Testimony of R. E. Smalley to the Senate Committee on Energy and Natural Resources; Hearing on sustainable , low emission, electricity generation, April 27, 2004

Energy is the single most important challenge facing humanity today.

As we peak in oil production and worry about how long natural gas will last, life must go on. Somehow we must find the basis for energy prosperity for ourselves and the rest of humanity for the 21st century. By the middle of this century we should assume we will need to at least double world energy production from its current level, with most of this coming from some clean, sustainable, CO_2-free source.

For worldwide peace and prosperity it must be cheap.

We simply cannot do this with current technology. We will need revolutionary breakthroughs to even get close.

I am an American scientist brought up in the Midwest during the Sputnik era, and like so many of my colleagues in the US and worldwide, I am a technological optimist. I think we can do it. We can find "the New Oil", the new technology that provides the massive clean, low cost energy necessary for advanced civilization of the 10 billion souls we expect to be living on this planet before this century is out.

Electricity will be the key.

Consider, for example, a vast interconnected electrical energy grid for the North American Continent from above the Artic Circle to below the Panama Canal. By 2050 this grid will interconnect several hundred million local sites. There are two key aspects of this future grid that will make a huge difference: (1) massive long distance electrical power transmission, and (2) local storage of electrical power with real time pricing.

Storage of electrical power is critical for stability and robustness of the electrical power grid, and it is absolutely essential if we are ever to use solar and wind as our dominant primary power source. The best place to provide this storage is locally, near the point of use. Imagine by 2050 that every house, every business, every building has its own local electrical energy storage device, an uninterruptible power supply capable of handling the entire needs of the owner for 24 hours. Since the devices are small, and relatively inexpensive, the owners can replace them with new models every 5 years or so as worldwide technological innovation and free enterprise continuously and rapidly develop improvements in this most critical of all aspects of the electrical energy grid.

Today using lead-acid storage batteries, such a unit for a typical house to store 100 kilowatt hours of electrical energy would take up a small room and cost over $10,000. Through revolutionary advances in nanotechnology, it may be possible to shrink an equivalent unit to the size of a washing machine, and drop the cost to less than $1,000. With intense research and entrepreneural effort, many schemes are likely to be developed over the years to supply this local energy storage market that may expand to several billion units worldwide.

With these advances the electrical grid can become exceedingly robust, since local storage protects customers from power fluctuations and outages. With real-time pricing, the local customers have incentive to take power from the grid when it is cheapest. This in turn permits the primary electrical energy providers to deliver their power to the grid when it is most efficient for them to do so, and vastly reduce the requirements for reserve capacity to follow peaks in demand. Most importantly, it permits a large portion -- or even all -- of the primary electrical power on the grid to come from solar and wind.

The other critical innovation needed is massive electrical power transmission over continental distances, permitting, for example, hundreds of gigawatts of electrical power to be transported from solar farms in New Mexico to markets in New England. Then all primary power producers can compete with little concern for the actual distance to market. Clean coal plants in Wyoming, stranded gas in Alaska, wind farms in North Dakota, hydroelectric power from northern British Columbia, biomass energy from Mississippi, nuclear power from Hanford Washington, and solar power from the vast western deserts, etc., remote power plants from all over the continent contribute power to consumers thousands of miles away on the grid. Everybody plays. Nanotechnology in the form of single-walled carbon nanotubes (a.k.a. “buckytubes”) forming what we call the Armchair Quantum Wire may play a big role in this new electrical transmission system.

Such innovations in power transmission, power storage, and the massive primary power generation technologies themselves, can only come from miraculous discoveries in science together with free enterprise in open competition for huge worldwide markets.

America, the land of technological optimists, the land of Thomas Edison, should take the lead. We should launch a bold New Energy Research Program. Just a nickel from every gallon of gasoline, diesel, fuel oil, and jet fuel would generate $10 billion a year. That would be enough to **transform** the physical sciences and engineering in this country. Sustained year after year, this New Energy Research Program will inspire a new Sputnik Generation of American scientists and engineers. At minimum it will generate a cornucopia of new technologies that will drive wealth and job creation in our country. At best we will solve the energy problem within this next generation; solve it for ourselves and, by example, solve it for the rest of humanity as well.

Give a nickel. Save the world.