Energy Report: Pima County, Arizona

Pima Prospers
Comprehensive Plan
2025

THE UNIVERSITY OF ARIZONA
Drachman Institute

Table of Contents

Summary 2

Introduction 3

1. Trends in Historical Energy Use in Pima County 4

1.1. Historical Power Sales by Sector 4

1.2. Historical Renewable Power Generation 5

1.3. Current Percentage of Generation from Renewable Sources 6

2. Projections of Power Generation in Pima County 7

2.1. Projections of Power Sales by Sector 8

2.2. Projections for Renewable Power Generation 9

Conclusions 11

Recommendations 12

References 13

Summary

The *Energy Report: Pima County, Arizona* investigates Pima County's current and future power generation by analyzing retail sales and renewable generation data. Historical trends and planned changes to power generation resources are used to make projections about power generation for the future.

The key findings of this report are:
1. Currently, 30% of total power generation in Pima County comes from renewable sources. With a planned 3x increase in renewable generation capacity in the next 15 years, this percentage is estimated to increase to 70% by 2038.

2. The residential sector has the highest power sales numbers, showing the greatest power demand in Pima County is for residential housing.

3. Residential power sales in Pima County are projected to grow by 12% by 2038, with an expected increase of 50,000 customers. A similar increase in sales (500 GWh) is projected for the industrial sector.

4. For the same future period, an 80% increase in power sales to the mining sector is anticipated. These sales will serve the proposed mine in the Santa Rita Mountains (Rosemont's Copper World), which, in power generation terms, is almost double the increase projected for the residential sector.

Introduction

Pima County, Arizona, is preparing an update to the Pima Prospers comprehensive plan. This plan is a decades-long vision aiming to deliver policies that will continue to support the county's resources, environments, and communities. This report analyzes current information and presents highlights that aim to inform energy production and usage policy.

The United States aims to reach net-zero carbon emissions economy-wide by 2050 as part of its pledge to the Paris Climate Agreement (Resolution 2022-25)[2]. With the global transition to renewable power generation underway, questions about the reliability of renewable power generation are often raised. Appling today's technology on a sufficiently large scale can satisfy annual demand; however, the timing of renewable generation often does not match times of peak demand. Battery energy storage enables utilities and balancing authorities to discharge power generated from renewable sources at peak demand.

The challenge, then, has shifted to the logistics of the transition to renewables rather than the development of new technologies. An example of the logistical issues we now face is that existing grid infrastructure is typically designed for one-way transmission from the generation source to the consumer. However, with more renewable generation penetrating the grid, power transmission needs to be bidirectional. Power generated across distributed utility-scale renewable sites and rooftops must be sent to battery storage before being discharged to consumers when needed.

The abundance of clear sky sunlight hours in Pima County presents the opportunity for solar power generation on rooftop and utility scales as a linchpin of the county's current and future energy portfolio. Also, although typically located outside the county, wind power resources have been harnessed by regional utilities to supply a significant portion of power to the county. The county's largest electric utility has set an ambitious goal of an "80 percent reduction in carbon dioxide (CO2) emissions from owned fossil generation by 2035", a target that, while not legally binding, demonstrates their commitment to a sustainable energy future. This type of commitment is not limited to regional utilities but one shared by the wider Pima County community, making it a collective priority for our shared future.

The findings presented in this report are based on data provided by Tucson Electric Power. Retail sales, renewable generation data, and information from the publicly available Integrated Resource Plan[1] were analyzed.

1. Trends in Historical Energy Use in Pima County

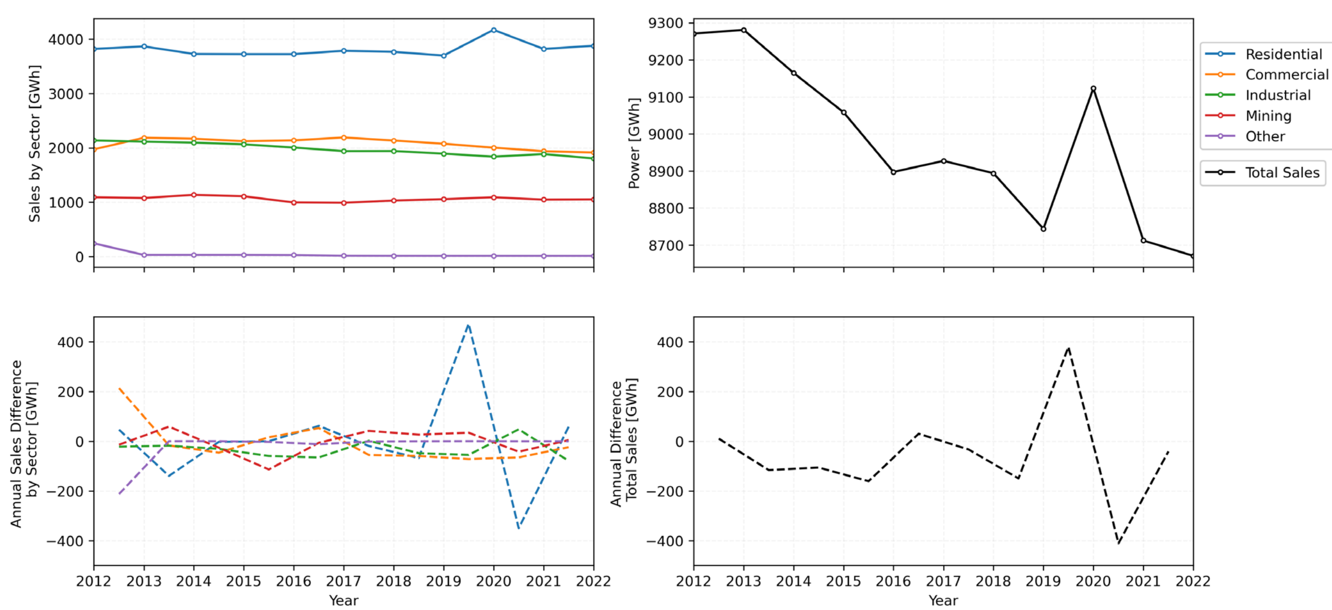
1.1. Historical Power Sales by Sector

To make informed projections for the future, we must first understand current and historical power production. In this section, we examine historical power sales by sector to assess the magnitude of usage per sector and how that usage has changed over the last 10 to 15 years. **Figure 1** shows that the residential sector uses the most power, almost 4000 GWh, double that of the commercial and industrial sectors. The mining sector has used approximately a quarter of the residential amount for the past decade.

Figure 1 also shows that sales to the residential sectors have remained relatively constant, except for 2020, when residential sales spiked due to the COVID-19 pandemic and resulting lockdown periods. Over the past decade, reductions in sales to the commercial and industrial sectors have caused total sales to decrease by over 500 GWh in Pima County. This is likely due to gains in energy use efficiency and the increase in commercial buildings with solar panels, meaning less power is sold to non-residential customers with rooftop solar installed.

We use sales data as a proxy for power generation for Pima County, though the sales data excludes losses and wholesale production. The addition of losses and wholesale could add between 8-15% to the sales numbers since external factors that are often not possible to predict can cause annual variations. The sales data represents a useful proxy as it describes the magnitude of utility-scale power generation and, when combined with rooftop solar generation, is the total amount of power generated. Next, we must consider rooftop generation as a portion of all renewable power generation in the same historical context.

Figure 1: *Timeseries showing energy sales in GWh from 2012 to 2022 for Pima County, split by sector (top left) and total (top right), see legend. The annual differences are shown in the lower panels (bottom left and right).*



1.2. Historical Renewable Power Generation

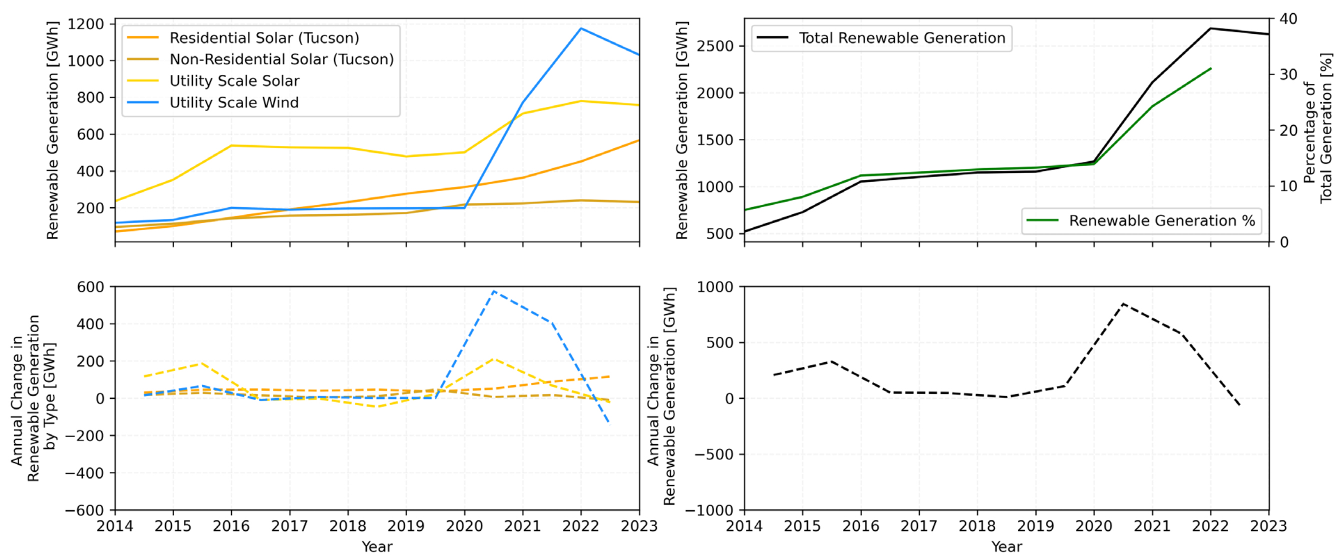
Figure 2 shows that total renewable power generation has increased from 2014 to 2023 in Pima County, with increases from each source: residential/non-residential rooftop solar, utility-scale solar, and utility-scale wind.

Residential solar generation increased at a near-constant positive rate, which aligns with what we would expect. This distributed network of solar generation incrementally grows with the adoption of rooftop solar panels on homes. For non-residential solar, similarly to residential, generation increased at a positive near-constant rate from 2013 to 2022, with a leveling of the increase in 2023. Again, since this is a distributed network of small-capacity solar sites, we can reasonably expect a similar rate of increase for the next 10-15 years. However, both depend on the continued growth of the residential and commercial sectors, respectively (see Section 2.2 for projection in renewable power generation).

Unlike rooftop solar, the rate of increase for utility-scale renewables is non-linear because new utility-scale sites come onto the grid sporadically. This causes significant jumps in renewable power production. For example, **Figure 2** shows historical utility-scale wind generation where we see the addition of two wind power sites as a sharp increase in production since 2020; the capacity added was 250 MW in 2021 and 100 MW in 2022. Issues with inverter infrastructure at the 250 MW site mean it is under a long-term curtailment (likely ~50-75% for 1-2 years), which explains the drop in utility-scale wind from 2022 to 2023.

Figure 2 also shows historical utility-scale solar generation and supports a similar interpretation. Significant increases in solar power generation occur after the addition of new sites to the grid. We see an initial increase in generation from 2014 to 2017, then a period of relatively constant solar generation from 2017 to 2020 when no additional solar sites were installed. More recently, in 2021 and 2022, we see another increase in utility-scale solar because of the addition of two large-capacity solar sites (100 MW and 12.5 MW capacity sites, respectively).

Figure 2: *Timeseries showing renewable power generation from 2014 to 2023 for Pima County. Renewable power generation is split by source (top left, see legend) and total renewable generation in GWh (top right) and Percentage of Total Generation (top right, right y-axis). The annual differences are shown in the lower panels (bottom left and right).*

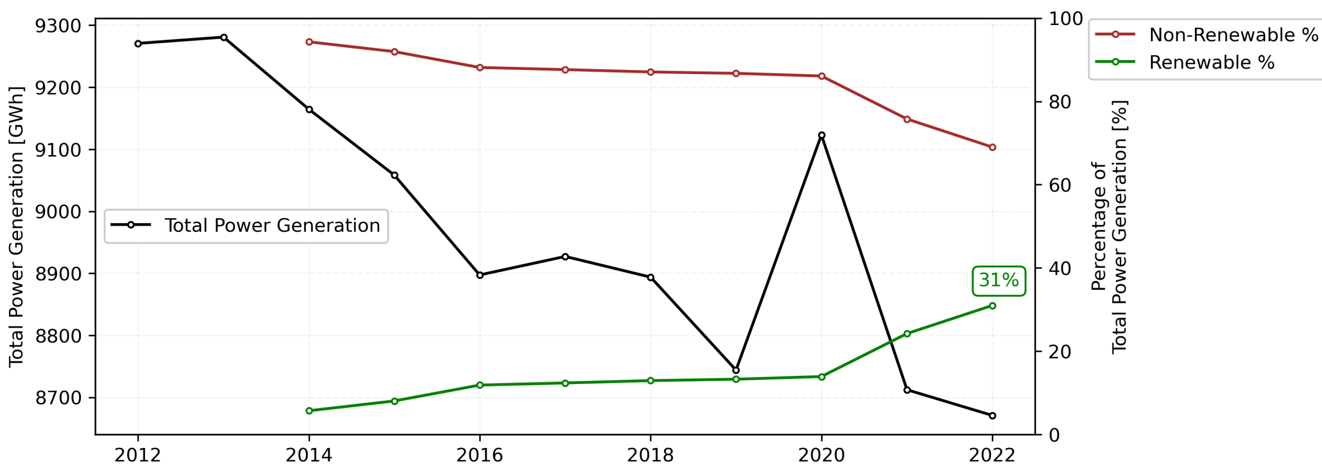


1.3. Current Percentage of Generation from Renewable Sources

Considering the total power sales and the amount of renewable generation shown in the previous two sections, we can now calculate how much power has been generated from renewable sources in Pima County during the historical record. Non-renewable generation, power from fossil fuels such as coal and natural gas, is assumed to be total sales minus renewable generation.

Figure 3 shows the percentage of power generation from renewable sources has increased over the past ten years. Pima County has been steadily increasing the percentage of renewable power generation since 2014, and as of 2024, Pima County produces just over 30% of its supply from renewable sources. This percentage value is significantly greater than the percentage for Maricopa County[8] (4-5%) and the state average of 17% for Arizona[3]. However, this percentage is less than that of San Diego County (33% as of 2020)[4] and California as a whole (54% as of 2023)[5]. The current percentage of generation from renewable sources is a promising sign for future power grids served exclusively by renewable energy resources. However, given the targets for carbon emissions set by the federal government and regional utilities stated earlier, the question of whether we will reach such targets arises. We first need to make power generation projections for the future to attempt to answer this.

***Figure 3:** Timeseries showing Total Power Sales (Total Generation, GWh, left y-axis) from 2012-2022 for Pima County and the percentage coming from renewables and non-renewable sources (right y-axis).*



2. Projections of Power Generation in Pima County

Building on Section 1, where we show how much power generation is currently needed to serve Pima County, Section 2 presents power sales projections for the future to estimate the generation for each sector (2.1) and the percentage of total generation that will come from renewable sources (2.2).

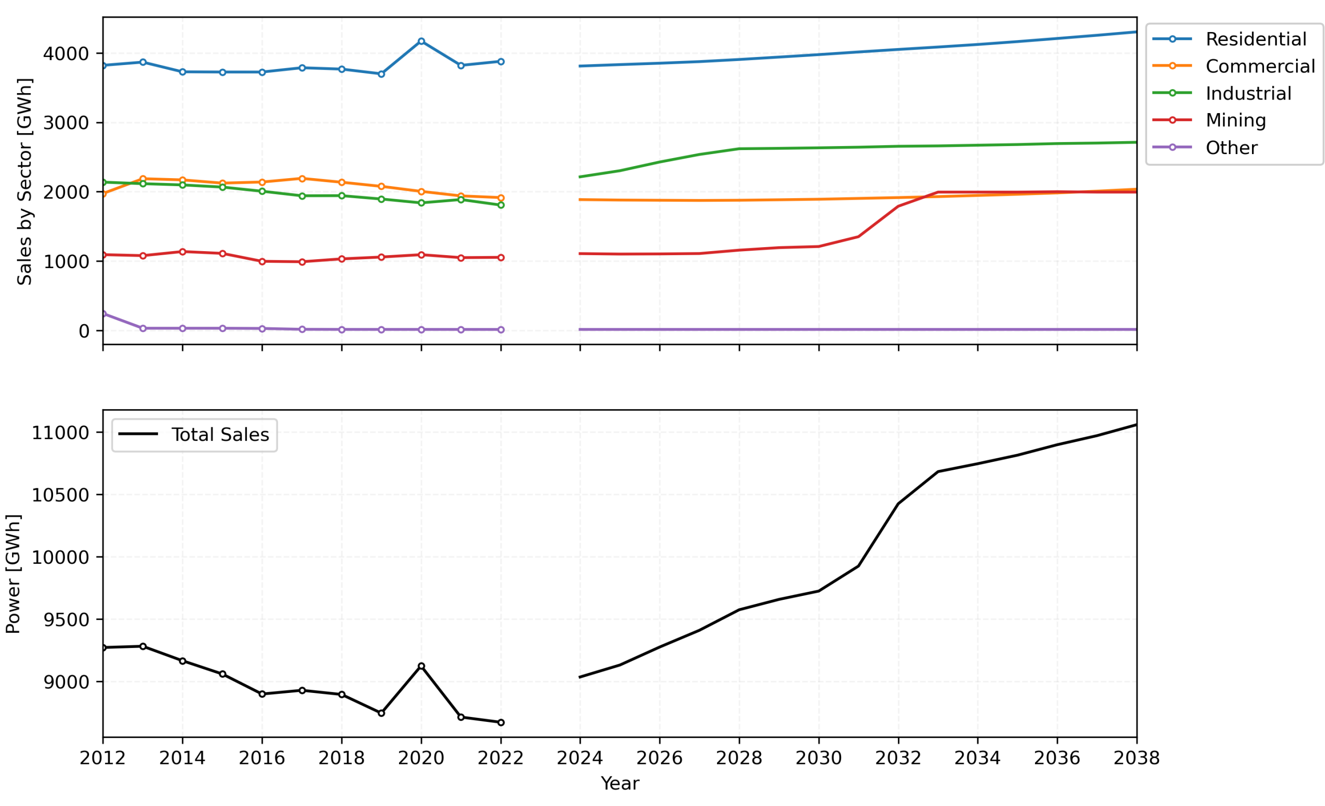
Sales projections by sector are taken from the Tucson Electric Power Integrated Resource Plan Appendix A[1]. These data are generated by statistical analytics models that produce monthly power forecasts by sector. The raw data inputs are not available for public dissemination, so we rely on other publicly available information to contextualize these projections.

2.1. Projections of Power Sales by Sector

Figure 4 shows power generation projections for the residential, commercial, industry, and mining sectors. By 2035, Pima County's population is expected to increase to about 1.3 million[6], and the number of residential customers is projected to increase from 400,000 to 450,000 from 2023 to 2038[1]. The increase in generation for the residential sector, shown in **Figure 4**, can be attributed to the expected customer increase. For the industrial sector, a similarly large increase of 500 GWh is shown by 2028 before leveling off. Meanwhile, we see a leveling of the projected sales for the commercial sector to an amount insignificantly different from today's.

The most striking aspect of **Figure 4** is a 2x increase in projected sales to the mining sector from 2030 to 2033, an increase of approximately 900 GWh. This is a significant increase compared to the growth of the largest sector, residential, which projects an increase of about 500 GWh for the same period. The anticipated sales to a proposed mine in Pima County have a large impact on the total projected sales and suggest different scenarios for the future of power generation that are dependent on the success of the mine. The success of the mine is difficult to predict; however, permits for the first phase of extraction are already in effect[9].

Figure 4: *Timeseries observed (lines with markers) and projected (lines) power sales in GWh from 2012 to 2038 for Pima County. Power sales are split by sector (top, see legend) and sum of the sectors, the total sales, is shown (bottom).*



2.2. Projections for Renewable Power Generation

Using the sales projections by sector, we calculate the total projected sales and combine that with the planned changes to the renewable generation capacity for the same period. From this, we can estimate the future percentage of power generation that comes from renewable resources.

As of 2024, Pima County's renewable generation capacity is 1151 MW. The capacity is projected to increase to 3851 MW by 2038, which marks the end of the current plans for renewable generation resources. The renewable capacity additions by type are shown in Table 1. We add the planned capacity changes for utility-scale solar and wind generation from new renewable sites coming onto the grid and those retired due to degradation[1]. We use 2022 to estimate the annual number of renewable generation hours as it was the last year of data at the full renewable capacity before the long-term curtailment of the wind site shown in Figure 2. We then use the number of renewable generation hours to estimate annual utility-scale solar and wind generation in GWh. For solar, the number of renewable generation hours is approximately 2400 hours, and for wind, it is 2700 hours.

Figure 5 shows that utility-scale renewable generation is estimated to increase from ~760 to 3910 GWh for solar and from ~1170 to 2300 GWh for wind by 2038. The planned installation of new utility-scale renewable resources represents a more than 2.5x increase in renewable power generation for Pima County.

Figure 5: *Timeseries showing observed renewable generation by source (top) through 2022 (lines with markers) and projections through 2038 (lines). Observed Total Retail Sales and Percentage from Renewable Generation (bottom) are shown through 2022 (lines with markers) and projections through 2038 (lines).*

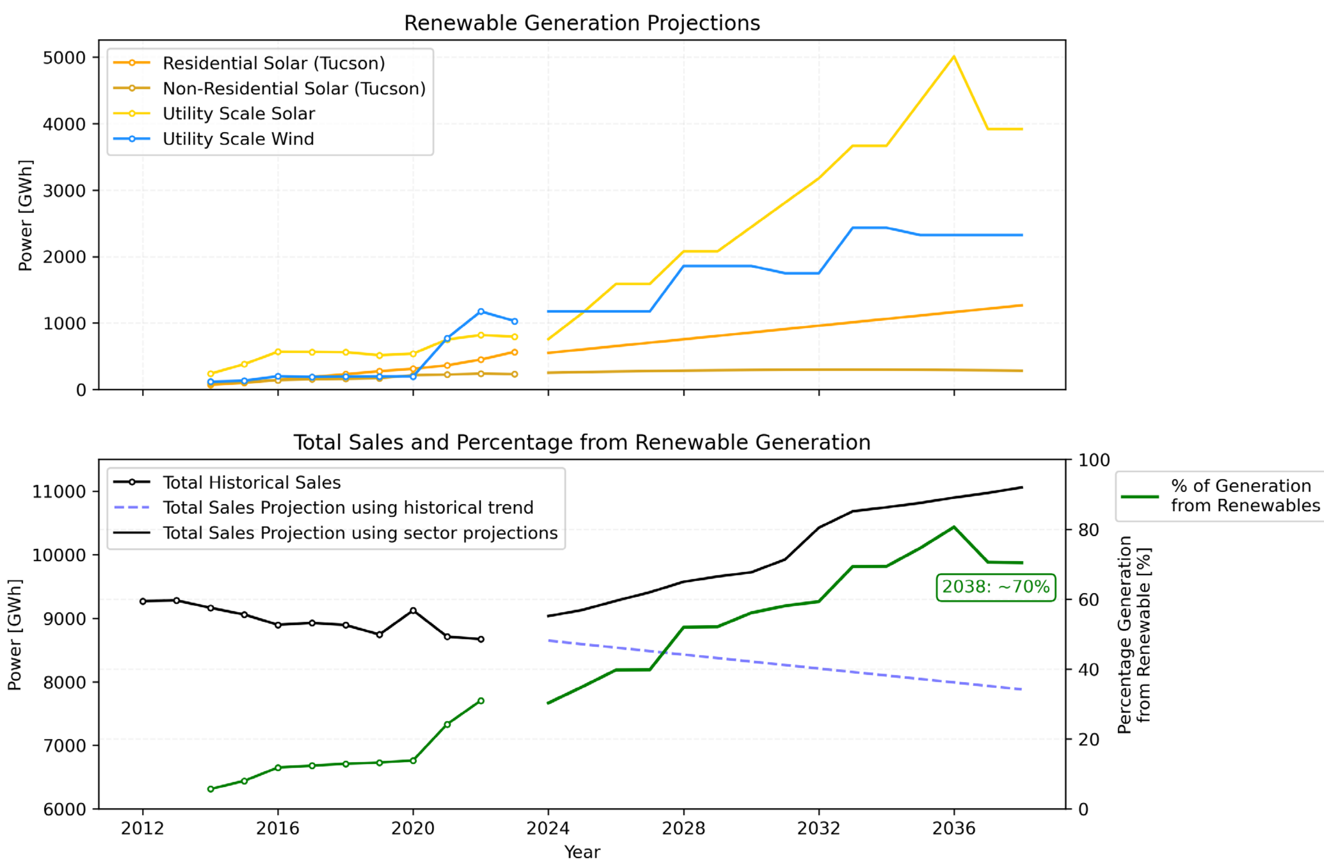


Table 1: *Table of capacities for renewable generation sources by type. Values for 2038 include 80 MW of wind and 172 MW of solar retired due to degradation.*

	2024 [MW AC]	2038 [MW AC]
Utilty-Scale Wind	429.4	849.4
Utility-Scale Solar	310.2	1878.2
Rooftop Solar	411.1	1124
Total Renewable Capacity	**1151**	**3851.6**

Conclusions

The analysis presented in this report shows historical information on power sales by sector and renewable energy generation. Using this historical information and the planned expansion of renewable resources, we create projections for the next 15 years of power sales by sector and estimate the percentage of power generation from renewable sources.

The residential sector has the greatest power sales of all sectors in Pima County. Residential sales are projected to grow by about 12% by 2038, reflecting the expected increase of 50,000 more customers in the county, and a similar level of growth is projected for the industrial sector. The mining sector is the only other sector with a significant change to sales projected by 2038. Sales to the mining sector are expected to increase by 80% due to a proposed mine in the Santa Rita Mountains, Pima County, which is almost double the growth in sales from the residential and industrial sectors.

Pima County is a leading county in Arizona for renewable power generation, with about 30% of the power currently generated from solar and wind resources. This percentage is comparable to counties in other U.S. states with significant renewable power generation, such as San Diego County, California.

Regional utilities plan to more than triple the renewable generation capacity by 2038, increasing the percentage of power generation from renewables to an estimated 70%. Delivering this plan requires regional utilities to persist the observed rate of increase for renewable capacity since 2020 for the next 15 years. A sustained rate of increase in renewable capacity, such as the one planned, has not been seen before in the historical record. Due to this rapid and sustained rate of change, regional electric utilities should expect and perhaps anticipate unforeseen challenges. Some potential challenges could include manufacturing lead times for renewable resource infrastructure, curtailment of solar resources without battery energy storage contingencies, and power delivery issues stemming from suboptimal transmission lines.

The projected percentage of generation from renewable sources is inherently uncertain. The value could change if one of the components going into the calculation is not realized in the future. For example, if the plans to install a significant amount of utility-scale solar or wind generation are not met or if total sales are different due to the status of the mine planned for Pima County in the 2030s. A similar analysis should be performed with updated information should any of these eventualities occur.

Recommendations

Rooftop solar

Despite the steady historical increase, rooftop solar remains an underused resource in Pima County. Though it presents a forecasting challenge for regional utilities, since demand is more complex to predict, rooftop solar is a resilient and reliable renewable generation source that has the potential to grow at the same pace as population and housing supply.

Developers of new houses in Pima County should be incentivized to install rooftop solar as part of the building process. Regional utilities should increase the number of existing houses that have rooftop solar installed, particularly in marginalized communities where affordability and access to rebate programs are more challenging.

Future additions to renewable and non-renewable generation

Fossil fuel additions, like the addition of a 400 MW natural gas plant, should be limited from a policy standpoint. Reserve power that can be deployed quickly can come from sources that reduce carbon dioxide emissions, such as hydrogen power or nuclear. However, these solutions will likely be less economically viable for regional utility companies. We must encourage power providers to no longer put profits before emission goals.

The rapid and sustained increase in renewable power generation should be coupled with a proportional battery energy storage capacity increase. Although plans to increase battery energy storage exist, questions about the adequacy of the planned increase remain. Battery energy storage is needed for renewable power generation to better fit consumer-driven power demand. And, if deployed on a sufficient scale, it can fill the need for fast-deployment reserve power.

Power for the mining industry

Pima County utility providers should be more transparent about plans to sell power to the mining industry and what generation sources will be used to satisfy that demand. Future/existing mining applications for the county should require a plan for their power supply that encourages the use of renewable resources. Mines in other counties in Arizona, e.g., Bagdad, Yavapai County, have co-located solar resources that supply power to the site.

References

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Eric Wilson, Pima County, Facilities
Lee Alter, TEP, Lead Resource Planner
Anita McNamara, Pima County, Senior Planner
Mark Holden, Pima County, Principal Planner

About the Author

Patrick Bunn, PhD
Senior Research Scientist
Lead, Power Forecasting Group
Expertise: I research improvements to solar and wind power forecasts developed for regional utility companies in the Southwest US. To enhance forecast accuracy, we use a combination of WRF modeling, post-processing, satellite data, and real-time telemetry from utility-scale power generation sites. We then integrate forecast developments into our operational forecast systems. Accurate and reliable power forecasts enable our regional utility sponsors to participate in the Western Energy Imbalance Market and help make better-informed decisions for site operations and management.

Catagories of Expertise: Atmospheric Modeling, Numerical Weather Prediction, Operational Forecasting for Solar and Wind Power Generation