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Environment

US hydropower generation set to fall as climate gets drier

Alec Luhn

HYDROPOWER generation in the western US may fall by as much as 20 per cent by 2050 due to global warming, even as electricity demand increases.

Snowy peaks are called the "water towers" of the western US because their meltwater feeds its rivers through the hot summer. But as temperatures rise, leading to less snow and more evaporation, stream flow will decrease across most drainage basins.

That could result in up to 20 per cent less electricity generation by dams annually and up to 30 per cent less in the summer, according to a model developed by David Yates at the National Center for Atmospheric Research in Boulder, Colorado, and his colleagues (*Earth's Future*, doi.org/mctm).

At the same time, water-related electricity use will increase by up to 4 per cent each year and 6 per cent in the summer, largely because farmers will have to pump more groundwater for irrigation. That is in addition to the higher summer electricity demand for air conditioning already expected.

"We see the whole Western Interconnect [power grid] on the electricity side responding to the push or the tension that the water sector will place upon it," says Yates.

Currently, the reservoirs behind the Glen Canyon and Hoover dams are barely a third full because cities and farms continue to extract too much water from the Colorado river, a problem compounded by the worst megadrought in 1200 years.

The study shows that the shift away from fossil fuels planned by several western US states could be more difficult than anticipated, because the traditional stopgap for falls in hydropower or surges in demand is to use natural gas, says Jordan Kern at North Carolina State University.

Astrophysics

The sun could contain a tiny black hole that formed in the big bang

Alex Wilkins

STARS could have tiny black holes hiding inside them that were formed during the big bang. This idea, first dreamed up by Stephen Hawking, might also explain the origins of dark matter, researchers have found.

In 1971, physicist Hawking was looking at a problem involving an apparent lack of high-energy particles coming from the sun. He wondered whether this so-called solar neutrino problem could be solved if the sun hosted a small black hole that formed at the start of the universe, known as a primordial black hole. Some astronomers took the idea further, but when this neutrino problem was solved in a different way in 2001, interest in black hole-hosting stars died out.

Now, Earl Bellinger at the Max Planck Institute for Astrophysics in Germany and his colleagues have revived the idea as a possible explanation for dark matter, and calculated what effects primordial black holes of different masses might have on the evolution of their host star.

If there is a black hole inside the sun, it would affect our star's activity

For our sun, Bellinger and his team ruled out black holes with masses smaller than a typical asteroid because these wouldn't grow or have measurable effects. They also ruled out those larger than the sun itself, as these would rapidly eat up their star. This left black holes with about the mass of the planet Mercury or larger, which would accrete matter and grow, but not too quickly (*The Astrophysical Journal*, doi.org/mcpm).

~500

Number of "red stragglers" that may show signs of black holes

Such a black hole that is sucking up the sun's fuel from the inside would make the star grow by producing powerful light that pushes out its outer layers. This would, over millions of years, cool the temperature below that needed for nuclear fusion, which is the reaction that keeps a star stable, says Bellinger.

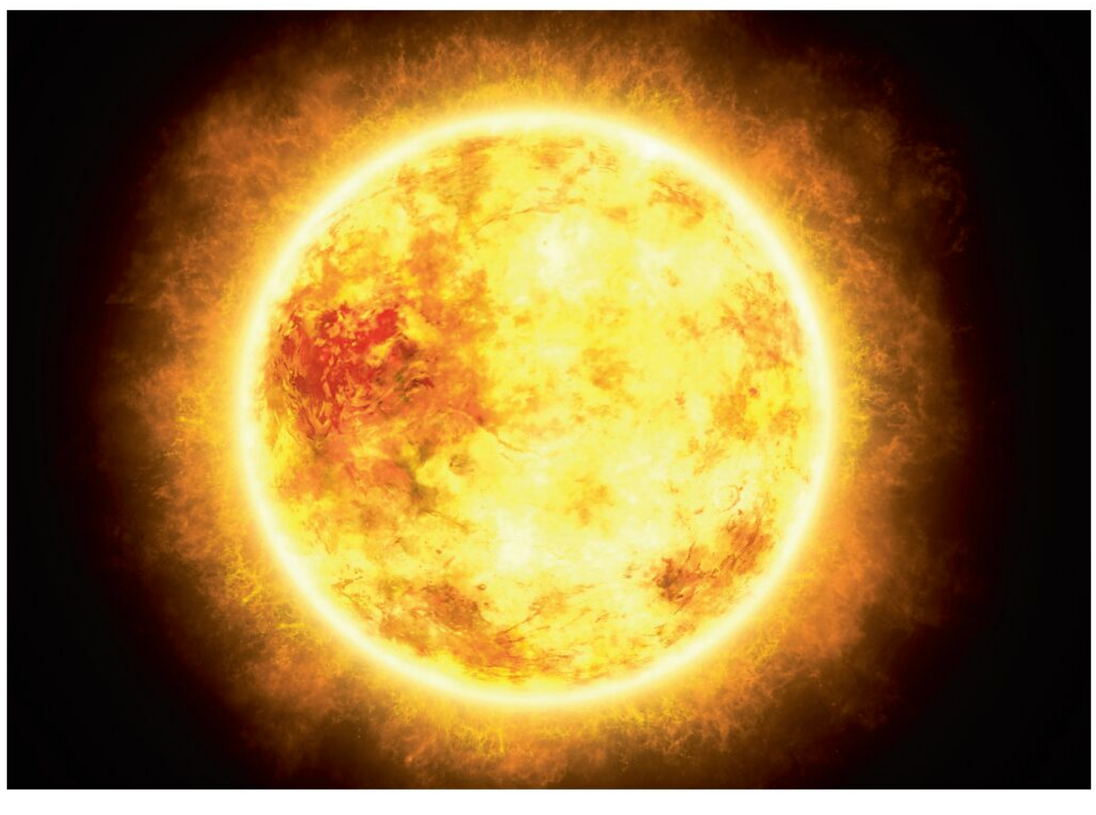
The cooling effect would cause the entire star to become tumultuous and chaotic, like a pot of boiling water. It would ultimately turn into a rare kind of unusually cool star called a red straggler. A black hole at the centre of a red straggler would also make it pulsate in a unique way – a signature that Bellinger hopes to now look for in the 500 or so red stragglers we currently know of.

The fact that black hole-hosting stars would pulse in this way means it is unlikely that our sun is one, because we would have already seen this signature, but it isn't impossible.

A black hole small enough to create a hard-to-spot signature could still affect the sun's evolution, says Bellinger. Such a black hole would lower the sun's temperature, saving Earth from being engulfed by our star when it eventually runs out of fuel and turns into a normal red giant. However, it would still get hot enough to boil off Earth's oceans and kill all life.

If we do find other stars hosting primordial black holes, then they could help explain dark matter, which is what is thought to cause the otherwise unaccounted for gravitational effects we see in the universe, such as galaxies rotating faster than expected based on the influence of visible matter alone. If black holes are hiding in stars, their extra mass could go some way to explaining this effect, says Bellinger.

Although such stars could theoretically explain dark matter, says Paulo Montero-Camacho at Tsinghua University in China, there is a large assumption in the work, which is that stars can grab primordial black holes in the first place. "It's difficult for a star to actually capture primordial black holes, since they are so tiny and move so fast," he says.



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