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OP-ED

How Seawater Can Power the World

By STEWART C. PRAGER
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DEBATE about America's energy supply is heating up: gas prices are rising, ethanol is under attack and nuclear power continues to struggle in the shadow of the Fukushima disaster in Japan.

But an abundant, safe and clean energy source once thought to be the stuff of science fiction is closer than many realize: nuclear fusion. Making it a reality, however, will take significant investment from the government at a time when spending on scientific research is under threat.

Harnessing nuclear fusion, the energy that powers the sun and the stars, has been a goal of physicists worldwide since the 1950s. It is essentially inexhaustible and it can be created using hydrogen isotopes — chemical cousins of hydrogen, like deuterium — that can readily be extracted from seawater.

Fusion energy is created by fusing two atomic nuclei, in the process converting mass to energy, which appears as heat. The heat, as in conventional nuclear fission reactors, turns water into steam, which drives turbines to generate electricity, or is used to produce fuels for transportation or other uses.

Fusion energy generates zero greenhouse gases. It offers no chance of a catastrophic accident. It can be available to all nations, relying only on the Earth's oceans. When commercialized, it will transform the world's energy supply.

There's a catch. The development of fusion energy is one of the most difficult science and engineering challenges ever undertaken. Among other challenges, it requires production and confinement of a hot gas — a plasma — with a temperature around 100 million degrees Celsius.

But potential solutions to these daunting technical challenges are emerging. In one approach, known as magnetic fusion, hot plasma is confined by powerful magnets. A second approach uses large, intense lasers to bombard a frozen pellet of fusion fuel (deuterium and tritium nuclei) to heat the pellet and cause fusion to occur in a billionth of a second. Whereas magnetic fusion holds a hot plasma indefinitely, like a sun, the second approach resembles an internal combustion engine, with multiple mini-explosions (about five per second). Once a poorly understood area of research, plasma physics has become highly developed. Scientists not only produce 100 million-degree plasmas routinely, but

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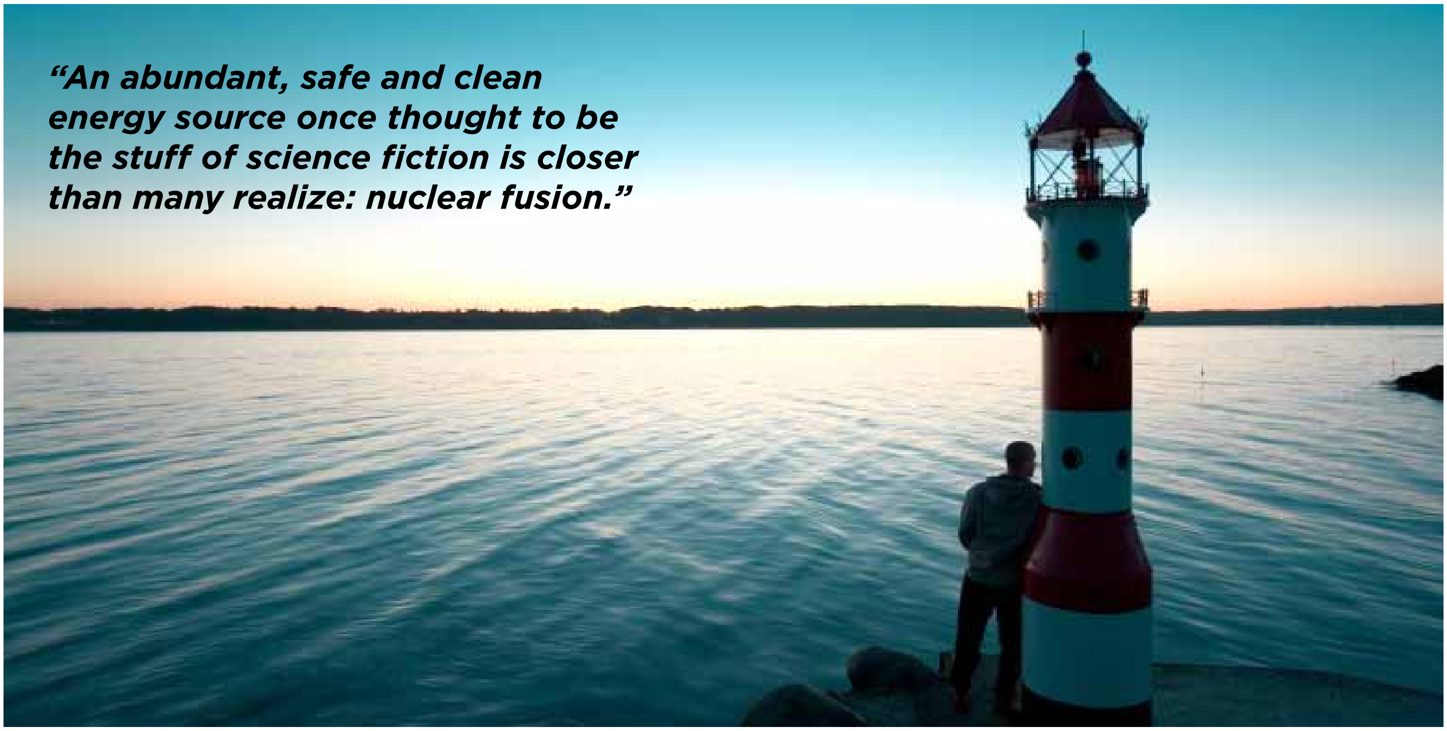

they control and manipulate such "small suns" with remarkable finesse. Since 1970 the power produced by magnetic fusion in the lab has grown from one-tenth of a watt, produced for a fraction of a second, to 16 million watts produced for one second — a billionfold increase in fusion energy.

Seven partners — the European Union, China, India, Japan, Russia, South Korea and the United States — have teamed up on an experiment to produce 500 million watts of fusion power for 500 seconds and longer by 2020, demonstrating key scientific and engineering aspects of fusion at the scale of a reactor.

However, even though the United States is a contributor to this experiment, known as ITER, it has yet to commit to the full program needed to develop a domestic fusion reactor to produce electricity for the American power grid.

Meanwhile other nations are moving forward to implement fusion as a key ingredient of their energy security. Indeed, fusion research facilities more modern than anything in the United States are either under construction or operating in China, Germany, Japan and South Korea. The will and enthusiasm of governments in Asia to fill their energy needs with fusion, as soon as possible, is nearly palpable.

What has been lacking in the United States is the political and economic will. We need serious public investment to develop materials that can withstand the harsh fusion environment, sustain hot plasma indefinitely and integrate all these features in an experimental facility to produce continuous fusion power. This won't be cheap. A rough estimate is that it would take $30 billion and 20 years to go from the current state of research to the first working fusion reactor. But put in perspective, that sum is equal to about a week of domestic energy consumption, or about 2 percent of the annual energy expenditure of $1.5 trillion.

Fusion used to be an energy source for my generation's grandchildren; now, plans across the world call for a demonstration power plant in about 20 years. Fusion has the potential to help with all the emerging challenges of this still-new century: energy independence, national economic competitiveness, environmental responsibility and reduction of conflict over natural resources. It is a litmus test for the willingness of our nation to tackle the tough challenges that will shape our future. Scientists and engineers stand ready to help.

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