certainly be repository capacity.

Decay heat creates the fundamental limitation on repository capacity. For spent fuel, the fission products—^{137}Cs and ^{90}Sr with half-lives of 30 years—generate roughly half of the total repository heat load. The actinides—principally the heavy elements ^{241}Am (458 years) and ^{238}Pu (86 years)—provide the other half. We can actively manage the fission product heat. For example, in unsaturated media like Yucca Mountain, the simple ventilation of the drift tunnels would recover ~50% of the repository thermal capacity every 30 years. But we cannot actively manage the actinide heat, which is deposited over too long a time. This is why, in the longer term, it will likely make economic sense to recycle actinides back into reactors, and why it is correct and appropriate for the United States to develop new technologies for this purpose.

Reactor and pyroprocessing research facilities at Argonne-West in Idaho.

CREDIT: ARGONNE NATIONAL LABORATORY

The broad adoption of the Nuclear Nonproliferation Treaty can be credited in large part to the commercial potential seen in nuclear energy. Our development of new fission-energy systems that better manage their waste streams could create new incentives for broad adoption of even more rigorous international norms: in particular, comprehensive International Atomic Energy Agency (IAEA) Safeguards Agreements that include an Additional Protocol, which, when adopted by a nation, allows IAEA inspections anywhere within that country to confirm the absence of undeclared nuclear activities (*2*). This creates a worthy goal for future nuclear energy R&D.

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2. Additional Protocols are now in force in 22 nations: http://www.iaea.or.at/worldatom/Programmes/Safeguards/sg_protocol.shtml

Response

PETERSON'S NIGHTMARE IS DIFFERENT FROM MY own. Mine is that the Bush Administration is undercutting the more than two-decade-old campaign to end civilian commerce in weapon-usable plutonium just when that campaign is on the verge of success. Britain, France, Russia, Japan, and India are still separating annually more than 20,000 kg of pure plutonium from spent fuel—enough for at least 2500 nuclear explosives—but, in fact, deregulated utilities are becoming more resistant to subsidizing these uneconomic programs.

Peterson worries about the challenge of siting "tens or hundreds" of deep underground respositories for spent fuel in the United States. But it would take hundreds of years for any such problem to develop. The proposed Yucca Mountain repository would hold about as much spent fuel as will be discharged over the lifetimes of the ~100 nuclear power plants in the United States. Because of a lack of utility interest, there has not been a construction permit for a new nuclear power reactor issued in the United States since 1979 (*1*). Worldwide nuclear capacity is ~3.5 times that of the United States' and is projected to stay about constant for the next 20 years as a result of a combination of modest growth in the developing world and decline in the industrialized world (*2*).

Peterson is right about the danger of the proliferation of small-scale uranium enrichment technology. Pakistan produced its weapon-grade uranium using technology acquired by A. Q. Khan while he worked in the Urenco commercial centrifuge enrichment plant in the Netherlands (*3*). Khan returned to Pakistan and built an enrichment plant reportedly based on Urenco designs (*4*). However, the fuel used in most of the world's nuclear-power reactors is low-enriched and not weapons useable. In contrast, commercial spent-fuel reprocessing technology produces pure plutonium directly useable for the production of nuclear weapons.

In short, my objections to the proposal to launch a new U.S. reprocessing R&D initiative are: (i) reprocessing is not needed within this century, and (ii) the Bush Administration proposal is being greeted by foreign reprocessing establishments as a rollback of U.S. opposition to commerce in plutonium.

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3. Z. Malik, *Dr. A. Q. Khan and the Islamic Bomb* (Hurmat, Islamabad, Pakistan, 1992).
4. L. Spector, *Nuclear Ambitions* (Carnegie Endowment/Westview, Boulder, CO, 1990).

Carbon Sinks and Conserving Biodiversity

ALTHOUGH CARBON SEQUESTRATION through better management of forests and farmland does not provide a long-term alternative to reducing greenhouse gas emissions, it might provide limited and short-term benefits for the climate. The Kyoto Protocol of the United Nations Framework Convention on Climate Change allows Land Use, Land Use Change and Forestry (LULUCF) projects under certain constraints. These projects include a planned set of activities designed to enhance carbon sequestration in terrestrial ecosystems. Concerns have been raised about the potential effect of such projects on biodiversity; for example, that old growth, biodiversity-rich forests could be replaced by plantations of fast-growing trees. However, under a number of circumstances, win-win situations could be created between climate change mitigation and biodiversity conservation, and these were the topic of discussion at the international conference "Carbon Sinks and Biodiversity" held in Liège, Belgium, in October.

For example, in developed countries and countries whose economies are in transition, ecosystem restoration through revegetation of a fraction of noncultivated agricultural and marginal lands offers a potential for climate change mitigation. This requires taking all greenhouse gas fluxes into account. Such revegetation can be achieved in a number of ways, including by encouraging the use of biofuels and chemicals derived from biomass. Peatlands could be protected and former peatlands converted back to either their original state or some other managed state with higher water tables. Afforestation of peatlands should generally be avoided, as it would endanger biodiversity and the greenhouse gas balance of such ecosystems.

In developing countries, measures to avoid deforestation and to restore native forests strike a good balance between climate change mitigation and conservation of biological diversity. Policies for the conservation and sustainable use of existing forests should be aimed at increasing rural incomes, empowering local users of forests, and promoting good governance of natural resources. Because measures to avoid deforestation would be difficult to translate into verifiable greenhouse gas emission credits in the Kyoto Protocol, they should be promoted through other policies. Sustainable agroforestry systems should be promoted as a form of land management for mitigating climate change and for biological diversity conservation, because these provide numerous socioeconomic and environmental benefits.

Whereas the potential of carbon sequestration measures in a given terrestrial ecosystem mainly depends on the quantity of land that would be managed for this purpose, biodiversity conservation also depends on the landscape spatial pattern. Therefore, land use planning is important to optimize climate change mitigation through carbon sinks while maintaining or developing conservation areas, for example, through protected reserves and reforestation of corridors and buffer zones.

Potentially, there are large synergies between LULUCF projects within the Kyoto Protocol and the objectives of the Convention on Biological Diversity, but for these to be realized, we need effective coordination between these international conventions, and among national policies on land use and natural resource management. Measures that ensure a long-term reduction in greenhouse gas emissions should always have priority over carbon sinks, as the latter only have short-term benefits for the climate. However, LULUCF projects will yield other long-term benefits when they have positive impacts on ecosystem functioning, including biodiversity conservation.

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CREDIT: J. BRADLEY AND R. REED

Nomenclature for Ion Channel Subunits

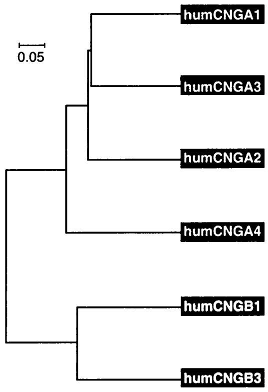
Cyclic nucleotide–gated (activated) ion channels are most well known for mediating visual and olfactory signal transductions, but they are also expressed in other cell types and tissues. In native tissues, these channels are heteromultimers, with different heteromers showing distinct nucleotide sensitivity, ion conductance (selectivity), and Ca^{2+} modulation.

Molecular cloning and genome sequencing efforts have revealed the presence of six genes coding for subunits of cyclic nucleotide–gated channels in human and mouse. The initial isolation and functional characterization of these subunits by different laboratories have led to a confusing and occasionally contradictory nomenclature for describing members of this gene family. To make future work on these channels more easily understood, a group of us engaged in the study of these channels have agreed to adopt a common nomenclature.

The adopted nomenclature (see the table) for these channel subunits recognizes two phylogenetically distinct subfamilies, CNGA and CNGB, defined by their sequence relationships illustrated in the figure. The members in each subfamily are now numbered to retain as much similarity as possible to previous identifiers. However, notably, the

ADOPTED NOMENCLATURE FOR CYCLIC NUCLEOTIDE-GATED ION CHANNEL SUBUNITS

Adopted nomenclature	Previous designations
CNGA1	CNG1/CNGα1/RCNC1
CNGA2	CNG2/CNGα3/OCNC1
CNGA3	CNG3/CNGα2/CCNC1
CNGA4	CNG5/CNGα4/OCNC2/CNGB2
CNGB1	CNG4/CNGβ1/RCNC2
CNGB3	CNG6/CNGβ2/CCNC2



A phylogenetic tree of the different subunits of cyclic nucleotide–gated ion channels.