GLOBAL WARMING

Acting Locally

IN CURBING GREENHOUSE GAS EMISSIONS, STATES GO IT ALONE **BY DAVID APPELL**

Frustrated by federal inaction on preventing climate change, states and municipalities have begun reducing greenhouse gas emissions on their own. In fact, their influence could be greater than that of many countries that have ratified the Kyoto Protocol, the international agreement that set reductions of carbon emissions but that the U.S. has refused to ratify. In the process, the local-area policies are serving as incubators for new procedures and technologies that will be important to a coordinated national effort.

REPLACING SPORT UTILITY VEHICLES with fuel-efficient autos is one strategy of states trying to reduce carbon emissions.

"There's been a remarkable turn of events in the past two to four years," observes Susan Tierney of Lexecon, an economics consulting firm in Cambridge, Mass., and past assistant secretary for policy in the U.S. Department of Energy. Traditional first actors on air-quality issues, such as California, New Jersey and the New England states, have initiated programs to reduce emissions. States are motivated not only by the danger of climate change but by the hope of cleaner air, cost savings from energy efficiency, and marketing opportunities for renewable energy.

Such a "bottom-up" approach has a large global potential: "If they were considered as independent nations, U.S. states would comprise about 25 of the top 60 countries that emit greenhouse gases," remarks Barry Rabe of the University of Michigan at Ann Arbor, whose "Greenhouse and Statehouse," a Pew Center report, presents case studies of initiatives in nine states. Texas alone exceeds France in emissions.

Raab reveals a surprising range of situations among those states working to cut emissions. States moving ahead have been successful, he says, in couching the climate change as a more immediate problem, such as New Hampshire's concern over the possible loss of maple trees and the concomitant loss of tourism dollars from autumn's leaf peepers. Many states have a champion pushing the issue, such as Robert Shinn, former administrator of the Department of Environmental Protection in New Jersey. California's historic Pavley Bill of 2002, requiring strict limits on vehicle emissions in 2009, could serve to force redesigns of entire automobile fleets. Sixteen states now require utilities to purchase "green power." Texas, for instance, sells renewable-energy credits and has seen a sixfold increase in wind power generation between 1999 and 2002.

The six New England states (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island and Vermont) have banded together with five Canadian provinces (New Brunswick, Newfoundland and Labrador, Nova Scotia, Prince Edward Island and Quebec) to enact a Climate Change Action Plan. Written in 2001, the scheme aims to curb greenhouse emissions to 1990 levels by 2010 and then by an additional 10 percent by 2020. (Under the Kyoto Protocol, the U.S. would have had to reduce average emissions in 2008 through 2012 to 7 percent below 1990 levels.)

The first step calls for states to assess the amount of their greenhouse gas emissions; only 38 states have completed these inventories, which account for 87 percent of U.S. emissions. Then, to reduce emissions, planners are focusing initially on "low-hanging fruit," including replacing sport utility vehicles in state government fleets, acquiring more energy-efficient office equipment, and using light-emitting diodes for traffic lights. Seven activities in the region reported emissions reductions or sequestrations totaling 1.2 million metric tons of CO_2-equivalent (MMTCE).

Cities, too, are acting on their own. Thirty-one specific plans have been filed by 141 U.S. members of the International Council for Local Environmental Initiatives, representing 16 percent of U.S. emissions. Ten MMTCE of emissions have been eliminated, according to the council's Susan Ode, in which western cities such as San Diego, Port-

FAST FACTS: HOT AIR

Greenhouse gas emissions are calculated in millions of metric tons of CO_2-equivalent (MMTCE), a measure that adds together the climate warming potential of the different atmospheric greenhouse gases in units relative to that of carbon dioxide.

- **Estimated U.S. greenhouse gas emissions, 2001:** 1,883.3 MMTCE
- **Emissions in 1990:** 1,683 MMTCE
- **Completed state action plans:** 20
- **Annual greenhouse gas reductions, 2000:** 3.2 MMTCE
- **Potential reductions by 2010:** 71 MMTCE
- **Potential by 2020:** 96 MMTCE
- **Estimated cost savings by 2010:** $8 billion

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land, Ore., and Salt Lake City are prominent.

Although individual states cannot replace a federal initiative, their patchwork regulatory approach could compel businesses to seek more consistent, predictable nationwide standards. States, however, often encounter the same reluctance that has dominated the national climate change scene. "We think, whether it's federal, state or local, they're ill-advised policies that are not going to help state or national economies and only succeed in putting more Americans out of work," says Darren McKinney of the National Association of Manufacturers, an industrial trade organization opposed to the Kyoto Protocol.

Still, the collective effort of the states is already beginning to compensate for the lack of reductions by the Bush administration. "You may have some American states that are better prepared, from a policy standpoint, to reduce greenhouse gases than a number of nations that have ratified Kyoto," Raab comments. The earth's atmosphere will take whatever help it can get.

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ROCKETS

Hybrids Take Off

ENGINEERS RECONSIDER CROSS-BRED PROPULSION **BY STEVEN ASHLEY**

With little fanfare last December, Lockheed Martin Space Systems launched a suborbital sounding rocket from a NASA pad in Virginia. Forty-four miles over the Atlantic, the five-story-tall, two-foot-diameter craft released an 800-pound payload. The package, containing aerodynamic reentry experiments, was nothing particularly special. The booster itself, however, was rather exceptional—it was the first launch of a rocket powered by a large-scale hybrid rocket motor.

Such rockets attempt to combine the best of solid and liquid propulsion, the traditional engine types. In a liquid-fuel rocket, the fuel and oxidizer, often liquid hydrogen and oxygen, are stored separately and then mixed to create combustion. Liquid-fuel rocket motors burn efficiently, provide high thrust and, critically, can be throttled and even stopped and restarted. Such control permits planners to tailor the rocket's trajectory. Complexity, though, is high, and so tends to be the price tag.

Simpler and cheaper are solid-fuel engines; their fiery impetus comes from burning premixed fuel and oxidizer grains that are packed like coffee grounds into a cylindrical casing. Unfortunately, the solid propellants—usually aluminum fuel and ammonium perchlorate oxidizer—burn fairly inefficiently, are toxic to the environment, and are difficult to fabricate and handle safely. A solid rocket cannot be throttled, either—once lit, it runs until the fuel is expended.

Hybrid propulsion offers significant advantages, claims Randy Tassin, a vice president at Lockheed Martin's Michoud Operations in New Orleans. "Hybrids are nonexplosive, can be throttled, are low cost and environmentally benign," he says. In addition, the compact power plant can produce nearly as much thrust as liquid-fuel motors. In a typical hybrid rocket motor, a rubbery fuel—a synthetic polymer called hydroxyl-terminated polybutadiene—cast into the tubular hull combusts fiercely when ignited in the presence of oxygen, pumped in from a separate tank as a liquid or a gas.

"The main difficulty in hybrid rocket technology is controlling the way the propellant burns," Tassin explains. The performance of hybrid fuels is not well understood,

POWERFUL PLUME blasts out of a hybrid rocket motor during a ground test conducted in 1999 at NASA's Stennis Space Center in Mississippi. An aerospace industry consortium developed the 250,000-pound thrust engine prototype as part of a $20-million program.

NASA

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