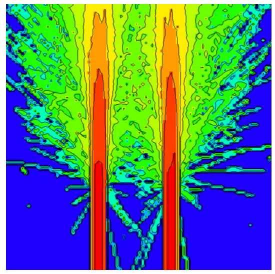
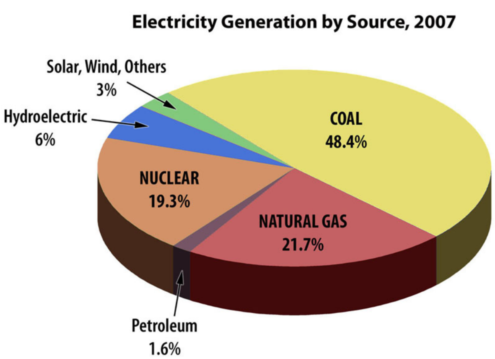



We are using our unique expertise in nuclear materials and geoscience to clean up conventional fuels.

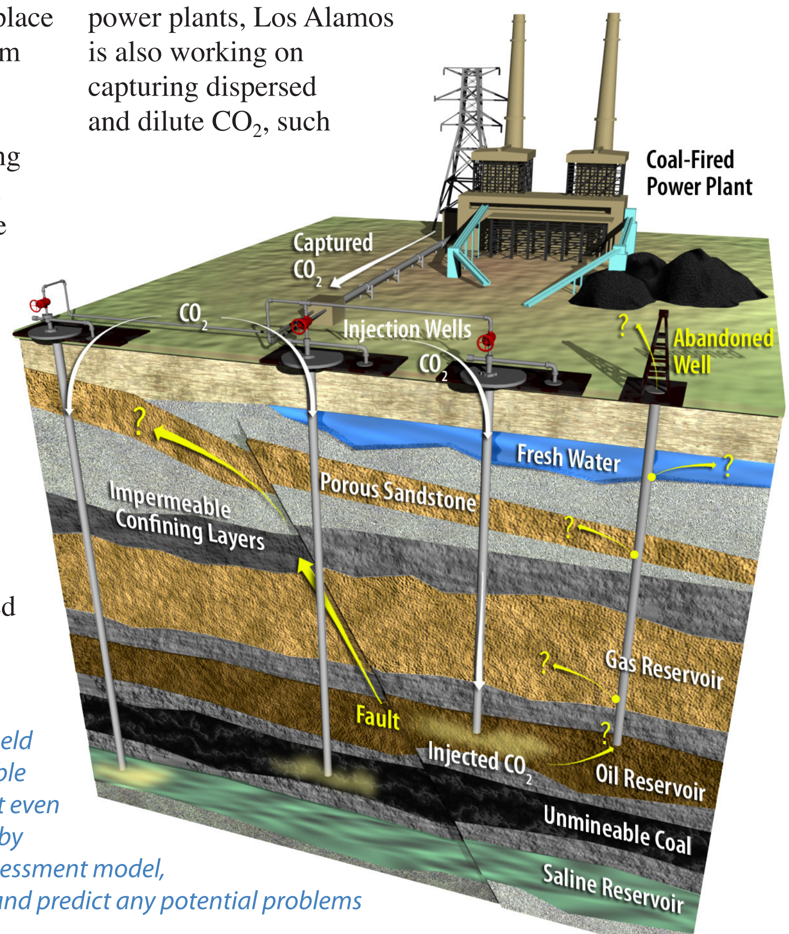
Advanced Fossil and Nuclear Energy

Seventy percent of U.S. electricity comes from fossil fuels and another 20% comes from nuclear energy. It would be comforting to think we could simply stop climate change by abandoning fossil fuels, or that we could free ourselves of nuclear waste and proliferation risks by shutting nuclear power plants, but the reality is that no alternative energy source is ready to replace 90% of our current generating capacity. And the problem goes beyond U.S. borders. Greenhouse gas emissions and nuclear proliferation are international problems. Developing countries like India and China are increasing their use of fossil fuels while developed nations around the world are embracing nuclear power as a carbon-free alternative. We cannot ignore these energy sources, but we can make them cleaner and safer through advanced technologies.



Carbon Sequestration

One way to make fossil fuels cleaner is to capture their CO_2 emissions and inject them underground. It's called "carbon sequestration" or "carbon capture and storage." The "capture" stage, in which CO_2 is separated from a mixed gas stream, poses a significant technical and economic challenge. Using current technologies, CO_2 separation could add up to 4 cents per kilowatt-hour, a 44% increase over the average 9 cents per kWh we pay now. Los Alamos is working on several different separation approaches, including a novel polymer-metallic composite membrane that promises to do the job with a price increase under 10%. The membrane can purify hydrogen and capture CO_2 at temperatures nearly 3 times higher than the limit for conventional membranes. This means it can be used directly in the stacks of conventional coal plants or in the high-temperature process streams of integrated gasification combined cycle power plants, which will be the wave of a cleaner coal future. While this membrane can capture CO_2 from concentrated point sources, like power plants, Los Alamos is also working on capturing dispersed and dilute CO_2, such



In geologic sequestration, porous layers like those that have held oil and gas for eons would hold injected CO_2 while impermeable caprocks would prevent its movement back to the surface. But even caprocks are typically fractured and many have been pierced by drilling operations (see yellow arrows). A systems level risk assessment model, like Los Alamos' CO_2-PENS, can select the most effective sites and predict any potential problems that might arise in a carbon sequestration operation.

as automobile emissions, directly from the air using large cooling towers and a potassium carbonate solution.

CO_2 Storage

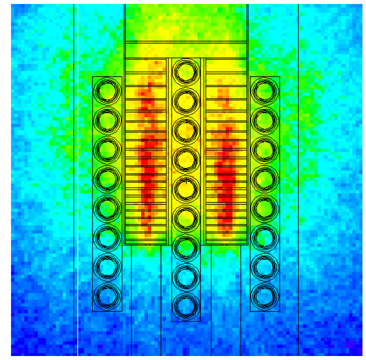
To impact climate change, billions of tons of CO_2 must be captured and stored. To understand the potential risks of storing such colossal amounts of CO_2, Los Alamos is developing a science-based computer prediction tool, called "CO_2-PENS" (for Predicting Engineered Natural Systems). Predictive models require scientific data and Los Alamos is working with industry and performing laboratory and field studies to obtain the information needed to program and validate CO_2-PENS. Los Alamos scientists have studied oil fields in West Texas and Canada that have experienced conditions similar to those of a sequestration operation, and are developing complex parallel computer codes to understand exactly how CO_2 will interact in the subsurface and where it may migrate over time. Los Alamos' long history in underground testing, nuclear waste repository science, and geothermal energy systems has led to a unique expertise in the geosciences required to characterize the subsurface, understand the geochemistry, and monitor CO_2 movement at storage sites.

A Los Alamos scientist works on an eddy covariance tower used to measure CO_2 flux at the land-atmosphere interface.

Advanced Nuclear Energy

Nuclear energy, which does not emit greenhouse gases, could be a major part of a clean energy future if we developed new ways to manage its waste stream while reducing the risk of nuclear proliferation. Currently we avoid that risk by storing spent fuel after it has been passed through a reactor only once, but a feasible option for reducing waste and proliferation risks at the same time is to recycle and burn up almost all of the fuel without ever separating plutonium.

It is possible, but we must do more research to understand how new nuclear "transmutation" fuels, which will contain elements beyond uranium, will react in an advanced fast-neutron reactor. It will require an integration of modeling and simulation, new materials fabrication, and materials testing using fast neutrons like those they'll be exposed to in advanced reactors. In addition, we must deploy new technologies under development around the world to create international nuclear energy systems that reduce proliferation risks.



Monte Carlo Neutron Particle (MCNP) simulation of new nuclear fuels undergoing performance tests at Los Alamos' Materials Test Station.

Because of its long history in nuclear science and technology, Los Alamos has long contributed to the development of nuclear energy and is uniquely qualified to improve future options. We have decades of reactor modeling experience and can simulate the entire process including the detailed physics in the reactor's core to the operation of an entire nuclear power plant and the flow and transport of nuclear materials throughout the nuclear fuel cycle. The Monte Carlo Neutron Particle (MCNP) Code and the Transient Reactor Analysis Code (TRAC), both developed at Los Alamos, are gold standards in international nuclear modeling. The International Atomic Energy Agency has used MCNP for over 30 years to track nuclear materials worldwide, and the Nuclear Regulatory Agency used TRAC safety evaluations to extend the lives of 18 nuclear reactors for more than 20 years.

In addition to modeling and simulation, it will take real testing of materials, and Los Alamos' Materials Test Station is the only facility in the U.S. that could expose new candidate fuels to the same conditions found in an advanced burner reactor. The Laboratory also has the materials science, chemistry, and metallurgy facilities to perfect the fabrication and scale-up of the new fuels.

Los Alamos uses hot cells to develop remote nuclear fuel fabrication techniques and conduct advanced materials research.

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