until it can hire and train more staff to assemble and test the machines. It also has had to scramble to line up specialized parts in anticipation of TSA orders, notably the computerized tomography scanners themselves and the precise ball bearings needed to rotate the machines.

InVision could double its production to 100 scanners if it could either outsource manufacturing to other Silicon Valley companies experienced in high-tech assembly or build a new manufacturing facility. It has subcontracted with CoorsTek Inc. (Golden, Colo.) to build some machines at CoorsTek's San Francisco area facility.

Certified absent

The U.S. policy of using only FAA-certified scanners originated in the aftermath of another air terrorist event, the 1988 explosion of Pan Am 103 over Lockerbie, Scotland. But certification takes time. The Transportation Security Administration is "working with the industry to resolve manufacturing issues," noted DOT's Price, but testing is tough. InVision certified its first computerized tomography scanner with the FAA in 1994, after four years of product development and testing. The first U.S. unit was installed in 1995 at the United Airlines check-in counter at San Francisco International Airport.

InVision explosives detectors near completion at the Newark, Calif., factory.

L-3 Automation, then part of Martin Marietta Corp., certified the eXaminer

All-Hydrogen Transportation Eyed by Iceland

Hopes to end reliance on fossil fuels

ENERGY • With backing from Iceland's government, a consortium has been formed that seeks to take the first step toward transforming the small nation into the world's first hydrogen-based economy. Iceland, says the consortium, is the ideal testbed for determining whether countries can turn hydrogen into one of their primary sources of power. The island's hydrogen production industry already uses electrolysis to pump out about 2000 tons of the gas each year, thanks to hydroelectric and geothermal energy sources that together provide far more nonpolluting, renewable (and incredibly cheap) energy than Icelanders require.

"We have a carbon dioxide–free energy chain," said Jón Björn Skúlason, general manager of the consortium in which DaimlerChrysler, Norsk Hydro of Norway, Shell Hydrogen, and VistOrka, a venture capital fund based in Reykjavik, are partners. Unfortunately, few other countries could split water into its component elements hydrogen and oxygen without first burning fossil fuels to generate the necessary electricity.

Iceland already relies on geothermal energy emanating from volcanic rock deep underground to produce electricity, pumping water into the ground and using the return steam to drive turbines [see photo, p. 19]. But its government believes it is tapping only 1 percent of the country's total geothermal energy (200 TWh per year)—and only 15 percent of its hydroelectric potential (30 TWh per year). If this energy powered enough electrolyzers to produce hydrogen for all of Iceland's vehicles and ships—currently driven by gasoline and diesel—no resources would be diverted from home or commercial space heating or the electric power grid.

Yet more than enough energy would be left for hydrogen's current primary use: the production of fertilizers needed to make the country's volcanic soil, which is susceptible to erosion, fit for farming and grazing. Some day, green hydrogen could

MARTIN KLIMEK

3DX 6000 scanner in 1998. But one of the machines in the first batch created lingering problems for the company. Installed at Dallas–Fort Worth International Airport, the eXaminer broke down about every fourth day and took six or so hours to repair each time. The faulty high-voltage power supply that turned out to cause the problem had to be redesigned.

Airline angst goes by the numbers

The idea that they should screen all checked baggage has irked the U.S. airlines ever since the FAA first broached the subject in the aftermath of Lockerbie. Their objection is that scanning more than 1 billion suitcases, an average of 3.8 million daily, will slow the air transport system to a crawl. But on 18 January, airlines began fulfilling requirements of the Aviation and Transportation Security Act by seeing to it that all bags are somehow screened, and by matching bags to passengers to ensure that no ownerless bag goes on a flight.

What will happen to air travel congestion when all bags must be checked by computerized tomography units? InVision's machines scan about 128–542 bags an hour, depending on the model, which is roughly two planeloads per hour. So, multiply that by however many flights leave an airport at any given time and however many machines are needed to process their bags. Dulles airport alone, one of the busiest, will need 47 machines to accommodate the checked luggage on its daily departures, not to mention 8–10 trained and certified operators per machine.

Still, delays predicted when the new screening law took effect in January have been few. The Transportation Security Administration has brought in executives from FedEx, Disney, and Marriott to help government officials and airport and airline personnel learn new techniques for, among other things, managing lines.

Even finding space for the machines is a big concern. L-3's machine measures 2.2 by 2.2 by 6.4 meters, and at several thousand kilograms cannot just be dropped in next to the ticket counter. InVision's Mattson says "it is critical that airports be prepared to receive these machines." And help is on the way. TSA is evaluating bids on an estimated $4 billion contract to install, operate, and maintain EDS machines in U.S. airports.

Beyond finding space for them, procedures need to be in place for getting bags in and out of the EDS unit, and for responding to alarms and possible threats in the bags. "The common response today is to open the bag that set off the alarm and use a [chemical] trace analyzer to assess the potential threat. That, too, takes space and trained manpower," Mattson says. "And that's using stand-alone EDS and trace machines. What happens when these EDS units are integrated into automated baggage handling operations?"

In short, accommodating the EDS machines will be tough, and airports cannot be too prepared.

–Elizabeth A. Bretz

A family enjoys the warm waters of Iceland's Blue Lagoon. In the background is the Svartsengi geothermal power plant.

ROGER RESSMEYER/CORBIS

be exported to the rest of the world once other nations began using the gas as fuel.

A more worrisome incentive for embracing hydrogen power is that, despite its huge clean energy resources, Iceland's transportation and fishing industries still depend heavily on foreign oil and coal, which together supply 34 percent of its energy needs. Per person, Europe's westernmost country is the world's leading consumer of oil and one of the world's top emitters of greenhouse gases. Plans to erect new metal-processing plants will raise present emission levels by more than 10 percent (which is why, unlike most other industrialized nations, it has not signed the Kyoto Protocol).

The government is confident that the transformation to a hydrogen economy will succeed, noting that it has already revamped its energy infrastructure once in the last 50 years. After World War II, which interrupted supplies of imported coal and heating oil, the government campaigned vigorously to replace costly fossil fuels used in the electricity sector, as well as for heating homes and businesses. According to government estimates, geothermal heat and hydroelectric generation now account for more than 99.9 percent of the nation's electric power generation and nearly two-thirds of its energy consumption.

This latest effort will advance Iceland's clean energy use even farther by extending it to transportation, its leading source of pollution. By scrapping internal combustion engines, said Karen Miller, program director of the National Hydrogen Association (Washington, D.C.), the country may be able to cut greenhouse gas emissions by two-thirds.

Doing so, incidentally, would also improve its economy. The government is sure it can find another use for the US $150 million it spends each year for crude oil to fuel about 2500 fishing vessels and 180 000 cars and trucks (two vehicles to every three people versus four to every three in the United States). At present, increases in oil prices affect the price of fish, the nation's primary

export, making it harder for fishermen to compete on the international market.

To kick things off, the aforementioned consortium, dubbed Icelandic New Energy Ltd., plans to introduce three demonstration fuel cell buses into the mass transit fleet in Reykjavik by summer 2003. Equipped by Mercedes-Benz and costing $1.25 million apiece, each will carry hydrogen pressurized at about 35 MPa in rooftop tanks, enough to keep them running all day on a single fueling. Next spring, a refueling station built by Shell will be brought on line.

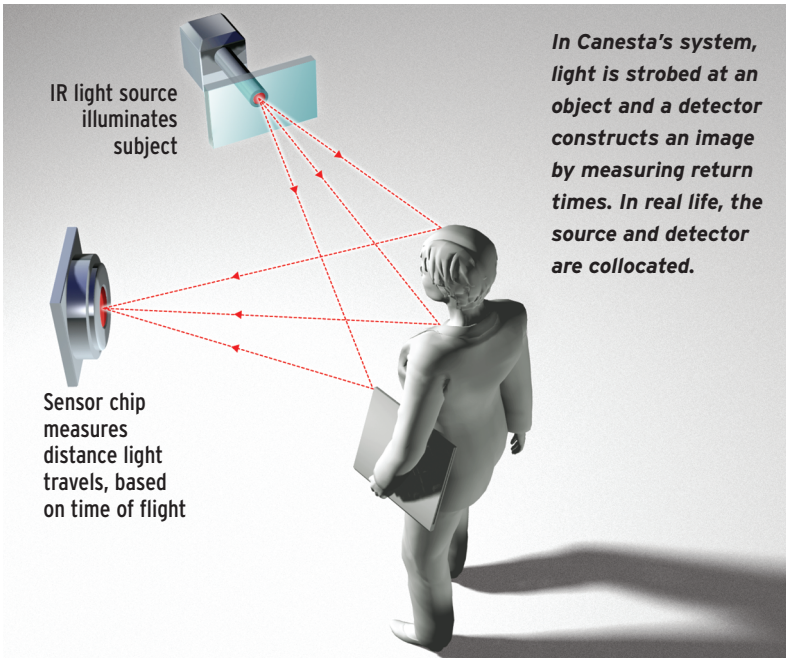
Alternative scenarios

According to Iceland's Minister of Industry, Valgerdur Sverrisdottir, the next step will be converting the capital's entire 80-bus fleet to hydrogen fuel. Then, given a positive outcome of the demonstrations, she said, it will be "on to private cars." Icelandic New Energy's Skúlason said that although there are roughly 150 gasoline stations on the island, fewer than 20 hydrogen stations may be plenty for Reykjavik, its largest population center.

The consortium plans to manufacture hydrogen at refueling stations instead of distributing it in tanker trucks like gasoline. Water and electricity lines will be connected to an electrolyzer that will separate the hydrogen, pressurize it, and—with luck, in the near future—pump it into cars, trucks, buses, and the country's many fishing vessels.

The group is also studying the practicality of extracting the gas from methanol, which eventually could be made synthetically. The National Hydrogen Association's Miller notes that using methanol in all vehicles, including the fishing fleet, would lop 40 percent off the country's emissions, even if natural methanol were used (methanol is cleaner and less carbon-intense than oil-based fuels). This figure could reach 55 percent if the carbon monoxide and carbon dioxide by-products of Iceland's expanding metals industries were recycled and mixed with hydrogen to produce methanol.

Such a plan would also take advantage of DaimlerChrysler's work on methanol fuel cells and the on-board methanol reformer demonstrated in the Necar 5, its fifth New Electric Car prototype, actually a converted A-Class Mercedes-Benz sport utility vehicle. **–Willie D. Jones**



In Canesta's system, light is strobed at an object and a detector constructs an image by measuring return times. In real life, the source and detector are collocated.

Machine Vision Goes Real-Time

Start-up Canesta's system relies on reflected infrared pulses

IMAGING • Real-time 3-D sensing for machines may soon be practical, thanks to a new electronic perception chip announced on 25 March by the start-up Canesta Inc. (San Jose, Calif.). Inexpensive yet robust, the technology combines imaging based on charge-coupled devices (CCDs) with infrared (IR) pulses.

In the Canesta system [see illustration, above], an IR source mounted next to a CCD-based chip strobes pulses of IR light 50 times a second at objects in its field of view, and measures the time till the light returns, so that a high-resolution contour map can be generated. As farther-off surfaces give rise to longer times of flight, the distance traveled—and the object's contours—can be calculated in a straightforward manner by electronics integrated into the chip package.

Determining distance at the sensor level eliminates the postprocessing work traditionally required. Conventional forms of 3-D imaging must reconstruct scenes by integrating data taken from a scanning beam or multiple cameras. Canesta's sensor chip does the whole job of processing and costs about the same as a normal CCD chip alone.

"Traditional methods of determining 3-D information, such as stereo vision or ultrasonic ranging, are either expensive or require considerable computational power," commented Nazim Kareemi, the president and CEO of Canesta.

The sensing range of the Canesta chip depends on the power of the IR source and is currently in the tens of centimeters. But that could be "extended to several meters" later on, says Kareemi. Although he refused to disclose the exact depth resolution of the system/package, a demonstration of a prototype showed it to be on the order of a millimeter or less.

The first applications will be in the realm of human computer interfaces, such as virtual keyboards for personal digital assistants, where a keyboard can be projected onto a nearby surface and the position of the user's fingers can be monitored by the chip. Face recognition is another possibility, as is machine navigation, such as allowing robots to find their way around hazards or warning a driver that a vehicle is in the blind spot.

Canesta will not manufacture application systems itself, but intends to sell the chips and accompanying software to original-equipment manufacturers. **–Stephen Cass**

BRYAN CHRISTIE