Peak time to take action

Peaker plants | In the hierarchy of grid needs, peaking power is often a priority in terms of providing resiliency and balance to the network. This is usually provided by natural gas turbines, which come at a high environmental and economic cost. Andy Colthorpe charts the rise of the solar-plus-storage peaker plant

What on earth can we do? The sense of frustration and fear felt right now over climate change – where it seems like half of the world now believes science to be some sort of political conspiracy – is understandable.

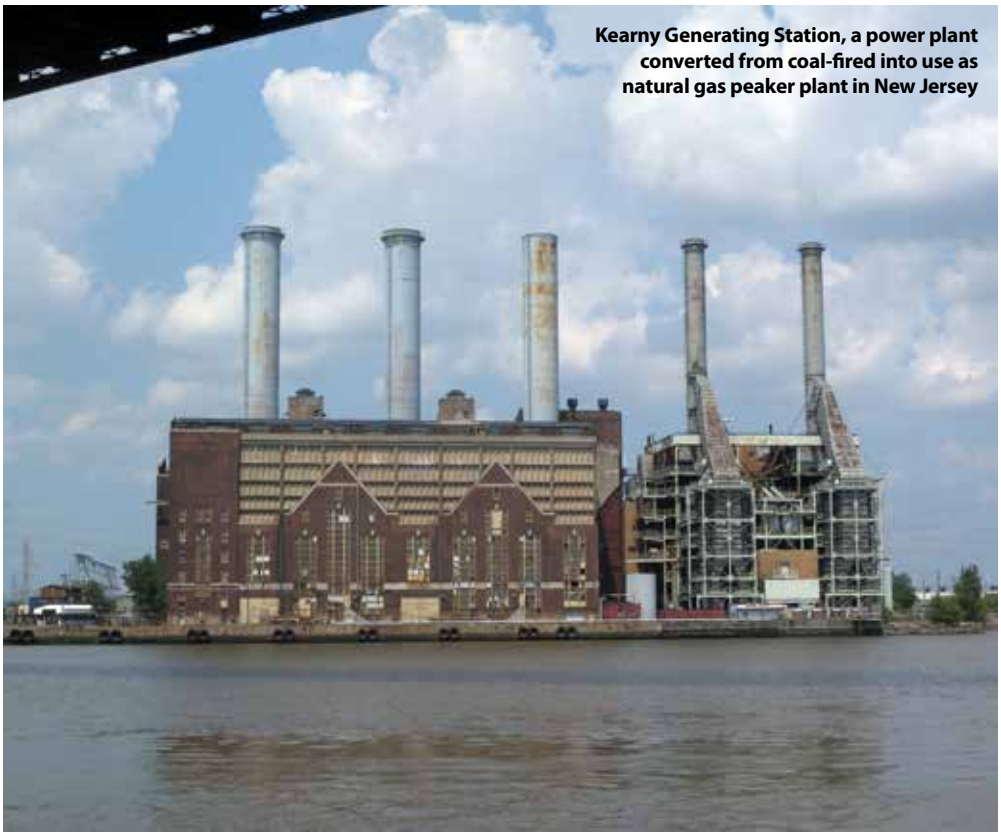
Unfortunately, as much as we've become aware that technical solutions to humanity's biggest existential challenges exist and the will to deploy them is strong, the existential threat to the fossil fuel industry appears to be more of a priority for some.

In the 'Solar Briefing 2019', Volume 17 of *PV Tech Power*, we wrote that energy storage arrives on the electricity network to fill niches as they become economically viable and/or unobstructed by policy and regulation. Mandates and support schemes to deploy energy storage have given huge kick-starts to the industry in the likes of the US and Australia, where governments – often regional rather than national – recognise the technology as vital for a high renewable penetration electricity mix.

At the moment, other front-of-meter opportunities to use a combination of energy storage and renewables to displace fossil fuel usage have to be based on meeting grid needs and expected demand. In some cases this can provide merchant opportunities, as in the case of providing peaking power to grids, mostly done with natural gas peaker plants.

Natural gas is of course not as bad as coal, but not as good as renewables. Nonetheless, many would still have it that there is a need for peaking capacity that can grow with renewable penetration and as the so-called baseload provided by coal is retired. Peaker plants are only fired up for perhaps less than 20% of their operating lifetime, but they are at their most polluting in the period during which they ramp up, spewing pollutants and greenhouse gases (GHGs) into the air. Solar-plus-storage is now starting to fill that niche.

"There's good reason to think that's an extremely competitive combination," says Alex Morris of Strategen Consulting.



Kearny Generating Station, a power plant converted from coal-fired into use as natural gas peaker plant in New Jersey

Credit: Wikimedia user: Jim Henderson

"Certainly it may depend on the grid needs and the timing of those needs and so on. But I think it's great…and the prevalence of how these things are being deployed is a good market signal."

Transition signals

We could have as little as 10 to 12 years left to arrest the most catastrophic global warming scenarios. It may already be too late. Yet it simply isn't possible to take every fossil fuel generator offline immediately, for a number of reasons. It's not that it isn't technically feasible, we just know that it's not going to happen for economic – and increasingly – political reasons. However, in a webinar hosted last summer by the US Clean Energy Group's Resilient Power Project, Elena Krieger of Physicians, Scientists and Engineers for Healthy Energy said that peaker plants are perhaps the most obvious candidate for immediate replacement.

Natural gas peaker plants do not pollute all of the time, because they do not run all of the time. As the name implies, they run when the network experiences a peak in demand and there is not enough generation to meet that demand. However, when they are running, they are among the dirtiest power plants of all, particularly when they start up, shut down or during ramping. For this and, as we will see later, for reasons of economics, Tom Buttgenbach, CEO of US solar developer 8minutenergy has become a fierce advocate of 'solar peaker plants'.

"The reductions in GHG emissions are tremendous. One point that folks often overlook if you look at a gas peaker is what kind of emissions a gas peaker actually produces as you fire them up," Buttgenbach says.

Credit: AES.

AES' Lawai Solar project in Hawaii delivers dispatchable solar energy into the evening peak using battery energy storage at just US$0.11 per kWh

"We all know the numbers of a combined cycle gas turbine (CCGT) are roughly half of a coal plant in carbon emissions per megawatt hour, but that's not true when you fire them up. Gas peakers' emissions profile is pretty bad. Especially in the ramp-up, they run kind of 'dirty' like a cold car engine does until the catalytic converter comes up to temperature."

Economics is the kicker here

"On certain days you need resources that can help to get those last increments of power to meet customers' needs. We call that peaking power. You can have solar and storage provide that and completely offset the need for other, more traditional resources like what we call peaker plants," Strategen's Alex Morris says.

As coal plants become an ever-diminishing contributor to the grid and renewables penetration increases, the need for peaking power increases. Natural gas turbines have been considered the easiest and quickest way to provide that power, which tends to only fall on short and infrequent periods of a couple of hours spread sometimes across weeks or months but nonetheless put extreme demand on constrained grids.

When the grid is "stressed" in sunny parts of the US such as California or Texas, Buttgenbach says, the high penetration of solar has started to make life difficult for gas peaker plant operators. Peak demand during the daytime is now covered by an abundance of solar. So where a gas peaker might in the past have had an eight hour window during which it might be called upon, it now only has a window of around 5pm until 9pm – a much shorter time during which to earn its living.

"That means their utilisation has gone down, that means their cost goes up per megawatt hour and there are quite a lot of fixed costs like O&M and staff that have to be amortised over a shorter time. So their costs keep going up, our costs keep coming down with solar technology," Buttgenbach says.

"However, to fill that evening peak, we need storage. You start looking at the economics and power prices in that evening peak can be very high, just because these peakers, typically gas peakers, are now pushed into a shorter period to recover their fixed costs. So pricing levels can be well over US$100 per MWh and we can build a solar plant with a four hour battery to service that peak – we can build that somewhere in the US$50 to US$60 per MWh range."

The big squeeze

Emitting both carbon dioxide and nitrogen oxide, gas turbine peakers are an unfortunate relic of the fossil fuel era that won't go away quietly. But as Buttgenbach points out, a battery storage system, able to ramp up in milliseconds, can outperform a gas peaker which at best is likely to take a few minutes, minimum. Long term, that will mean the economics are safely hedged against the rising price of natural gas. As we went to print with this edition the US announced more open LNG export policies which could exert upward pressure on gas prices domestically, while solar-plus-storage projects have free fuel for the duration of their lifetime and lower O&M costs too.

"The squeeze gets harder and harder for those gas peakers; as you have more solar-plus-storage coming online, that squeezes them even more and it's also going to start depressing the price points, so eventually, even the existing plants will be replaced. It's kind of a death spiral. The economics are just dying for those peakers," Buttgenbach says.

Even if the environmental benefits are not yet being valued as highly as we might hope for, batteries can meet or exceed technical performance criteria and still win on economics. In a competitive, open solicitation process last year, utility Arizona Public Service (APS) awarded a 15-year power purchase agreement (PPA) to First Solar for a 50MW/135MWh battery energy storage system combined with 65MW of PV.

Not only did it outdo its competitors on price, but in that instance all project proposals submitted to APS had to guarantee the dispatch and availability of power during the afternoon to evening peak, from 3pm to 8pm each night. APS was clear that its selection of the First Solar tender was also partly a hedge against gas price volatility as well as an opportunity to diversify its portfolio.

It seems regulators increasingly 'get it', too. California utility Pacific Gas & Electric (PG&E) in November last year saw a proposal approved by the state Public Utilities' Commission to replace three gas peaking power plants with four lithium-ion battery storage systems, including the 300MW/1,200MWh (four hours) Vistra Moss Landing project.

The solar-plus-storage solution still pencils out best in sunnier locations of the US, but overall there is something like 120GW of peaker plant capacity online in the country, including 3GW of ageing peakers in New York alone. Some of the fleet runs on oil or a combination of gas and oil, even more polluting and expensive than gas peakers alone, particularly for nitrogen oxide emissions. Reciprocating internal combustion engine (RICE) turbines meanwhile, the 'cleanest' generators of electricity from gas, are not cost-effective at scale for peaking capacity applications either. It is not simply hoped that the domino effect will bring the economic proposition of solar peakers from sunny states to the rest of the country; according to Tom Buttgenback, it is instead an inevitability.

"For over 100 years, power plant operators and grid planners have looked to their 'toolkit' to build solutions that keep the lights on for everybody. It's very true to say that solar-plus-storage is now clearly a resource that can be considered and it's more and more included in that 'toolkit'," Strategen's Morris says.

Storage-plus…. gas?

One technical alternative that always elicits controversy is batteries-plus-natural gas. An existing gas peaker can be hybridised with a battery to improve its efficiency and drastically reduce the number of times it has to start or ramp up and similarly reduce the time it takes when it does.

In light of global warming in particular, the smartest solution for the transformation of the electric grid's fleet of generation capacity would be as aggressive in its pursuit of renewables goals as possible, Alex Morris argues. In practical reality, that's not what we would expect to see. Some of the existing plants are tied not only to already sunken costs borne by ratepayers; others have a kind of protected 'must run' status due to their accepted role in keeping the lights on.

"A lot of money has been spent to build the grid and the fleet that we currently have. It's prudent to consider how best to evolve that fleet and grid," Morris says.

In some cases this will mean the retirement of ageing peakers and replacing them with solar-plus-storage peakers, which can also provide energy capacity to the grid at other times and provide ancillary services too. In other cases, where it is too expensive to retire an ageing peaker, hybridisation may be a better option than business-as-usual.

"I don't think there's a single general rule about it. You generally want to be aggressive but also cost-conscious as you pursue this grid transformation," Morris says.

Yet even switching on a gas turbine comes at a price every time from an O&M perspective, and, as Tom Buttgenbach points out, "folks in the gas peaker business are not in the natural gas business, they're in the business of servicing peaks".

A battery might even enable peaker plant operators to catch the very short but higher value peaks that gas cannot. Solar prices continue to tumble even in lower irradiance markets of the world and battery prices – including longer duration solutions such as flow batteries – are coming down in price too on a continual basis.

"At some point you're going to have the question of why do you have the gas peaker, sitting there," Buttgenbach says.

"The [short-term] reality is you already have the interconnection and all of the permits so it makes it a lot easier to participate in the market with the battery. But in the long term I wouldn't think of them as gas peakers, I would think of them as a gas peaker converted to a battery."

Inaction threatens existence

Due to their very nature as assets that serve loads quickly and locally to meet network demand, peaker plants are often also located in more densely populated areas than other types of thermal power plant. This means storage, charged by clean energy, can have positive impacts on air pollution for those populations too.

Unfortunately not every jurisdiction has policy makers and regulators able or willing to price externalities, and widespread enforcement of the polluter-pays principle or carbon pricing mechanisms still seem like some way off. We can only hope it becomes more widely recognised that, as Morris says, the cost of inaction on global warming is far more expensive than the cost of action:

"It's unfortunate that there are still parties that have a hard time evaluating the science on that because really, if you're being smart, you would try to work with the science and then look at the least-cost path forward and no action is extremely expensive. Because of all the global warming side effects, it's sub-optimal to allow that to go on."

In the same auction last year in which Nevada utility NV Energy brokered a PPA for Battle Mountain (101MW PV, 25MW/100MWh battery storage), a project to replace natural gas peaking capacity, to Cypress Creek Renewables, 8minutenergy was awarded a deal for the 300MW standalone Eagle Shadow Mountain. Eagle Shadow Mountain came in at US$23.76 per megawatt hour, locked in for 25 years, while Battle Mountain's levelised cost of energy (LCOE) also competed and won at US$30.94 per megawatt hour. The existential threat to the fossil fuel industry appears to be real after all, and peakers are next in the firing line. ■

Utility Arizona Public Service decided that the advantages of battery energy storage include a hedge against fossil fuel price volatility

Credit: APS