Japan Bids for Global Leadership in Clean Industry

"In the past, Japan was criticized because we did not create new technology," says Ikuo Tomita, Director for Global Environmental Technology at the Ministry of International Trade and Industry (MITI). But as Tomita lists the innovative, high-technology environmental projects that MITI has begun as part of its strategy for sending world greenhouse gas emissions plunging by the year 2025, it's clear that he is determined to put the lie to that criticism. "This program is completely different," he says. "Japan wants to be a leader in global environmental technology."

Japan first laid out its comprehensive plans for a technical fix for global warming and ozone depletion in 1990, in MITI's "The New Earth 21—Action Program for the Twenty-First Century." New Earth 21 is a "vision," as the ministry calls its long-term strategic plans, and as such it comes with plenty of hype. The ultimate goal, says MITI, is "to undo the damage done to the earth over the past two centuries, since the Industrial Revolution." But this is no utopian dream: Like the "visions" that preceded Japan's conquest of world semiconductor markets, it signals a consensus in industry that it is time to move into a particular area of technology. And like earlier visions, New Earth 21 has spurred the formation of new government-industry-university joint research institutes, in this case aimed at transferring existing "clean" technologies to developing countries and—a longer-term goal—devising completely new technologies that would actually strip carbon dioxide out of industry smokestacks.

That big-budget, long-term technological approach to global warming is unparalleled elsewhere. "[Even] in the United States," remarks Tomita, "the Department of Commerce, the National Science Foundation, and the Environmental Protection Agency have no such programs for environmental technology development." And Japan's effort is attracting plenty of plaudits abroad. National Academy of Engineering president Robert White, for example, has cited it as a potential nucleus for a global effort to develop and transfer clean technology—an effort likely to be discussed next month in Rio de Janeiro at the United Nations Conference on Environment and Development.

Japan is well positioned to take the lead in environmental technology, as industry and government spokesmen are fond of pointing out. Turn to the Ministry of Foreign Affairs handbook on Japan's environmental policies and you'll find a proud boast in big, bold headlines: "Japan's carbon dioxide emission

A Technical Fix for the Greenhouse

When Japanese government and industry get together to develop a new technology, they're in it for the long haul. And the national effort to seize the lead in technologies for reducing greenhouse gas emissions and protecting the ozone layer (see main text) is no exception. With government and industry promising funding for "at least 10 years," says Ikuo Tomita, director for global environmental technology at MITI, scientists at the Research Institute of Innovative Technology for the Earth (RITE) know that they can think really long-term in their quest for technological solutions to the problems of the global environment.

Five of RITE's suite of seven big projects have familiar goals: substitutes for the chlorofluorocarbon compounds that attack ozone, biodegradable plastics, improved bioreactors for low-energy synthesis of chemicals, production of hydrogen by bacteria, and recycling of steel scrap. But the two front-runners, sharing half of the total $28 million-a-year budget, are more unusual. Both projects aim at new methods for removing carbon dioxide from industrial exhaust gases. If they succeed, factories and power plants might one day run without net production of carbon dioxide.

One project, run by Hiroshi Kuwahara, general manager of Hitachi's Industrial Systems and Equipment Division, would harness biology. At the mercy of rainfall and soil quality, plants are normally working at less than optimal efficiency when they use sunlight to convert carbon dioxide into carbohydrates. RITE would outdo nature, placing algae capable of extraordinarily high rates of photosynthesis in a perfect environment: a nutrient bath at the ideal temperature, with sunlight piped in through special optical fibers that diffuse light through their sides to produce an even illumination. If the plan works, carbon dioxide bubbled into this algal heaven from industrial exhausts will simply vanish, turned straight into carbohydrate, which can in turn serve as a fuel or food source.

"To find the superior photosynthetic microorganisms, microalgae have been collected from lakes and hot springs,"says Mamoru Kodama, chief scientist at the Marine Biotechnology Institute in Kamaishi, on the north Pacific coast of Japan. "Several species were found that could grow under carbon dioxide concentrations of 20%," he says. Screening of the organisms is now under way, and biotechnologists are ready to try to improve the best the microbiologists can find. Meanwhile, physicists are developing new reflective coatings for solar collectors and new types of glass for light-diffusing optical fibers; biochemists are examining ways of turning end products into useful fuels or foodstuffs; and, at the top of the hierarchy, computer engineers are developing fuzzy logic controls that would operate the whole system automatically. Sixteen companies are involved in the work, including Hitachi, Asahi Glass, and Sumitomo Chemical Company, each bringing its own special area of expertise. The goal is to have a test plant running early in the next century, at a projected total cost of $123 million.

But if biology can't gulp enough carbon dioxide, then maybe blunter chemical methods will work. Another group of 14 companies, plus three of MITI's own research institutes, is also spending big—$77 million over 10 years—to create new kinds of selectively permeable membranes that could filter carbon dioxide out of high-volume, high-concentration industrial sources. "We have found two or three types of membrane with high efficiency for carbon dioxide separation," says Hiroshi Mano of Sumitomo, who directs the membrane research. The next step might be to turn the carbon dioxide into methanol, a fuel, by adding hydrogen in the presence of new high-performance metal catalysts. A copper-based catalyst already looks promising, says Taiki Watanabe, a researcher from Kawasaki Heavy Industries who directs the catalyst side of the project. Together, the membrane and the catalyst could yield an elegant recycling scheme: When the methanol is burned, the carbon dioxide could be recovered and turned into fuel again. One way or another, it seems, RITE is determined to turn carbon dioxide from a problem into a profit center.

–F.S.M.

is about 4% of the world's total and one-fifth that of the United States." The figure is so low because Japan uses less energy per head (and per dollar of GDP) than any other advanced nation, thanks to the rapid response of industry to the 1970 oil shock.

"In retrospect," says Genya Chiba, who runs the Science and Technology Agency's Exploratory Research for Advanced Technology (ERATO) program, "the oil crisis was valuable in that it compelled Japan to draw on both technology and a flexible management system. As a result Japan was propelled into the emerging era of conservation and efficiency much faster than the nations that were less threatened. In some cases, within 2 or 3 years industrial oil consumption decreased by 20% to 30%."

To build on that record, MITI began work in 1990 to create the Research Institute of Innovative Technology for the Earth (RITE), intended to develop the environmental technologies New Earth 21 says will be needed early next century. Instead of searching for ways to improve energy efficiency (with lowered carbon dioxide emissions as a lucky byproduct), RITE is aiming toward schemes for stripping carbon dioxide out of industrial emissions and recycling the carbon (see box).

Industry has responded enthusiastically. In the half-year after the institute was set up, $45 million came in from Japanese industry, adding to the $80 million in seed money provided by MITI. Every sector is represented: the huge electric utilities, engineering companies, car manufacturers, shipbuilders, electronics companies, steel manufacturers, and even clothing makers. All have their own environmental technology programs too—Tokyo Electric Power, for example, is searching for ways to extract carbon dioxide from smoke by chemical absorption—but they see involvement with RITE as essential to keep abreast of long-term technological change and the latest in government thinking.

Thanks to industry's largess, RITE is now able to spend about $28 million a year to support work by about 200 researchers. Half of the money goes toward the two big carbon dioxide fixation projects and the rest is divided among the remaining big projects, subsidies to private companies for the development of environmental technology, and grants for basic research. For the time being, all of the work is going on at the laboratories of the companies, universities, and MITI institutes that have joined RITE projects. But next year this will change when RITE's own laboratory is completed in the new "Kansai Science City" under construction near Osaka.

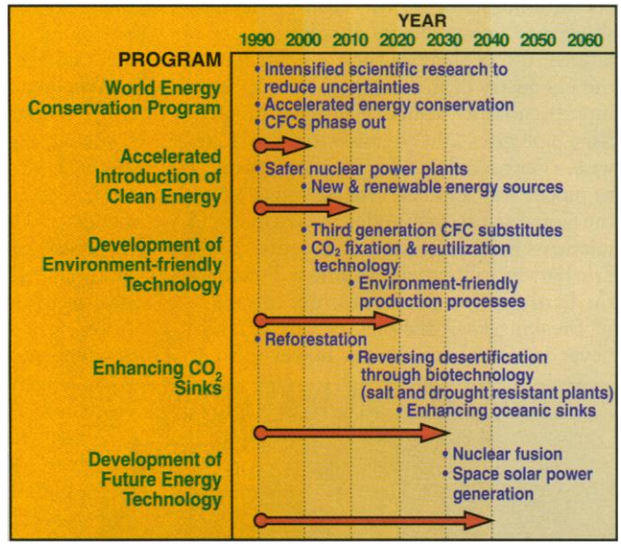
International participation in all RITE projects is welcome—a highly unusual arrangement for a Japanese institution—but at a price: Intellectual property rights on the fruits of research must be shared with RITE. Last year, applications for grants came in from the United Kingdom, the United States, Canada, Australia, and the Netherlands, says Hidefusa Miyama, director of the Research Planning Department of RITE. Already, an Italian company has joined one large project on microbial generation of hydrogen, and a British group at the Agriculture and Food Research Council has won funding to study the uptake of methane by agricultural soils.

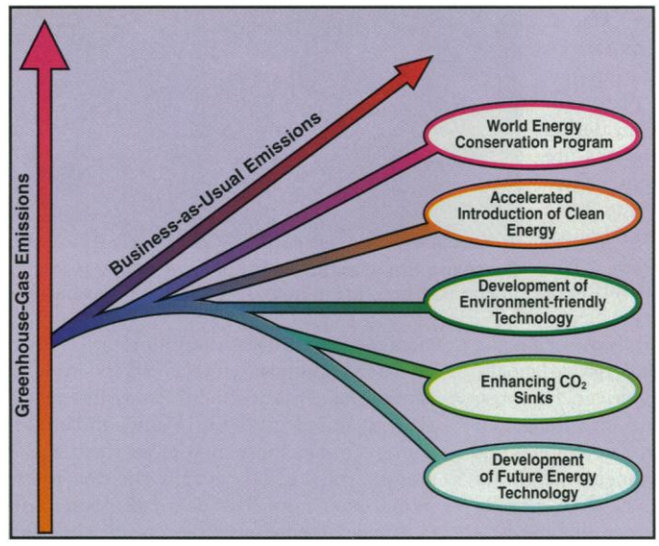
But the new technology being developed at RITE won't be ready for 20 years; until then Japan sees transferring its existing energy-efficient technology to the developing world as the best way to tackle global warming. The logic is simple: Most industrial countries can now hold their carbon dioxide emission at current levels or start to reduce them, says Tomita, but industrializing countries going for quick economic growth to support growing populations will pump out more greenhouse gases every year. He cites World Bank figures that show that developing countries will produce 44% of total carbon emissions in 2050, up from 20% now.

Japan's answer to the threat is the International Center for Environmental Technology Transfer (ICETT), which won MITI backing last year. Its objectives are ambitious: Tomita says it and an associated energy center are going to try "to train 10,000 people over the next 10 years" in energy conservation, pollution control technology, and environmental protection regulations. Most participants will come from developing countries and, as with other Japanese overseas programs, many will end up working for Japanese companies when they get back home. Naturally enough, their first choice of technology is likely to carry the "Made in Japan" label.

That's an unsettling prospect for some observers outside Japan, and they now have another cause for worry: a new United Nations Environment Program International Environmental Technology Center (UNEP/ITEC), first proposed by the then-Japanese Prime Minister Toshiki Kaifu at the Houston Summit of advanced nations in July 1990. Like RITE and ICETT, it will be built in Kansai Science City and should be up and running this fall. This added boost for Japan's technology-transfer activities is worrying presidential science adviser D. Allan Bromley, among others. Bromley has already voiced concerns that the decision to put the UN institute in Japan may mean U.S. industry has missed the environmental technology boat. But Miwako Kurosaka, senior researcher at the World Resources Institute in Tokyo, argues that Japan deserves the job: Its design and manufacturing skills will speed the effort to disseminate environmental technology before developing countries build polluting industries. And if Japan can sell environmental technology as fast as it sells video recorders, the world will surely be a better place.

–Frederick S. Myers





The RITE way to save the planet. RITE will provide technology for a five-phase program to send greenhouse emissions plunging.

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