV capacity that is incorporated into the BTM PV + Storage should be deducted from the overall BTM PV numbers when aggregated. One way to display this is in a super-summary of the four technologies, by "netting out" the PV numbers.

For the commercial and industrial classes for BTM PV + Storage, the PV and storage numbers are somewhat additive to the individual BTM PV and BTM Storage forecasts. The recommended approach is to make an adjustment to the commercial and industrial totals to incorporate an "overlap factor" to reduce the likelihood of over-aggressive estimates. This overlap factor is estimated at 25% of the commercial and industrial forecasts for BTM PV + Storage, that would then be deducted from the individual BTM PV and BTM Storage forecasts when aggregating all the forecasts into a super-summary.

Appendix B: Forecast Models

ICF delivered four forecast models to Evergy in August 2020:

- *Evergy BTM PV Forecast, 2020-2050*
- *Evergy BTM Storage Forecast, 2020-2050*
- *Evergy BTM PV+Storage Forecast, 2020-2050*
- *Evergy Community Solar+Storage Forecast, 2020-2050*

Each of the models features the underlying mechanics, inputs, and specific forecasted outputs by year for a given technology or technology combination. Each one includes:

- A cover sheet that provides:
    - A description of the tool
    - Instructions on how to use it to create alternative iterations of the forecast
    - Descriptions of the key parameters, their uses within the model, and the sources of the inputs used
    - Definitions of the output metrics
    - Visual depictions of the model architecture (as seen in Appendix A above)
- Summary charts (as seen in sections IV.2 through IV.5), plus:
    - The underlying data tables
    - Compound annual growth rates of:
        - MW capacity
        - MWh energy output or net energy impact
        - Number of installations
- The key inputs, input data sets, and modeling controls
- Complete sets of output numbers by:
    - Scenario
    - Service territory
    - Customer class