operated submarine vehicle. Then, after further miniaturization—in three months the electronics package went from the size of a lunch box to half the size of a business card—the detectors were ready for mass production, enabling a myriad of remote field capabilities.

The safety benefit of lighthouse detectors for automated mapping of complex sites is twofold. First, the time and amount of exposure are minimized because the detectors can quickly zero-in on the location of a source. Second, dangerous tasks—like entering a site after an event, which can include physical instability, cumbersome maneuvering in radiation suits, and eventual fatigue—can be exchanged for less dangerous tasks, like sitting in a control booth a safe and comfortable distance away, controlling a HAZMAT robot carrying lighthouse detectors.

In keeping with the noble job of their namesake, lighthouse detectors cast their gaze into the darkness, helping to keep people out of harm's way.

—Eleanor Hutterer

Megapower

Imagine an electrical power plant small enough to be delivered by truck, simple enough to be fully operational in a few days, and energetic enough to power a small town for a decade or more without refueling. It can provide electricity to remote communities, hardware installations, and deployed military bases. It can protect critical infrastructure like hospitals from reliance on the electrical grid. It runs with minimal moving parts, continuously self-regulates to match changing electrical demand, and produces zero greenhouse-gas emissions. It's coming soon to the places that need it. But where does it come from?

Mars.

Working in partnership with NASA, Los Alamos scientists recently unveiled Kilopower: a small, fully automated nuclear power plant designed to operate continuously for decades on deep-space craft, on the moon, or on Mars—providing abundant and secure power for human exploration or colonization. [*See "Power to the Planet" in the August 2018 issue of* 1663.] But in an unusual twist, instead of just adapting an existing technology for use in space, the scientists went on to scale up the space technology for use on Earth. Because Kilopower was already designed to work safely and reliably in an exceedingly hostile and remote environment, it was a natural model for safe, reliable, and especially portable power for sensitive or remote locales here at home.

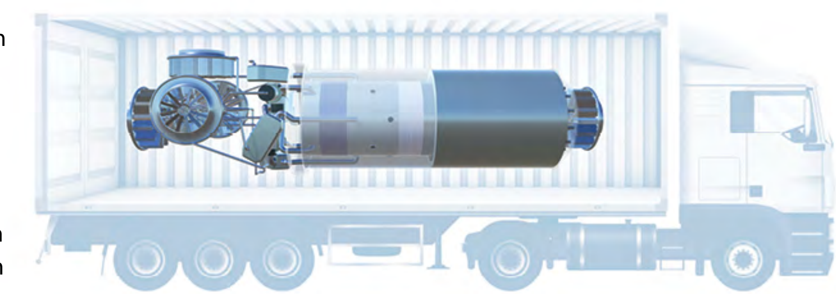
Thus, Megapower was born. Like its space-worthy predecessor, Megapower employs an entirely new kind of nuclear reactor, in which several pieces of specially arranged solid uranium undergo a fission chain reaction. The reaction generates heat (instead of, say, burning coal or gasoline), and that heat is delivered to an engine by a Los Alamos invention called a heat pipe. Whenever more power is needed, the heat pipe draws heat faster, cooling the reactor and therefore slightly shrinking the uranium. With the fissionable fuel now denser, the neutrons causing the chain reaction naturally encounter more nuclei to split, thus increasing the reaction rate; in this way, the reactor automatically increases power when it's needed and, conversely, cuts power when it's not.

This self-regulation also acts as a built-in safety guarantee. A conventional nuclear power plant constantly operates a network of valves and pumps to pipe in vast quantities of water from a nearby lake or river to cool the reactor; these components can potentially fail in an emergency. But Megapower is self-cooling; it requires no water and no specific safety subsystems to secure the reactor. Runaway reactions, such as those that might lead to a meltdown, are simply not possible because the reaction rate is always limited by the fact that rising temperature expands the solid fuel, thereby putting the brakes on the reaction.

Los Alamos has partnered with Westinghouse, a major producer of nuclear (and nonnuclear) power plants, to refine the design and manufacture the plants under the name eVinci™. For safety, reliability, portability, and ease-of-use that's sufficient for operation on another planet, it will have the Los Alamos-designed reactor core and heat-pipe systems. For efficiency and economy appropriate to Earth-bound applications, it will have a Westinghouse engine-generator system to convert reactor heat into electricity.

The unit is designed to be modular and produce about 10 megawatts of electricity. That's on the order of one hundredth of the maximum power output of a large nuclear power plant—plenty for a small town or remote research facility, such as a cluster of mountaintop observatories. A modest city like Santa Fe, New Mexico, with a residential population of 150,000, would probably require five to ten units. However, because Megapower is designed to sacrifice economy of scale in favor of versatility, the electricity would be somewhat more expensive than typical grid-based power. Therefore, the technology would be better suited for isolated and specialized applications requiring significant uninterrupted power than for existing grid-connected cities.

The Los Alamos team is currently maturing designs, testing materials, and exploring manufacturing options, with component and systems testing not far behind. If all goes according to plan,



Megapower—a small self-regulating, carbon-free, standalone power plant—will fit in a standard shipping container for transport by road, rail, air, or sea.

then anyone looking to retire off-grid with ten thousand households' worth of stable, automated power (and, not for nothing, a security perimeter suitable for safeguarding uranium) could see the ideal technology come online in as little as five years. LDRD

—Craig Tyler