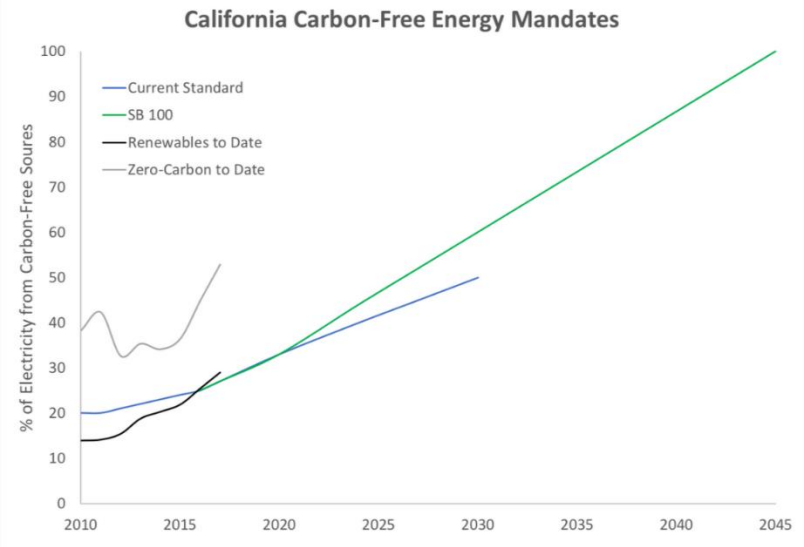
the weekly anthropocene

dispatches from the wild, weird world of humanity and its biosphere

By Sam Matey



USA: California. In a landmark moment in the fight against climate change, California's legislature has passed SB 100, a bill requiring the Golden State to generate 100% of its electricity from carbon emissions-free energy (renewables plus nuclear) by 2045. (The bill still needs Governor Jerry Brown's signature, but given that Brown is known as a world leader on climate action, this is almost certain to occur within the next few weeks). It is not an exaggeration to say that this is by far the most substantive legislative measure to address climate change in history. If California was its own nation, it would be the world's fifth-largest economy, behind only China, Japan, Germany, and the United States. Their setting this ambitious (yet eminently reachable) target is an example to the world, and will make California a world hub of renewable energy technology. While the Trump Administration works to roll back fuel efficiency standards and prop up the dying coal industry (stories we are not currently covering, as both will entail prolonged court battles that would require near-constant updates), California is leading the way. As ex-California Governor Arnold Schwarzenegger, a supporter of the bill, said on Twitter: "We are Californians. We don't wait. We build the future economy here." This is absolutely spectacular news. Thanks to the Guardian for the awesome graph. For more, check out goo.gl/Az87kV and goo.gl/FBdahp.

New Inventions: Engineered Sand. Engineers from the University of California at Berkeley have created a mineral-coated sand that removes pollutants from stormwater runoff. The sand is created by coating regular sand with two forms of manganese, which react with air to form manganese oxide, a nontoxic compound that destroys organic pollutants. "Our coated sands represent an inexpensive, new approach that can remove many of the contaminants that pose risks to groundwater systems where storm water is being infiltrated," said Joseph Charbonnet, UCB graduate student and leader of the project. The sand loses its effectiveness over time, but can be quickly and easily "recharged" by the addition of a weak solution of chlorine. Running polluted stormwater through this sand could transform a liability into a new source of pure drinking water. This is a spectacular new invention that has the potential to serve as a vital water purification tool around the world. Great work! For more, see goo.gl/cjeSSo.

Peru. A new species of tarantula has been discovered in the Peruvian Andes. *Hapalotremus vilcanota* is less than two inches long, lives at the highest elevation ever recorded for a tarantula, and is described as very beautiful, with fuzzy blond legs, a black body, and a red spot on its back. Another addition to our knowledge of Earth's amazing wildlife! For more, see goo.gl/4xq4pk.

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Science Spotlight #1: Photosynthesis. As this writer begins the Fall 2018 semester at the University of Southern Maine, this newsletter is incorporating a new education-focused feature: the weekly Science Spotlight. These articles will describe a science-related concept, person, event, or object in non-technical terms for the benefit of the general public. Our first Science Spotlight focuses on one of the most ubiquitous and vital biological processes in the world: photosynthesis. (New terms first appear in italics).

$$\underset{\text{Carbon dioxide}}{6CO_2} + \underset{\text{Water}}{6H_2O} \xrightarrow{\text{Light}} \underset{\text{Sugar}}{C_6H_{12}O_6} + \underset{\text{Oxygen}}{6O_2}$$

On the face of it, photosynthesis is a miracle. It's a biological method, used by plants, algae, and some bacteria, of transforming solar energy into chemical energy, or, as acclaimed science writer Oliver Morton puts it, eating the sun. This is one of the niftiest tricks on Earth, and without it, neither we nor the vast majority of other multicellular life forms would be here. Photosynthesis first evolved in *cyanobacteria* well over two billion years ago (the exact time is highly disputed), when the only life-forms on earth were single-celled organisms. It quickly became their killer app, opening up a vast new source of energy that enabled the evolution of the vast diversity of plant life we see today. The simplified chemical equation for photosynthesis (above right) shows why: it only requires some widely available basic components. Carbon dioxide and water enter the plant, and light turns them into sugars that the plant uses for energy (glucose, in the equation, represents a plethora of sugars including starches, carbohydrates, and more). The "waste product" is oxygen, which, as it turned out, enabled the evolution of a whole new kingdom of life, the animals, all of which survive by breathing this plant exhaust. Without photosynthesis, almost none of the life we're familiar with would exist today.

Photosynthesis takes place in *chloroplasts*: descendants of those original photosynthesizing bacteria that live symbiotically in plant and algae cells. It has two basic components, the *light reactions* and the *Calvin cycle*. The light reactions take place in structures within the chloroplast called *thylakoids*, which contain a light-capturing molecule called *chlorophyll*. That molecule absorbs violet, blue, and red light to use in photosynthesis, and reflects green light: this is the reason plants appear green. The light reactions use light energy to convert water, plus a bunch of extra nutrients like nitrogen and phosphorus (the stuff we add in fertilizer) into energy-storing molecules like ATP and NADPH. Their by-product is oxygen. The ATP and NADPH then leave the thylakoids and go through the Calvin cycle (a long and complex chemical process outside the scope of this article) in the rest of the chloroplast. The Calvin cycle adds carbon dioxide, gathered from the air, to these molecules to create a variety of sugars used for everything from energy storage (the purpose of sucrose, which we use as common table sugar) to building material for cell walls (the purpose of cellulose, the major constituent of paper). One interesting takeaway here is that the majority of the mass of most of these sugars comes from the carbon and oxygen in carbon dioxide. This means that majority of the mass of a plant comes not from water or soil, but from air. With that amazing thought, this Science Spotlight ends. Thank you for reading!