Arizona Peaker Power Plants

Energy Storage Replacement Opportunities

Across Arizona, 17 gas- and oil-fired peaker power plants and peaking units at larger plants help meet statewide peak electric demand. These facilities include a mix of gas turbines designed to ramp up quickly to meet peak demand and steam turbine units which ramp up slowly but currently help meet peak demand as well. Both unit types are often located at the same plant. Many of these units are old—twelve are over 45 years old—and operated infrequently. Most are less efficient than similar plants nationwide. These features suggest that they may be good targets for replacement with energy storage and solar, demand response, solar or other clean alternatives. However, many of Arizona's peakers run for somewhat longer hours on average compared to peakers in other states, so their replacement may require a portfolio of clean energy resources, rather than shorter-duration batteries, in order to meet similar grid needs.

Many of Arizona's peakers have high rates of greenhouse gas and criteria pollutant emissions for every unit of electricity generated, and those with the largest total emissions of nitrogen oxides (an ozone precursor) frequently operate on days exceeding federal ozone standards. Moreover, Arizona's peaker plants are located disproportionately in Arizona's low-income and minority communities, where vulnerable populations already experience high levels of health and environmental burdens. The state has significant solar generation potential and has recently weighed policies to reduce peak grid emissions, which could support the adoption of solar+storage and other clean resources to replace inefficient, high-emitting peaker plants in vulnerable communities throughout the state.

Arizona State Policy and Regulatory Environment

Arizona has enacted policy targets to support clean energy adoption and emission reductions

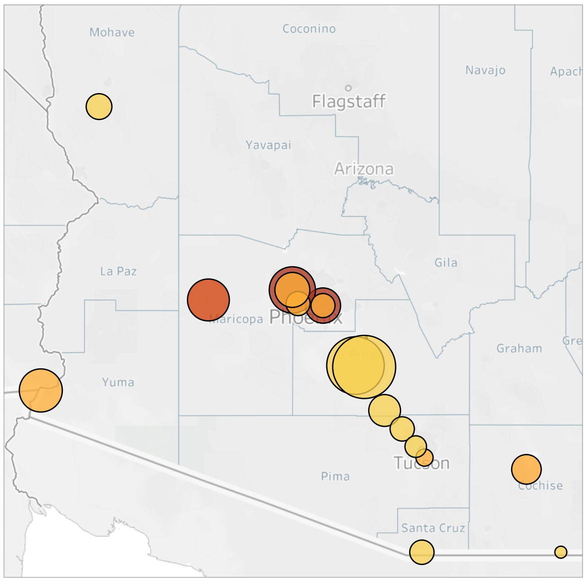

Figure 1: Peaker plants across Arizona

that could facilitate replacement of peakers with solar and storage. Key targets include:

- **2025:** 15 percent of electricity from renewables, including a third from distributed energy resources.
- **2040:** 50 percent reduction in greenhouse gas emissions below 2000 levels.

In recent years, the Arizona Corporation Commission (ACC) has considered higher renewable energy targets, an energy storage target, and the adoption of a Clean Peak Standard, the passage of which would support additional clean resource adoption. The ACC also defines load pockets which require local resources to meet local reliability needs, including Maricopa, Pima, Yuma, Mohave, Santa Cruz, Pinal and Cochise Counties. Of these, Maricopa, Pima, Cochise, and Santa Cruz counties all have peaking units which operate at very low capacity factors, suggesting opportunities for replacement with local clean alternatives. Two new peakers have been proposed in Arizona, but construction on both appears to be on hold.

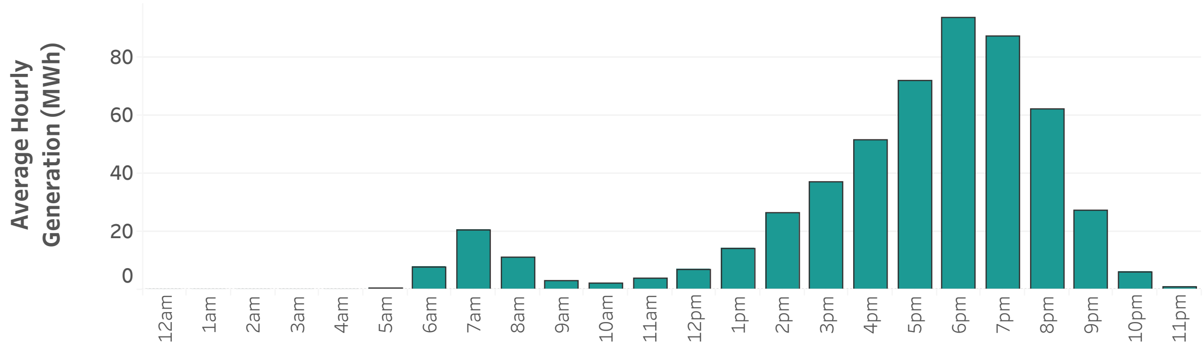

Figure 2: Average hourly generation from the Coolidge Generating Station. The plant's generation profile suggests it occasionally meets morning loads, ramps down as solar production increases midday, and ramps up to meet the late afternoon peak. Coolidge ran an average of 4.8 hours each time it started up between 2016 and 2018 and had a capacity factor of 2.6 percent. Batteries can serve a similar role on the grid.

Arizona Peaker Plants

Peak electricity demand in Arizona is partially met by 17 gas and steam turbine units, many of which are co-located at the same facilities. One unit is located at a coal plant. A number of factors may make these plants good candidates for replacement with energy storage, demand response, and other clean alternatives, including:

- **Aging:** Twelve are over 45 years old.
- **Inefficient:** Fourteen are less efficient than similar plant types nationwide, and one unit (Kyrene gas turbine) even reports consuming more electricity on site than it generates.
- **Infrequently used:** Eleven operate at a capacity factor less than 3 percent—that is, they generate 3 percent of the electricity that they would if they were running constantly at full power year-round (see **Figure 2**).

However, replacing Arizona's peaker plants may require additional considerations. While data is limited, the nine plants which report hourly generation tend to run longer each time they are turned on than peakers in other parts of the country. If this long-duration peak supply is required to meet grid needs, replacing these plants may require long-duration energy storage (more than four hours) or a portfolio of multiple clean resources. However, longer runtimes also appear correlated with plant age, suggesting Arizona's plants old, inflexible peaker plants do not respond quickly, leading to longer runtimes than required to meet peak demand. Further analysis is needed to assess local peak generation requirements. Additionally, replacing peaking units at larger facilities with energy storage may require careful consideration to ensure that emissions are effectively reduced. For example, replacing the Apache gas turbine unit with a battery that is charged with generation from Apache's coal unit will actually increase net greenhouse gas and criteria pollutant emissions. The deployment of combined solar+storage systems, either at utility scale or distributed, may help mitigate this risk.

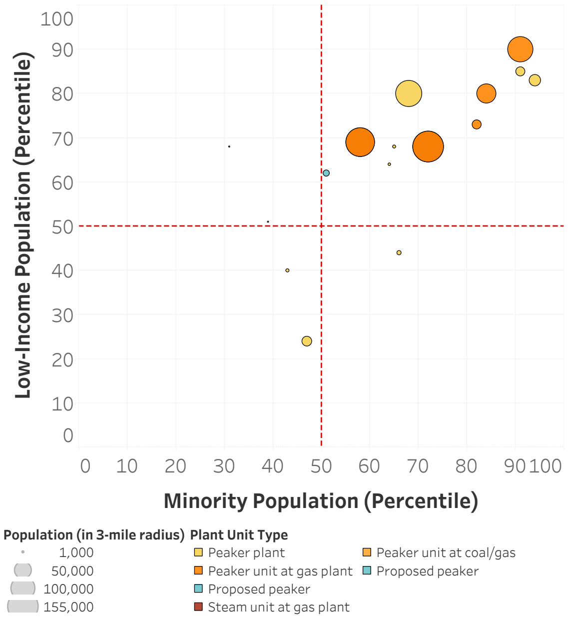

Figure 3: Arizona power plants are located in largely low-income and minority communities. Bubbles reflect population size. Axes mark state percentiles for low-income (double federal poverty limit) and minority populations living within three miles of each facility.

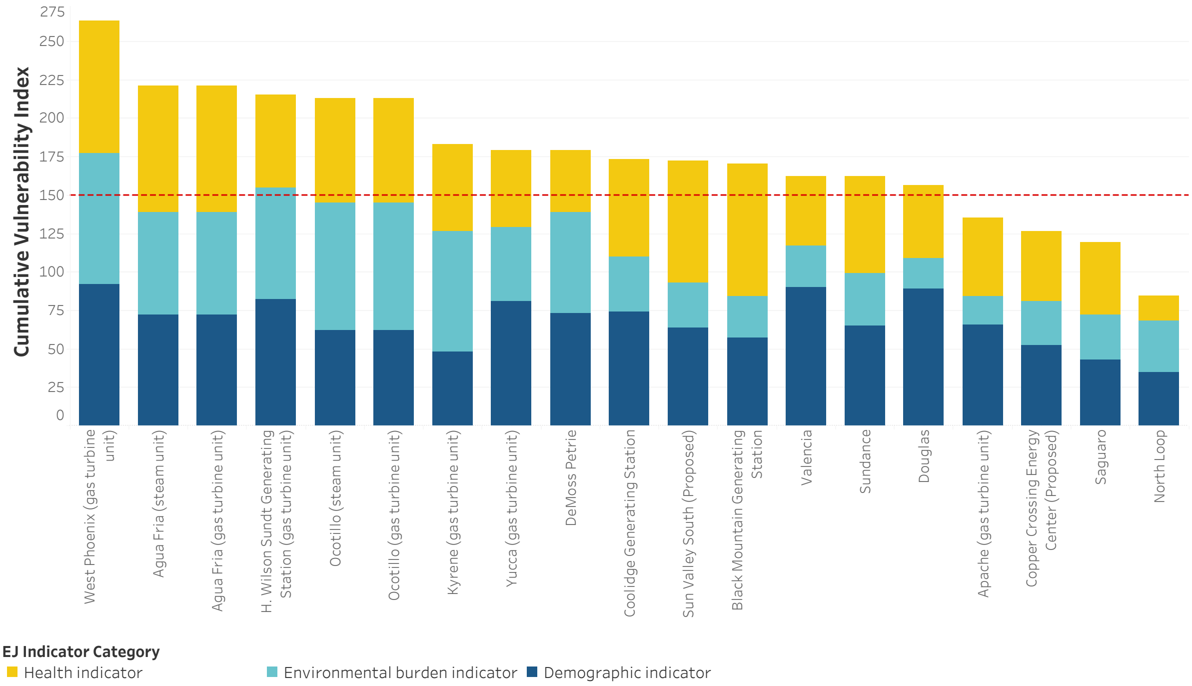

Figure 4: The cumulative vulnerability index reflects a set of environmental, human health and demographic indicators for populations living within three miles of each plant. The score is based on a comparison of indicators to statewide values: if a plant ranked at the median percentile for all indicators, it would score 150, which is indicated by the red dashed line.)

Nearby Populations

Arizona peaker plants are located in a mix of urban and rural areas, with populations in a three-mile radius ranging from nearly no one to more than 150,000 near the Agua Fria facility. Communities living within three miles of these plants tend to have disproportionately low-income and minority populations, particularly for the urban plants: communities near 13 plants are above the 50th percentile statewide for low-income populations (that is, they have more low-income households than half of Arizona census tracts), and communities near 14 plants are above the 50th percentile for minority populations (see **Figure 3**). Many communities also experience high cumulative exposure to environmental health burdens from numerous sources. We developed a cumulative vulnerability index that integrates data on health burdens (asthma, heart attacks, premature birth rates); environmental burdens (ozone, particulate matter, toxics, traffic proximity, lead paint, and hazardous facilities); and demographic indicators (low-income, minority, linguistically isolated, and non-high school educated populations). The cumulative vulnerability index for populations living within three miles of each facility is shown in **Figure 4**.

Emissions and the Environment

Arizona's peaker power plants burn primarily natural gas, which produces greenhouse gases as well as criteria pollutants like nitrogen oxides (NO_x). NO_x is a precursor to ozone and particulate matter formation. One plant burns primarily oil. Six units at four plants are located in the Phoenix-Mesa and Yuma regions, which are considered out-of-attainment for federal ozone standards; operation of these plants on hot summer days to meet air conditioning demands can exacerbate these poor air quality conditions. The highest total annual NO_x emissions come from two steam units co-located with gas peaking units (Ocotillo and Agua Fria). Both of these facilities have a larger total population living within a three-mile radius than the other Arizona plants, and both of the steam units generate more than 10 percent of their electricity on days when local ozone concentrations exceed federal standards.

Summary

Arizona peak demand is met by an aging fleet of peaker power plant units located disproportionately in the state's low-income and minority communities. The state's aging, inefficient and infrequently used facilities serving urban load pockets might be good candidates for replacement with cleaner alternatives. Replacement of these plants offers an opportunity to invest in distributed solar, storage and other resources in historically under-resourced communities. In the attached table, we provide operational, environmental and demographic data for Arizona peakers and nearby populations. Indicators such as nearby population, emission rates, heat rate (fuel used per megawatt-hour), operation on poor air quality days, capacity factor, and typical run hours can also inform whether a given plant might be a good target for replacement with storage or solar+storage. These data should be accompanied by engagement with affected communities to determine replacement priorities and strategies.

Arizona peaker plant operational and demographic data.
For methods see: www.psehealthyenergy.org.

	Plant description					Operation and emissions						Demographics (3-mile radius)			
Name (EIA ID)	**Status**	**County**	**Fuel**[1]	**MW**[2]	**Age**[3]	**Capacity factor**[4]	**Run hours/ start**[5]	**Heat rate**[6] MMBtu/ MWh	**CO_2 rate**[7] tons/ MWh	**NO_x rate**[8] lbs/MWh	**% MWh high ozone days**[9]	**Pop.**	**% non-white** (percen-tile)[10]	**% low-income** (percen-tile)[11]	**CVI**[12]
Agua Fria (gas turbine unit) (141)	Operating	Maricopa	Natural gas	223	45.2	0.1%	NA	31	1.8	13.3	NA	153,008	60% (72)	49% (68)	221
Agua Fria (steam unit) (141)	Operating	Maricopa	Natural gas	390	63	3.9%	11.5	10.6	0.6	3.9	14.4%	153,008	60% (72)	49% (68)	221
Apache (gas turbine unit)[13] (160)	Operating	Cochise	Natural gas	160	48	3.5%	8.1	10.9	0.6	0.3	1.7%	159	26% (31)	50% (68)	135
Black Mountain Generating Station (56482)	Operating	Mohave	Natural gas	121	12	6.2%	7.9	9.9	0.6	0.9	2.8%	2,950	54% (66)	30% (44)	170

[1]Primary fuel; many plants burn both natural gas and oil.
[2]Installed nameplate capacity (plant size).
[3]Age of oldest unit in 2020.
[4]Percent of time running as compared to running all year at full capacity.
[5]Average number of hours plant runs each time it is turned on.
[6]Heat rates are energy burned per unit of electricity generated; high heat rates reflect low efficiency.
[7]Direct carbon dioxide emissions per unit of electricity generated; does not include upstream emissions.
[8]Nitrogen oxides (NO_x) emitted per unit of electricity generated; NO_x contributes to ozone and particulate matter formation.
[9]Percent of generation on days nearby monitors record exceedances of federal ozone standards.
[10]Percentile minority population indicates percent of census tracts across the state with lower fraction of non-white populations.
[11]Percentile low-income population indicates percent of census tracts across the state with lower fraction of households below double the federal poverty limit.
[12]Cumulative Vulnerability Index combines state percentiles for demographic, health and environmental exposure indicators. A median on all values would score 150.
[13]Gas turbine unit at 660 MW coal and natural gas plant.

Coolidge Generating Station (56948)	Operating	Pinal	Natural gas	726	9	2.6%	4.8	9.8	0.6	0.1	6.3%	1,558	52% (65)	50% (68)	173
Copper Crossing Energy Center (58413)	Proposed; postponed	Pinal	Natural gas		NA	NA	NA	NA	NA	NA	NA	6,344	39% (51)	44% (62)	126
DeMoss Petrie (124)	Operating	Pima	Natural gas	85	19	1.0%	4.7	13.8	0.8	0.5	0.8%	110,698	56% (68)	61% (80)	179
Douglas (114)	Operating	Cochise	Oil	26	48	0.1%	NA	31.3	2.5	28	NA	13,424	90% (91)	68% (85)	156
H. Wilson Sundt Generating Station (gas turbine unit) (126)	Operating	Pima	Natural gas	54	48	2.4%	NA	12.3	0.7	5.3	NA	59,658	80% (84)	61% (80)	215
Kyrene (gas turbine unit) (147)	Operating	Maricopa	Natural gas	174	49	0.0%[14]	NA	NA	NA	NA	NA	124,268	42% (55)	27% (39)	183
North Loop (6088)	Operating	Pima	Natural gas	108	48	0.4%	NA	12.2	0.7	3.9	NA	15,403	36% (47)	19%(24)	84
Ocotillo (gas turbine unit) (116)	Operating; repowering	Maricopa	Natural gas	106	48	1.7%	NA	21.7	1.3	4.5	NA	133,271	44% (58)	50% (69)	213
Ocotillo (steam turbine unit) (116)	Operating; repowering	Maricopa	Natural gas	227	60	10.2%	14.9	12.2	0.7	1.5	10.6%	133,271	44% (58)	50% (69)	213
Saguaro (118)	Operating	Pinal	Natural gas	185	48	2.5%	5.9	12.1	0.7	0.5	1.3%	1,701	33% (43)	28% (40)	119
Sun Valley South	Proposed; postponed	Maricopa	Natural gas	320	NA	NA	NA	NA	NA	NA	NA	171	30% (39)	35% (51)	172
Sundance (55522)	Operating	Pinal	Natural gas	605	18	6.3%	6.8	11.4	0.7	0.2	0.9%	1,122	51% (64)	46% (64)	162

[14] Kyrene gas turbine unit reports net negative generation between 2016 and 2018, meaning it consumes more electricity on site than it provides to the grid.

Valencia (6515)	Operating	Santa Cruz	Natural gas	108	31	0.2%	NA	15.7	0.9	4.8	NA	21,014	95% (94)	65% (83)	162
West Phoenix (gas turbine unit) (117)	Operating	Maricopa	Natural gas	106	48	1.7%	NA	22.2	1.3	0.3	NA	103,381	90% (91)	72% (90)	263
Yucca (gas turbine unit) (120)	Operating	Yuma	Natural gas	338	49	4.9%	7.4	11.3	0.7	0.1	1.5%	13,381	77% (82)	53% (73)	179