

Ammonia—a renewable fuel made from sun, air, and water—could power the globe without carbon

By [Robert F. Service](#) Jul. 12, 2018 , 2:00 PM

SYDNEY, BRISBANE, AND MELBOURNE, AUSTRALIA—The ancient, arid landscapes of Australia are fertile ground for new growth, says Douglas MacFarlane, a chemist at Monash University in suburban Melbourne: vast forests of windmills and solar panels. More sunlight per square meter strikes the country than just about any other, and powerful winds buffet its south and west coasts. All told, Australia boasts a renewable energy potential of 25,000 gigawatts, one of the highest in the world and about four times the planet's installed electricity production capacity. Yet with a small population and few ways to store or export the energy, its renewable bounty is largely untapped.

That's where MacFarlane comes in. For the past 4 years, he has been working on a fuel cell that can convert renewable electricity into a carbon-free fuel: ammonia. Fuel cells typically use the energy stored in chemical bonds to make electricity; MacFarlane's operates in reverse. In his third-floor laboratory, he shows off one of the devices, about the size of a hockey puck and clad in stainless steel. Two plastic tubes on its backside feed it nitrogen gas and water, and a power cord supplies electricity. Through a third tube on its front, it silently exhales gaseous ammonia, all without the heat, pressure, and carbon emissions normally needed to make the chemical. "This is breathing nitrogen in and breathing ammonia out," MacFarlane says, beaming like a proud father.

Companies around the world already produce \$60 billion worth of ammonia every year, primarily as fertilizer, and MacFarlane's gizmo may allow them to make it more efficiently and cleanly. But he has ambitions to do much more

than help farmers. By converting renewable electricity into an energy-rich gas that can easily be cooled and squeezed into a liquid fuel, MacFarlane's fuel cell effectively bottles sunshine and wind, turning them into a commodity that can be shipped anywhere in the world and converted back into electricity or hydrogen gas to power fuel cell vehicles. The gas bubbling out of the fuel cell is colorless, but environmentally, MacFarlane says, ammonia is as green as can be. "Liquid ammonia is liquid energy," he says. "It's the sustainable technology we need."