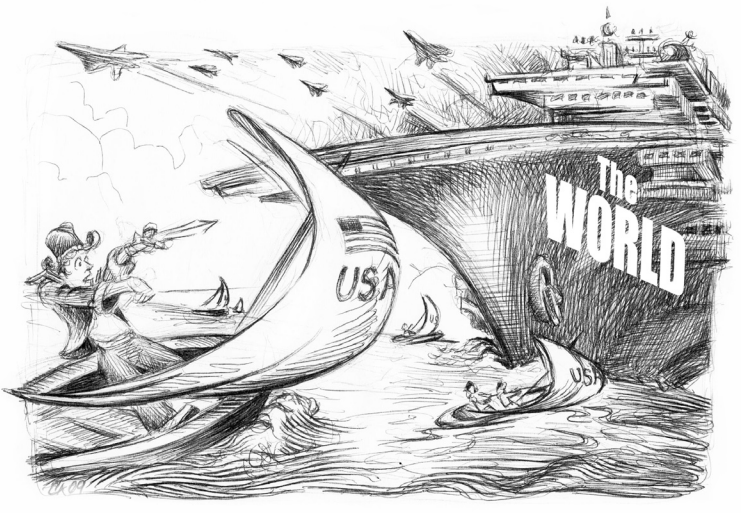
Going to War in Sailboats



Why Nuclear Power Beats Windmills for America's Green Energy Future

Five Addresses by
United States Senator Lamar Alexander (R. Tenn)
Chairman, Senate Republican Conference

2010

Preface

During 2009, America's national energy policy looked more like a national windmill policy—the equivalent of going to war in sailboats. If we were going to war, the United States would not think of putting its nuclear navy in mothballs. Yet, we did mothball our nuclear plant construction program—our best weapon against climate change, high electricity prices, polluted air and energy insecurity. Although 107 reactors were completed between 1970 and 1990 producing 20 percent of our electricity today—*which is 69 percent of our carbon free electricity*—the United States has not started a new nuclear reactor in thirty years.

Instead of using our own nuclear power invention to catch up with the rest of the world, President Obama in his Inaugural Address set out on a different path: America would rely upon "the sun, the winds and the soil" for energy. There was no mention of nuclear. Windmills would produce 20 percent of our electricity. To achieve this goal, the federal government has committed nearly $30 billion in subsidies and tax breaks for wind developers who are primarily large banks, corporations and wealthy individuals. According to the Energy Information Administration, Big Wind receives an $18.82 subsidy per megawatt hour, *twenty-five times as much per megawatt hour as subsidies for all other forms of electricity production combined!* Two billion of these subsidy dollars were in last year's jobs stimulus bill, but unfortunately they mostly created jobs in China and Spain.

According to an American University study, nearly 80 percent of that $2 billion went to overseas manufacturers. And despite the billions in subsidies, not much energy is being produced. Wind accounts for just 1.3 percent of America's electricity, available only when the wind blows since wind power can't be stored except in small amounts.

Conservation groups have begun to worry about "renewable energy sprawl." For example, producing 20 percent of U.S. electricity from wind would cover an area the size of West Virginia with 186,000 turbines and require 19,000 new miles of transmission lines. These are not your grandmother's windmills. Turbines are fifty stories high. Their flashing lights can be seen for twenty miles. An unbroken line of giant turbines along the 2,178-mile Appalachian Trail (except for coastlines, ridgetops are about the only place turbines work well in much of the East) would produce no more electricity than four nuclear reactors on four square miles of land—and, of course, you'd still need the reactors for when the wind doesn't blow.

There are other ways a national windmill policy also risks destroying the environment in the name of saving the environment. The American Bird Conservancy estimates that the 25,000 U.S. wind turbines kill 75,000 to 275,000 birds per year. Imagine what 186,000 turbines would do. One wind farm near Oakland, California, estimates that its turbines kill eighty golden eagles a year. To be sure, similar concerns about sprawl exist for other forms of renewable energy. For example, it would take continuously foresting an area one-and-a-half times the size of the Great Smoky Mountains National Park to produce enough electricity from biomass to equal the electricity produced by one nuclear reactor. And a new solar thermal plant planned for

California's Mojave Desert was to cover an area three miles by three miles, until environmental objections stopped it.

At least for the next couple of decades, relying on wind to provide our nation's clean electricity needs would be like wandering off track from your house in Virginia through San Francisco on the way to the corner grocery store. This unnecessary journey offends the common sense theory of parsimony, defined by scientist Spencer Wells as "don't overcomplicate… if a simpler possibility exists." The simpler possibility that exists for producing lots of low-cost, reliable green electricity is to build 100 new nuclear plants, doubling U.S. nuclear power production. In other words, instead of traveling through San Francisco on your way to the corner grocery store, do again what our country did between 1970 and 1990. Build 100 reactors on 100 square miles of space (several would be built on existing reactor sites) —compared with the 126,848 new square miles needed to produce that much electricity from biomass or the 26,170 square miles needed for wind.

Unlike wind turbines, 100 new reactors would require few new transmission lines through suburban backyards and pristine open spaces. They would also require much less taxpayer support. At current rates of subsidy, taxpayers would shell out $170 billion to subsidize the 186,000 wind turbines necessary to equal the power of 100 reactors. While federal government loan guarantees should jump-start the first few reactors, the subsidy cost to taxpayers of building 100 reactors would be one-tenth as much.

My concern about the unrealistic direction of our "national windmill policy" led to the five addresses on clean energy collected in

this booklet. The first of these I delivered at the Oak Ridge National Laboratory nearly two years ago calling for a New Manhattan Project, like the one we had in World War II, but this time for clean energy independence. Then, a year ago at Oak Ridge, I proposed building 100 new nuclear plants, a goal that all forty Senate Republicans adopted along with three other goals: electrifying half our cars and trucks, expanding offshore exploration for natural gas and oil, and doubling clean energy research and development.

My concern during 2009 deepened as members of the Obama administration, with the conspicuous exception of Energy Secretary Stephen Chu, seemed to develop a stomachache whenever nuclear power was mentioned. The President himself seemed unable to mention the subject. Last year, at a climate change summit in New York City, President Obama chided world leaders for not doing more to address climate change, but did not mention the words "nuclear power" during his entire speech—ironic because many of the countries he was lecturing were making plans to build nuclear plants to produce carbon-free electricity, and we were not. Climate change was the inconvenient problem, but nuclear power seemed to be the inconvenient solution.

Fortunately, with the arrival of 2010 has come a more welcoming environment for nuclear power. In his State of the Union address, President Obama called for "a new generation of safe, clean nuclear reactors." His 2011 budget request recommends tripling loan guarantees for the first reactors, and last week his administration announced the awarding of the first two loan guarantees for nuclear power. He has selected distinguished members, both for the Nuclear Regulatory

Commission and for a new Blue Ribbon Commission to figure out the best way to dispose of spent nuclear fuel. Democratic senators—several of whom, in fairness, have long been supporters of nuclear energy—have joined the forty Republicans to create bipartisan support. Last December, Democratic Senator Jim Webb of Virginia, a former Navy secretary, and I introduced legislation to double nuclear power production and to accelerate support for alternative forms of clean energy.

There seems to be a growing public understanding that nuclear reactors are as safe as other forms of energy production. A nuclear plant is not a bomb; it can't blow up. Our sailors have lived literally on top of reactors for sixty years without a nuclear incident. And most scientists agree that it is safe to store used nuclear fuel on site for sixty to eighty years while they figure out how to recycle used fuel in a way that reduces its mass by 97 percent, reduces its radioactive lifetime by 99 percent, and does not allow the isolation of plutonium—which could be dangerous in the wrong hands. In addition, there is a growing realization by those who worry about climate change that if Americans want to keep consuming one-fourth of the world's electricity, and we want large amounts of it to be low-cost and carbon-free, nuclear power is the only answer for now.

It has also helped, and been a little embarrassing, that the rest of the world has been teaching Americans the lesson that we first taught them. China is starting a new nuclear reactor every three months. France is 80 percent nuclear and has electricity rates and carbon emissions that are among the lowest in Europe. Japan gets 35 percent of its electricity from nuclear and plans ten more reactors by 2018. There

are fifty-five new reactors under construction in fourteen countries around the world—none of them in the United States.

I believe we must address human causes of climate change as well as air pollution that is caused by sulfur, nitrogen and mercury emissions from coal plants. But I also believe in the common-sense theory of parsimony: don't overcomplicate things if a simpler possibility exists. My formula for the simplest way to reach the necessary carbon goals for climate change without damaging the environment and without running jobs overseas in search of cheap energy is this:

(1) Build 100 new nuclear power plants in twenty years;

(2) electrify half our cars and trucks in twenty years (if we plug vehicles in at night, we probably have enough electricity to do this without building one extra power plant);

(3) explore for more low-carbon natural gas and the oil we still need;

(4) launch "mini Manhattan Projects" to invent the low cost five hundred mile battery for electric cars and a fifty percent efficient solar panel for rooftops that is cost-competitive with other forms of electricity, as well as better ways to recycle used nuclear fuel, to create advanced biofuels, and to recapture carbon from coal plants.

These four steps should produce the largest amount of energy with the smallest amount of pollution at the lowest possible cost, thereby avoiding the pain and suffering that comes when high energy costs push jobs overseas and make it hard for many low-income Americans to afford heating and cooling bills.

One day solar and other renewable energy forms will be cheap and efficient enough to provide an important supplement to our energy needs and can do so in a way that minimizes damage to treasured landscapes. Today, nuclear power beats windmills for America's green energy future.

Lamar Alexander
February 25, 2010

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"A NEW MANHATTAN PROJECT FOR CLEAN ENERGY INDEPENDENCE"

Delivered May 9, 2008, at the Oak Ridge National Laboratory

In 1942, President Franklin D. Roosevelt asked Senator Kenneth McKellar, the Tennessean who chaired the Appropriations Committee, to hide $2 billion in the appropriations bill for a secret project to win World War II.

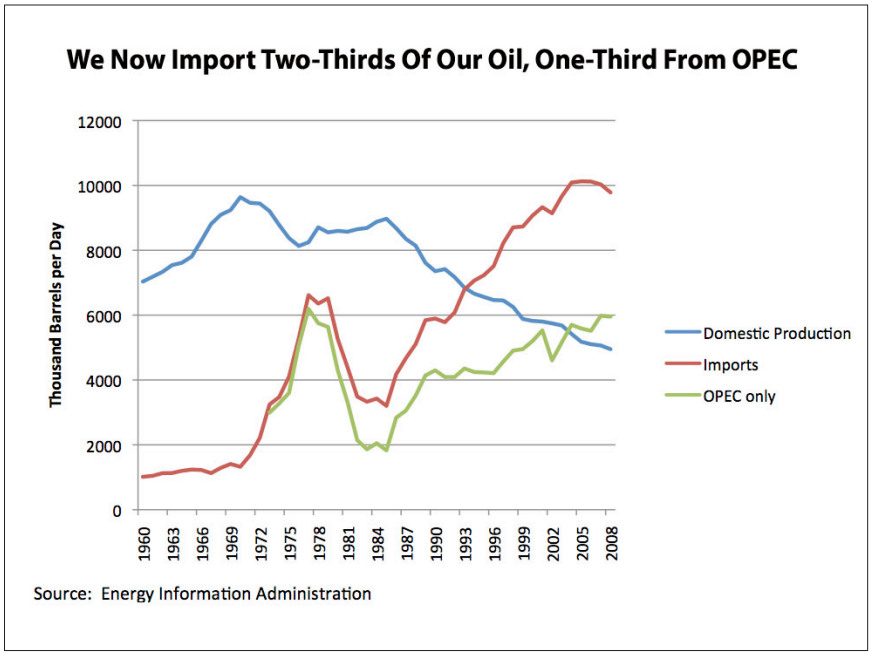
Senator McKellar replied, "Mr. President, I have just one question: where in Tennessee do you want me to hide it?"

"By independence I mean that the United States could never be held hostage by any country for our energy needs."

That place in Tennessee turned out to be Oak Ridge, one of three secret cities that became the principal sites for the Manhattan Project.

The purpose of the Manhattan Project was to find a way to split the atom and build a bomb before Germany could. Nearly 200,000 people worked secretly in thirty different sites in three countries. President Roosevelt's $2 billion appropriation would be $24 billion today.

According to *New York Times* science reporter William Laurence, "Into [the bomb's] design went millions of man-hours of what is without doubt the most concentrated intellectual effort in history."



I am in Oak Ridge today to propose that the United States launch a new Manhattan Project: a five-year project to put America firmly on the path to clean energy independence.

Instead of ending a war, the goal will be clean energy independence – so that we can deal with rising gasoline prices, electricity prices, clean air, climate change and national security – for our country first and, because other countries have the same urgent needs and therefore will adopt our ideas, for the rest of the world.

By independence I do not mean that the United States would never buy oil from Mexico or Canada or Saudi Arabia. By independence I *do* mean that the United States could never be held hostage by any country for our energy needs.

In 1942, many were afraid that the first country to build an atomic bomb could blackmail the rest of the world. Today, countries that supply oil and natural gas can blackmail the rest of the world.

We've done it before, we can do it again.

A new Manhattan Project is not a new idea – but it is a good idea and fits the goal of clean energy independence.

The Apollo Program to send men to the moon in the 1960s was a kind of Manhattan Project. Presidential candidates John McCain and Barack Obama have called for a Manhattan Project for new energy sources. So have former House Speaker Newt Gingrich, Democratic National Committee Chairman Howard Dean, Senator Susan Collins of Maine and Senator Kit Bond of Missouri – among others.

And, throughout the two years of discussion that led to the passage in 2007 of the America COMPETES Act, several participants suggested that focusing on energy independence would force the kind of investments in the physical sciences and research that the United States needs to maintain its competitiveness.

The overwhelming challenge in 1942 was the prospect that Germany would build the bomb and win the war before America did.

The overwhelming challenge today, according to National Academy of Sciences president Ralph Cicerone, in his address last week to the Academy's annual meeting, is to discover ways to satisfy the human demand for and use of energy in an environmentally satisfactory

and affordable way so that we are not overly dependent on overseas sources.

Cicerone estimates that this year Americans will pay $500 billion overseas for oil – that's $1,600 for each one of us – some of it to nations that are hostile or even trying to kill us by bankrolling terrorists. Sending $500 billion abroad weakens our dollar. It is half our trade deficit. It is forcing gasoline prices toward $4 a gallon and crushing family budgets.

"Congress doesn't do 'comprehensive' well. Step-by-step solutions are easier to digest and have fewer surprises."

Then there are the environmental consequences. If worldwide energy usage continues to grow as it has, humans will inject as much CO_2 into the air from fossil fuel burning between 2000 and 2030 as they did between 1850 and 2000. There is plenty of coal to help achieve our energy independence, but there is no commercial way (yet) to capture and store the carbon from so much coal burning – and we have not finished the job of controlling sulfur, nitrogen and mercury emissions.

In addition to the need to meet an overwhelming challenge, other characteristics of the original Manhattan Project are suited to this new challenge:

- It needs to proceed as fast as possible along several tracks to reach the goal. According to Don Gillespie, a young engineer at Los Alamos during World War II, the "entire project was

being conducted using a shotgun approach, trying all possible approaches simultaneously, without regard to cost, to speed toward a conclusion."

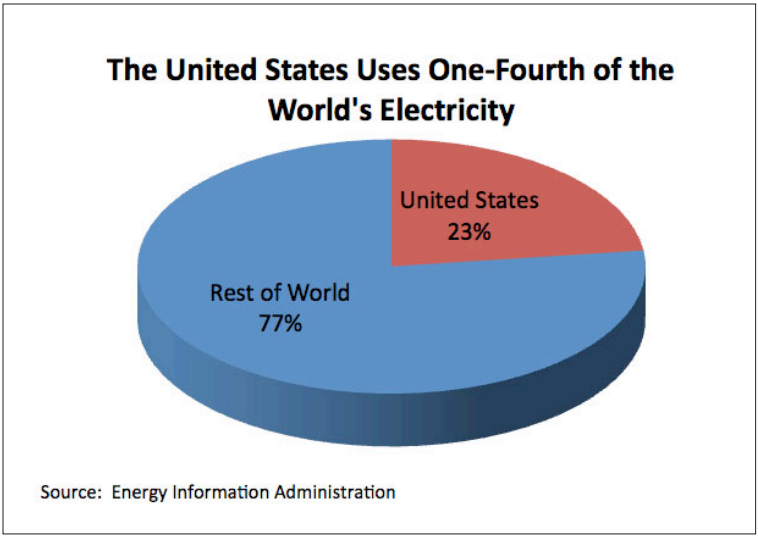
- It needs presidential focus and bipartisan support in Congress.

- It needs the kind of centralized, gruff leadership that General Leslie R. Groves of the Army Corps of Engineers gave the first Manhattan Project.

- It needs to "break the mold." To borrow the words of Dr. J. Robert Oppenheimer in a speech to Los Alamos scientists in November of 1945, the challenge of clean energy independence is "too revolutionary to consider in the framework of old ideas."

- Most important, in the words of George Cowan, as reported by Cynthia C. Kelly's excellent book on the history of the era, "The Manhattan Project model starts with a small, diverse group of great minds."

Congress doesn't do "comprehensive" well, as was demonstrated by the collapse of the comprehensive immigration bill. Step-by-step solutions or different tracks toward one goal are easier to digest and have fewer surprises. And, of course, the original Manhattan Project itself proceeded along several tracks toward one goal.



Here are my criteria for choosing several grand challenges:

- *Grand consequences, too* – The United States uses 25 percent of all the energy in the world. Interesting solutions for small problems producing small results should be a part of some other project.

- *Real scientific breakthroughs* – This is not about drilling off-shore for oil or natural gas in an environmentally clean way or building a new generation of nuclear power plants, both of which we already know how to do – and, in my opinion, should be doing.

- *Five years* – Grand challenges should put the United States within five years firmly on a path to clean energy independence so that goal can be achieved within a generation.

- *Family Budget* – Solutions need to fit the family budget, and costs of different solutions need to be compared.

- *Consensus* – The Augustine panel that drafted the "Gathering Storm" report wisely avoided some germane topics, such as excessive litigation, upon which they could not agree, figuring that Congress might not be able to agree either.

"The electric cars are coming. We have the plug. All we need is the cord."

Here is where I invite your help. Rather than having members of Congress proclaim these challenges, or asking scientists alone to suggest them, I believe there needs to be preliminary discussion – including about whether the criteria are correct. Then, Congress can pose to scientists questions about the steps to take to achieve the grand challenges.

The seven grand challenges

To begin the discussion, I suggest asking what steps Congress and the federal government should take during the next five years toward these seven grand challenges so that the United States would be firmly on the path toward clean energy independence within a generation:

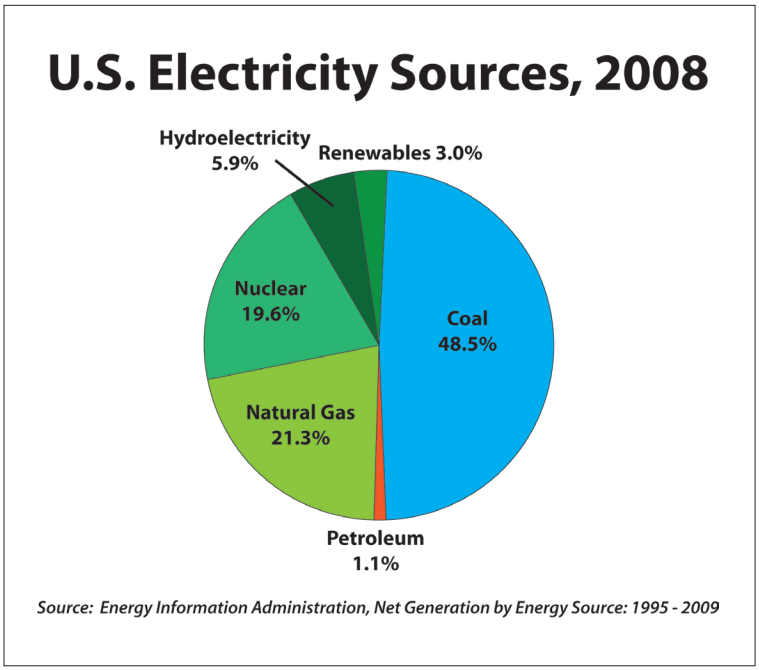
1. Make plug-in electric cars and trucks commonplace. In the 1960s, H. Ross Perot noticed that when banks in Texas locked their doors at 5 p.m., they also turned off their new computers. Perot bought the

idle nighttime bank computer capacity and made a deal with states to manage Medicare and Medicaid data. Banks made money, states saved money, and Perot made a billion dollars.

Idle nighttime bank computer capacity in the 1960s reminds me of idle nighttime power-plant capacity in 2008. This is why:

- The Tennessee Valley Authority has 7,000-8,000 megawatts – the equivalent of seven or eight nuclear power plants or fifteen coal plants – of unused electric capacity most nights.

- Beginning in 2010, Nissan, Toyota, General Motors and Ford will sell electric cars that can be plugged into wall sockets. FedEx is already using hybrid delivery trucks.



- TVA could offer "smart meters" that would allow its 8.7 million customers to plug in their vehicles to "fill up" at night for only a few dollars, in exchange for the customer paying more for electricity between 4 p.m. and 10 p.m. when the grid is busy.

Sixty percent of Americans drive less than thirty miles each day. Those Americans could drive a plug-in electric car or truck without using a drop of gasoline. By some estimates, there is so much idle electric capacity in power plants at night that over time we could replace three-fourths of our light vehicles with plug-ins. That could reduce our overseas oil bill from $500 billion to $250 billion – and do it all without building one new power plant.

In other words, we have the plug. The cars are coming. All we need is the cord.

Too good to be true? Haven't U.S. presidents back to Nixon promised revolutionary vehicles? Yes, but times have changed. Batteries are better. Gas is $4. We are angry about sending so many dollars overseas, worried about climate change and clean air. And, consumers have already bought one million hybrid vehicles and are waiting in line to buy more – even without the plug-in. Down the road is the prospect of a hydrogen fuel-cell hybrid vehicle, with two engines – neither of which uses a drop of gasoline. Oak Ridge is evaluating these opportunities.

Still, there are obstacles. Expensive batteries make the additional cost per electric car $8,000-$11,000. Smart metering is not widespread. There will be increased pollution from the operation of coal plants at night. We know how to get rid of those sulfur, nitrogen and mercury pollutants (and should do it), but haven't yet found a way to get rid of the carbon produced by widespread use in coal-burning power plants. Which brings us to the second grand challenge:

2. Make carbon capture and storage a reality for coal-burning power plants. This was one of the National Institute of Engineering's grand challenges. And there may be solutions other than underground storage, such as using algae to capture carbon. Interestingly, the Natural Resources Defense Council argues that, after conservation, coal with carbon capture is the best option for clean energy independence because it provides for the growing power needs of the U.S. and will be easily adopted by other countries.

3. Make solar power cost-competitive with power from fossil fuels. This is a second of the National Institute's grand challenges. Solar power, despite fifty years of trying, produces one one-hundredth of one percent of America's electricity. The cost of putting solar panels on homes averages $25,000-$30,000, and the electricity produced, for the most part, can't be stored. Now, there is new photovoltaic research as well as promising solar thermal power plants, which capture the sunlight using mirrors, turn heat into steam, and store it underground until the customer needs it.

4. Safely recycle and store spent nuclear fuel. Nuclear plants produce 20 percent of America's electricity, but 70 percent of America's clean electricity – that is, electricity that does not pollute the air with

mercury, nitrogen, sulfur or carbon. The most important breakthrough needed during the next five years to build more nuclear power plants is solving the problem of what to do with used nuclear fuel. A political stalemate has stopped used nuclear fuel from going to Yucca Mountain in Nevada, and $15 billion collected from ratepayers for that purpose is sitting in a bank. Recycling used fuel could reduce its mass by 97 percent, creating less stuff to store temporarily while long-term storage is resolved.

5. *Make advanced biofuels cost-competitive with gasoline*. The backlash against ethanol made from corn because of its effect on food prices is a reminder to beware of the great law of unintended consequences when issuing grand challenges. Ethanol from cellulosic materials shows great promise, but there are a limited number of cars capable of using alternative fuels and of places for drivers to buy it. Turning coal into liquid fuel is an established technology, but expensive and a producer of much carbon.

6. *Make new buildings green buildings*. Japan believes it may miss its 2012 Kyoto goals for greenhouse gas reductions primarily because of energy wasted by inefficient buildings. Many of the technologies needed to do this are known. Figuring out how to accelerate their use in a decentralized society is most of this grand challenge.

7. *Provide energy from fusion*. The idea of recreating on Earth the way the sun creates energy and using it for commercial power is the third grand challenge suggested by the National Institute of Engineering. The promise of sustaining a controlled fusion reaction for commercial power generation is so fantastic that the five-year goal should be to do everything possible to reach the long-term goal. The

failure of Congress to approve the President's budget request for U.S. participation in the International Thermonuclear Experimental Reactor – the ITER Project – is embarrassing.

Dealing with the "gathering storm."

This country of ours is a remarkable place. Even during an economic slowdown, we will produce this year about 30 percent of all the wealth in the world for the 5 percent of us who live in the United States. Despite "the gathering storm" of concern about American competitiveness, no other country approaches our brainpower advantage – the collection of research universities, national laboratories and private-sector companies we have.

And this is still the only country where people say with a straight face that anything is possible – and really believe it.

These are precisely the ingredients that America needs during the next five years to place ourselves firmly on a path to clean energy independence within a generation – and in doing so, to make our jobs more secure, to help balance the family budget, to make our air cleaner and our planet safer and healthier – and to lead the world to do the same.

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"BUILD 100 NEW NUCLEAR POWER PLANTS IN TWENTY YEARS: FOR A REBIRTH OF INDUSTRIAL AMERICA WHILE WE FIGURE OUT RENEWABLE ELECTRICITY"

Delivered May 27, 2009, at the Tennessee Valley Corridor Summit Oak Ridge, Tennessee

One year ago I came to Oak Ridge to propose a new "Manhattan Project" to put America on the path to clean energy independence. The project would focus on seven "grand challenges": plug-in electric cars and trucks, carbon capture from coal plants, making solar power cost-competitive, recycling used nuclear fuel, advanced biofuels from crops we *don't* eat, green buildings, and finally, fusion.

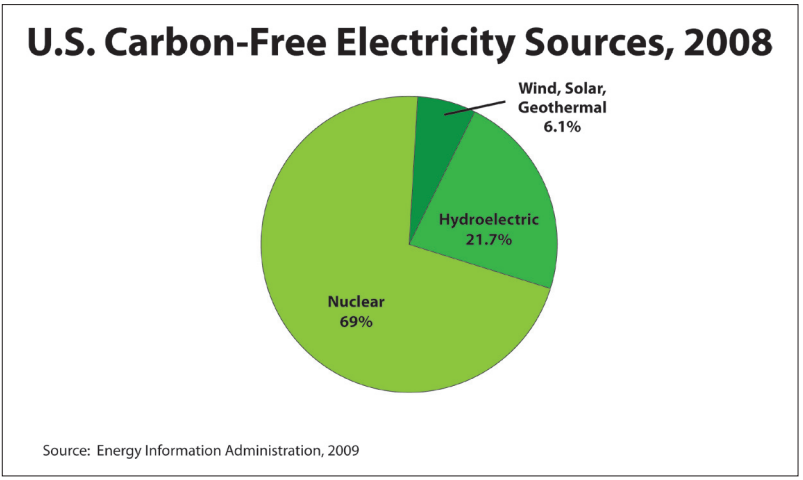
Today I am in Oak Ridge to propose that the United States build 100 new nuclear power plants during the next twenty years while scientists and engineers figure out these grand challenges. This would double America's nuclear plants that today produce 20 percent of *all* our electricity, and 70 percent of our *pollution-free, carbon-free* electricity.

"There is a huge gap between renewable energy we would like to have and the reliable, low-cost electricity we must have."

It is an aggressive goal, but with presidential leadership it could happen. And I am convinced it should happen because conservation and nuclear power are the only real alternatives we have today to produce enough low-cost, reliable, clean electricity to clean the air, deal with climate change, and keep good jobs from going overseas.

Climate change may be the inconvenient problem of the day, but nuclear power is the inconvenient solution.

The nuclear skeptics don't agree. They cite regulatory delays, bring up past problems with safety, and appoint commissions to slow-walk



decisions about recycling used nuclear fuel. They point to the shortage of welders for new plants. They complain that Japan and France are building most of the essential equipment for new nuclear plants — no surprise since Japan is building one nuclear plant a year and France is producing 80 percent of its electricity from nuclear. The skeptics say that carbon from coal plants contributes to climate change, which is true, and so they offer their solution: operate our big complex country, which uses 25 percent of all the energy in the world, on electricity generated from the wind, the sun and the earth.

One day, that might be possible. But today there is a huge energy gap between the renewable electricity we would like to have and the reliable, low-cost electricity we must have. My guess is it will be

thirty, forty, or fifty years before these new sources of electricity are cheap enough and reliable enough to supply most of the power to our electric grid – if it ever happens.

Expecting too much from renewable resources

The nuclear skeptics in Congress, urged along by the President, reported last week an energy and climate change bill that would require 20 percent of our electricity to be made from a narrow definition of renewable energy.

You are meeting in Oak Ridge to discuss how to attract and keep high tech jobs in this region. So let me try to paint a picture of how this legislation would affect you, and what we should do instead.

To put things in perspective, the Tennessee Valley Authority produces on average about 27,000 megawatts of electricity for industrial and household customers in its seven-state region. Sixty percent comes from coal, 30 percent from nuclear, 8 percent from hydroelectric power and 1 percent from natural gas. Nationally, it is 50 percent coal, 21 percent natural gas, 19 percent nuclear and 6 percent hydro.

Nationally, only one and one-half percent of electricity comes from the sun, the wind and the earth, and almost none of TVA's power does. But the 40 percent of TVA power that comes from nuclear and hydro is just as clean as these narrowly defined renewables – free of pollution that dirties the air and of carbon that contributes to global warming. In that sense, TVA is the 16th cleanest utility in the country.

Here is another yardstick: the new nuclear unit at Watts Bar can produce 1240 megawatts, the Bull Run coal plant 870 megawatts, the Fort Loudoun Dam 150 megawatts. All three operate almost all the time. That is called base load power, which is important since large amounts of electrical power can't be stored. Some forget that solar power is only available when the sun shines, and the wind is available only when the wind blows.

So how much renewable electricity is available in our region? The new solar plant Governor Bredesen has proposed for Haywood County will produce five megawatts. That's 1/30th of the Fort Loudoun Dam, which is not a very large dam. The eighteen big wind turbines atop Buffalo Mountain just a few miles away have the capacity to produce twenty-nine megawatts, but actually produce only six megawatts. It may also be possible to squeeze a few hundred megawatts from turbines in the Mississippi River. The Southern Company's new biomass plant in Georgia — biomass is a sort of controlled bonfire of waste wood products — will produce ninety-six megawatts. That's less than 1/10th the size of a conventional coal plant.

Each of these sources of renewable energy consumes a lot of space. For example, the big solar thermal plants in the Western desert where they line up mirrors to focus the sun's rays take more than thirty square miles – that's more than five miles on a side – to produce the same 1000 megawatts you can get from a single coal or nuclear plant that sits on one square mile.

Or take wind – to generate the same 1000 megawatts with wind you would need 270 square miles. An unbroken line of wind turbines fifty stories high from Chattanooga to Bristol would only give us one-

fourth of the electricity we get from one unit at Watts Bar – which fits on less than one square mile – and we'd still need Watts Bar to back it up when the wind doesn't blow. There is a good reason why there is only one wind farm in the entire southeast – here, the wind blows less than 20 percent of the time and much of the time is at night, when TVA has thousands of megawatts of unused electricity.

Biomass, we are told, will be the renewable source we're going to emphasize in the South. That's a good idea. It might reduce forest fires and will conserve resources. The National Forest Service tells us there are two million tons of wood scraps and dead trees in Tennessee forests. And pulp and paper companies might produce another two million tons. But let's not expect too much. We'd need a forest the size of the entire 550,000-acre Great Smoky Mountains National Park to feed a 1000-megawatt biomass plant on a sustainable basis. And think of the energy it's going to take to haul all this stuff around. Georgia Southern says it will take 160-180 trucks a day to feed its 96-megawatt wood-burning plant.

"The point is, if you care about jobs of any color, be it green or red, white and blue, the cost of electricity matters."

Of course, conservation and efficiency are the places to start when looking at America's and Tennessee's electricity futures. Tennesseans use more electricity per person than residents of any other state. If we just reduced our use to the national average it would equal the electricity produced by four nuclear plants. We might still have to

build some new power plants because our experience is that conservation only limits electricity growth, it doesn't reduce it. For example, twenty years ago we never would have guessed that computers would be using nearly 5 percent of our electricity.

So you can see we are going to need some breakthroughs, something like a new Manhattan Project before we can rely very much on renewable electricity.

Of all these renewable forms of electricity, in my judgment, solar has the most promise. It takes up massive spaces, but we can use rooftops. It only works when the sun shines, but the sun shines during peak times of electricity use. I believe Governor Bredesen is exactly right to try to make Tennessee a hub for solar power. The first grand challenge of my proposed Manhattan Project is to try to make solar power cost-competitive. According to TVA, in our region, solar costs four-five times as much as the baseload electricity TVA now produces.

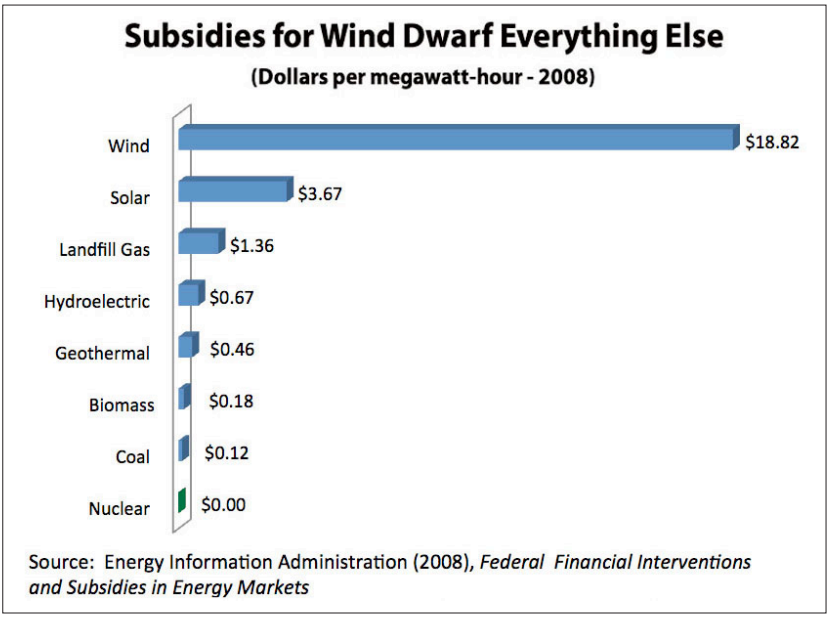
Wind power, on the other hand, can supplement electricity on the Great Plains or offshore, but for our region it would be a terrible mistake. Here, it is a waste of money and destroys the environment in the name of saving the environment. The turbines are three times as high as Neyland Stadium. In our region they only work on mountaintops where the winds are strongest, and they barely work there. And I haven't even mentioned the new transmission lines necessary from the mountaintops through your backyard. Someone asked Boone Pickens if he would put any of these turbines on his 68,000-acre ranch in Texas. "Hell no," he said, "They're ugly." Well, if

Boone doesn't want them on his ranch, why would we want them on the most beautiful mountaintops in America?

Is it enough to say we are creating "green jobs"?

Some of the jobs you will be growing and attracting to this high technology area will be so-called "green jobs" created as scientists and engineers work on the grand challenges. Please remember that nuclear power is also green, that electric cars and trucks are green, and that one-third of Tennessee's manufacturing jobs are auto-related.

And even "green jobs" need low-cost electricity. The two new poly-silicon plants – locating in Cleveland and Clarksville to manufacture poly-silicon for solar cells – together use 240 megawatts of electricity, about one-fifth of the production of the new nuclear unit at Watts Bar. And don't forget about places like Alcoa, which has closed its smelter



Source: Energy Information Administration (2008), *Federal Financial Interventions and Subsidies in Energy Markets*

in Blount County until it can get a twenty-year low-cost electricity contract from TVA. Or the steady stream of regional manufacturers who have been to my office saying that electric rates are already too high for them to keep jobs here.

The point is, if you care about jobs of any color, be it green or red, white and blue, the cost of electricity matters. That is why it is especially galling to see France—a country we usually don't like to emulate—using the technology we invented to give themselves some of the lowest electric rates and lowest carbon emissions in the European Union.

Whatever happened to nuclear?

So why is it that nuclear energy, perhaps the most important scientific advance of the 20th century, was invented in America, yet we have stopped taking advantage of it just when we most need it?

"As Oak Ridge National Laboratory workers know better than almost anyone, a reactor is not a bomb."

Shortly after World War II, Glenn Seaborg, the great American Nobel Prize winner, said that nuclear energy had come along just in time because we were reaching the limits of the fossil fuels. And he was right. The succeeding decades proved that fossil fuels are not unlimited and their supplies can seriously compromise our energy independence. And that doesn't even begin to address global warming.

Yes, I do believe global warming and climate change are problems we must address. We can't go on throwing three billion tons of carbon dioxide into the atmosphere every year without running into some kind of trouble. Every session I have been in Congress, I have introduced legislation to cap carbon emissions from coal plants.

The way both to deal with global warming and to keep our jobs is to encourage what is being called the "Nuclear Renaissance" and start making nuclear energy the backbone of a new industrial economy. Right now there are seventeen proposals for twenty-six new reactors in licensing hearings before the Nuclear Regulatory Commission. That's a start. But I think we need to go well beyond that. I propose that from the years 2010 to 2030 we build 100 new nuclear reactors to match the ones we already have operating. That's what we did from 1970 to 1990. During that twenty-year interval, we built almost every one of the 104 reactors that now provide us with 20 percent of our electricity. If we built another 100 by 2030, we'll be able to provide well over 40 percent. Clean hydropower provides 6 percent of our electricity and with the electrification of small dams around the country we may be able to expand this to 8 percent. With diligent conservation, and other renewable resources, we can add another 10 to 12 percent. Then, my friends, we'll be talking about a clean energy economy!

Still, that's only the beginning. The second largest source of carbon emissions – and the biggest source of our energy instability – is the twenty million barrels of oil we consume everyday to run our cars and trucks. I believe we should make half our cars and trucks plug-in within twenty years. That would reduce by one-third the oil we import from foreign sources. The Brookings Institution scholars estimate

that we can power those cars and trucks by plugging them in at night without building one new power plant. As our fleet of electric vehicles grows, the most logical option for plugging in will be supplied by clean nuclear power. Until we make great advances in storage batteries, it can't be electricity that's sometimes there and sometimes not. We can't have Americans going to bed every night praying for a strong wind so they can start their cars in the morning.

What if there was another Three Mile Island?

Still, when it comes to nuclear power, a lot of people worry about safety. They say, "Nuclear power sounds great to me, but I'm afraid one of those reactors is going to blow up and cause a nuclear holocaust."

Well, let's be clear about a few things. As Oak Ridgers know better than almost anyone, a reactor is not a bomb. It can't blow up, that's impossible. There's not enough fissionable material present.

What a nuclear reactor can do is overheat if it loses its cooling water, just the way your car engine can overheat and break down if it loses its antifreeze. It's called a meltdown. Nuclear scientists have worried about this from the beginning and take many precautions to prevent this from happening.

Nuclear skeptics like to bring up Three Mile Island. So let's talk about that. What happened at Three Mile Island was basically an operator error. A valve failed, and when the automatic safety mechanism kicked in, the operators overrode it because a mass of flashing

lights and sirens on the control panel confused them about what was happening.

> ***"The valve that failed at Three Mile Isand had failed nine times before but the manufacturer kept it a secret."***

Three Mile Island completely changed the nuclear industry. The Kemeny Commission, appointed by President Jimmy Carter, analyzed the problems and made many recommendations, all of which were put into practice. The valve that started the whole thing had failed ***nine times before*** in other reactors, but the manufacturer had tried to keep it a secret. People in the nuclear industry just didn't talk to each other.

Now all of that has changed. Nuclear operators train for five years before they can take over in the control room. They spend one week out of every five in a simulator honing their skills. The nuclear companies have special emergency teams that can be dispatched anywhere in the country at a moment's notice in case anything goes wrong. A Nuclear Regulatory Commission inspector practically lives on the site. What's more, every reactor in the country is on the hook for $100 million if something goes wrong at another reactor. As you can imagine, they watch each other very carefully.

And it shows. Our entire nuclear fleet – 104 reactors – is now up and running ***90 percent*** of the time. There has been only one yearlong shutdown for safety problems in the last decade. We've added the equivalent of twenty-nine new reactors since 1990 just by doing a

better job of running the ones we already have. If the rest of America ran as well as the nuclear industry, we'd probably still be the world's dominant manufacturer.

"But what about Chernobyl?" someone will say. "Wasn't that a nuclear catastrophe?" Well, the Soviets did things very differently at Chernobyl than how we do it in this country. For one thing, they didn't put a containment structure around the reactor, which is like not putting a roof on your house and then acting surprised when the rain starts pouring in. They also did something no American power reactor has ever done – they surrounded the core with carbon in the form of graphite. That's like building your reactor in the middle of a charcoal grill. When the reactor overheated, the graphite caught fire, spewing radioactive smoke all over the world. That could never happen at an American reactor – and it won't happen again in Russia since they've made a lot of changes over there, and now they are building reactors the same way we build reactors.

"What we're talking about here is essentially a rebirth of Industrial America."

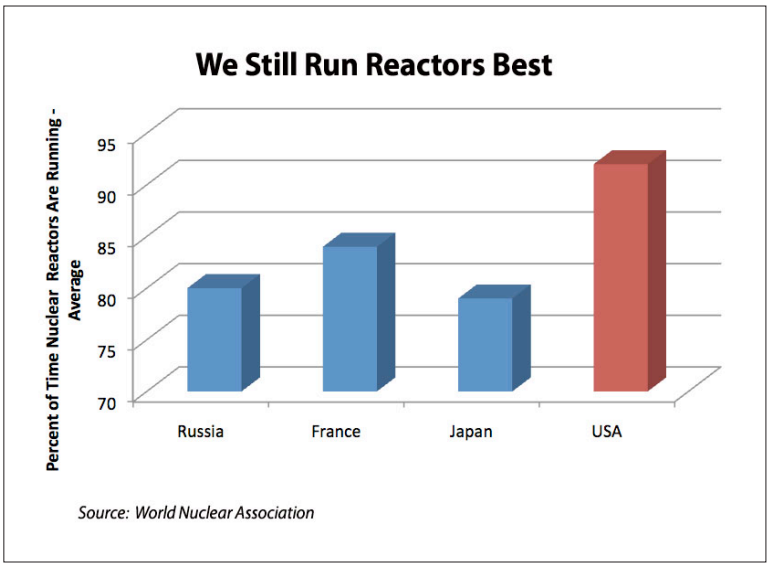
So why not build another generation of reactors?

So let's build 100 new reactors in the next twenty years. Our new reactors have even better safety features– although it's never good to be overconfident. We've learned how to run the current fleet at its full potential. Most reactors are making close to $2 million a day.

The attorney general of Connecticut proposed a windfall profits tax a few years ago when fossil fuel prices went through the roof. He said it wasn't fair that reactors could run so cheaply. So why not expand on our winnings? Why not build another generation of reactors?

A lot of people still say it can't be done. They say we don't manufacture anything in America anymore. We have to import all our hard goods from China. They say we don't have the nuclear engineers to design the new generation. They say we don't have the specialty welders to forge the pieces together on-site. They say we can't manufacture the steel vessel heads anymore, and our steel forges aren't big enough. Right now, the only forge in the world big enough to make a reactor vessel is Japan Steel Works, and they've been backed up four years. People say our new plants will spend a decade standing in line behind the thirty-four other reactors that are already under construction in the world, mostly in Asia.

And you know something? They're right.



They're right because all the things they're saying here are true. We don't currently have a nuclear construction industry. But then they don't know America. America can respond to a challenge. Just as we rose to the occasion in 1943 when we built this complex here at Oak Ridge, so can we rise to the occasion today to build a new generation of nuclear reactors that will provide clean, reliable power for America for the rest of this century.

It's not going to be easy. What we're talking about here is essentially a rebirth of Industrial America. But it's already starting to happen. Westinghouse is opening a school for training welders who can knit together a containment structure strong enough to protect the environment from the reactor and the reactor from outside threats. Alstom, a French company, is investing $200 million in Chattanooga to manufacture heavy turbines for nuclear plants. We're now training a new generation of nuclear engineers to take over from the great generation that embraced the technology in the 1960s and 1970s. We have to find a steel manufacturer somewhere in this country that is willing to step up and say, "Here, we can do those forgings right here in Pennsylvania or Ohio or Michigan. We don't have to stand in line in Japan." And we have to find investors who are willing to put up their money and say, "Yes, I have faith in America. I have faith in technology. I'm ready to invest in building a cleaner, safer, more prosperous world."

With presidential leadership we could add more loan guarantees to accelerate construction, and could streamline the permit system to ensure that new reactors don't become ensnared in regulatory mazes or endless lawsuits. But we can't just sit on our hands, because in

America we don't sit around waiting for the government to do things for us. We do things for ourselves.

So the task we face here today is no less formidable than the task the Oak Ridge pioneers faced when they first arrived here in 1943. They were trying to save the world from Japanese militarism and Nazi totalitarianism. Now, we are trying to save the world from the pending disaster of dwindling energy supplies, the uncertain dangers of a warming planet, and the stagnation and decay that can only follow if we do not revive American industry.

So I ask you here today to join in the task of bringing about this Nuclear Renaissance, in helping to generate the Rebirth of an Industrial America.

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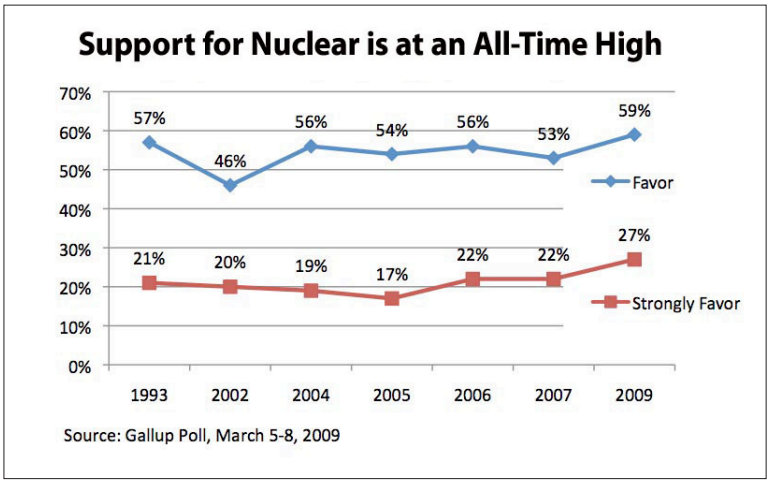
NATIONAL CLEAN ENERGY POLICY OR NATIONAL WINDMILL POLICY?

Speech delivered at the American Enterprise Institute, July 29, 2009

Today I want to challenge two popular misconceptions in the Waxman-Markey climate change and energy bill that is now before the Senate after passing the House of Representatives. *[The Senate later introduced its own version of climate legislation, the Kerry-Boxer Bill, in which most of the provisions discussed here were the same.]*

The first is the idea that deliberately raising energy prices will somehow be good for job growth and the economy.



The second is that, whatever the problems created by Waxman-Markey, they can mostly be resolved by building more windmills.

Waxman-Markey started out as a bill to reduce carbon emissions in order to deal with climate change. It has ended up as a $100-billion-a-year energy tax nailed to a renewable energy mandate that will saddle consumers with expensive energy for years to come. Instead of a broad-based, national clean energy policy, Waxman-Markey has given us a narrow, expensive national windmill policy.

I believe cheap energy means good jobs.

My perspective comes, of course, from Tennessee:

- *Alcoa* has shut down its smelter where my dad worked. They are waiting for a cheaper electricity contract from the Tennessee Valley Authority.

- *Goodman,* a company in Fayetteville that makes a large percentage of all the air conditioners in the United States, tells me that if their electricity prices go up too much then those jobs will go overseas.

- *Eastman Chemical* employs 7,000 Tennesseans and uses coal as a feedstock. The company says if Waxman-Markey goes through, they too might be headed overseas.

- *The Valero refinery in Memphis* employs 600 people refining fuels, including jet fuel for Federal Express at its Memphis hub. Waxman-Markey would cost Valero $400 million or more per year. Today its profits are $40 million per year at that refinery.

- We have two big *supercomputers* at the Oak Ridge National Laboratory in part because of our abundance of low-cost electricity. Just one of these machines consumes seven megawatts. Nationwide, computers use 5 percent of our electricity, and it's still growing.

- Our governor has attracted two manufacturing plants to make poly-silicon for solar cells – these are the "green jobs" everyone loves to talk about. Each of those plants consumes 120 megawatts. If they're going to make affordable solar cells, they can't pay high electricity costs.

- A third of Tennessee's manufacturing jobs are in auto manufacturing. Auto parts suppliers watch their costs, including electricity costs, and if they go up too much they will be making auto parts in Mexico and Japan instead of Tennessee and Michigan.

- Last December 10 percent of Nashvillians, even with TVA's relatively low residential electric rates, said they couldn't afford to pay their electric bills.

Do we want renewable energy or carbon-free energy ?

So let's step back for a moment and ask, "What kind of America are we trying to create with this climate-change and energy bill?"

- We want an America in which we have enough clean, cheap and reliable energy to create good jobs and run a prosperous industrial and high-tech society. In order to support the American economy that creates about 25 percent of the world's wealth, we need to produce about 25 percent of the world's energy.

- We want an America in which we are not creating excessive carbon emissions and running the risk of encouraging global warming.

- We want an America with cleaner air – where smog in Los Angeles and in the Great Smoky Mountains is a thing of the past – and where our children are less likely to suffer asthma attacks brought on by breathing pollutants.

- We want an America in which we are not creating "energy sprawl" by occupying vast tracts of farmlands, deserts and mountaintops with energy installations that ruin scenic landscapes. The Great American Outdoors is a revered part of the American character. We have spent a century preserving it. We do not want to destroy the environment in the name of saving the environment.

"One of government's biggest mistakes is taking a good idea and expanding it until it doesn't work anymore."

- We want an America in which we create hundreds of thousands of "green jobs" but not at the expense of destroying millions of red, white and blue jobs. It doesn't make any sense to employ people in the renewable energy sector if we are throwing them out of work in manufacturing and high tech. That's what will happen if these new technologies raise the price of electricity and send manufacturing and other energy-intensive industries overseas searching for cheap energy. We want new, clean, energy-efficient cars, but we want them built in Michigan, Ohio and Tennessee, not Japan and Mexico.

- We want an America where we are the unquestioned champion in cutting-edge scientific research and lead the world in creating the new technologies of the future.

- And we want an America capable of producing enough of our own energy so that we can't be held hostage by some other energy-producing country.

None of these goals are met by Waxman-Markey. This bill provides a huge new tax on the economy. In addition, it requires 15 percent of our electricity to come from a narrowly defined group of renewable sources (defined as wind, solar, geothermal and biomass.) While

promising and intriguing, we can't expect renewable energy to do anything more for the foreseeable future than *supplement* our current base load electrical production. It cannot *replace* it. What the Waxman-Markey bill proves once again is that one of government's biggest mistakes is taking a good idea and expanding it until it doesn't work anymore.

Republican senators have a better idea: produce more American energy and use less. First and foremost we should build 100 new nuclear reactors over the next 20 years – just as we did from 1970 to 1990. That would double our level of nuclear generation to 40 percent of our electricity. Add 10 percent for sun and wind and other renewables, another 10 percent for hydroelectric, maybe 5 percent more for natural gas—and by 2030 we begin to have a low-cost clean energy policy that also puts us within sight of meeting the goals of the Kyoto Protocol on global warming.

Step two is to electrify half our cars and trucks. This should reduce dependence on foreign oil by one-third, clean the air and keep fuel prices low. According to estimates by Brookings Institution scholars, we could do this with the unused nighttime electricity we have today without building one new power plant.

Step three is to explore offshore for natural gas (which is low-carbon) and oil (we should use less, but more of our own).

The final step is to double funding for energy research and development and launch "mini Manhattan Projects" like the one we had in World War II to meet seven energy challenges: improving batteries

for plug-in vehicles, making solar power cost-competitive, making carbon capture a reality, safely recycling used nuclear fuel, perfecting advanced biofuels, designing green buildings and providing energy from nuclear fusion.

Basically our policy should be to conserve and use our nuclear, gas and oil resources until we figure out how to make renewable and alternative energies more reliable and cost-competitive.

Throwing billions of dollars to the wind

Instead of following this simple, fourfold low-cost clean energy strategy, the Obama administration wants to spend tens of billions covering an area the size of West Virginia with 50-story wind turbines while it squirms uncomfortably at every mention of nuclear power.

According to the *San Francisco Chronicle* last week,

> *"The Department of Energy is starting a new partnership with the nation's six largest wind turbine manufacturers, in an effort to. . . provide 20% of the nation's energy from wind by 2030, a goal the DOE says is within reach."*

The President in his inaugural address spoke eloquently of powering the country with the wind, the sun and the earth.

In June the *Wall Street Journal* asked Boone Pickens, Amory Lovins, Al Gore and President Obama how to reduce dependence on foreign oil and contribute less to climate change. These four came up with twenty-four suggestions – everything from placing veterans in green

jobs to generating 20 to 30 percent of electricity by wind – but made no mention of nuclear power.

Over the next ten years, the wind industry will receive direct federal taxpayer subsidies of about $28 billion, according to the Congressional Joint Committee on Taxation.

- Most of this cost is due to the renewable production tax credit that is worth about 3 cents per kilowatt-hour to wind developers and costs taxpayers $26 billion. 75 percent of the renewable tax credit goes to wind – solar, geothermal, biomass and hydropower combined make up the remaining 25 percent.

- There will be $1 billion for construction subsidies through Clean Renewable Energy Bonds (CREBS).

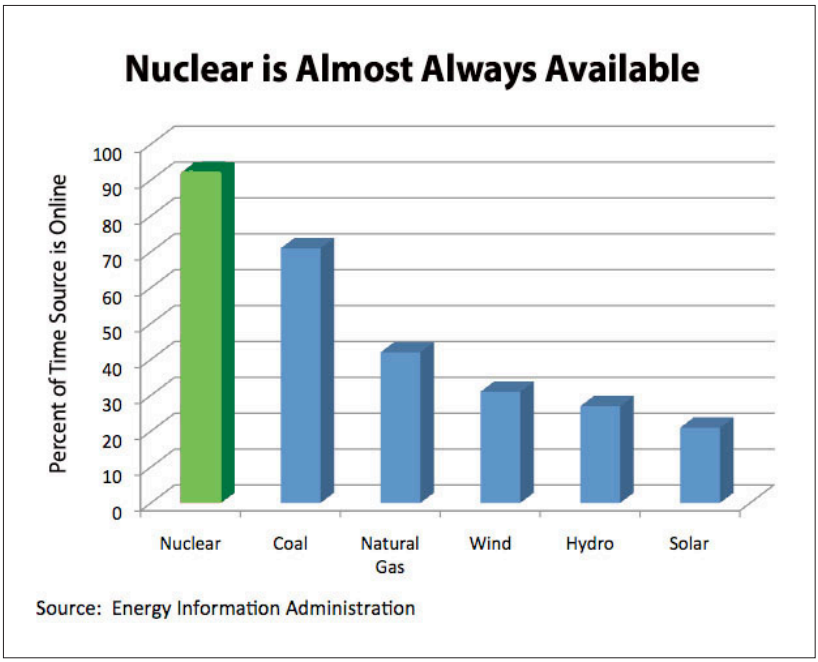
- There will be an Investment Tax Credit (ITC) for residential and small industrial wind turbines.

- There will be accelerated depreciation of small wind turbines.

- Plus, there is $11 billion provided by the stimulus for building a "smart grid" and new transmission lines. The North American Electric Reliability Corporation tells us the entire U.S. grid needs upgrading, but the transmission projects announced so far would all go to bringing wind and solar electricity from remote places to population centers.

And all this doesn't even mention the Waxman-Markey Renewable Energy Mandates, which will have the practical effect of forcing utilities in many states to buy government-subsidized wind energy they don't necessarily need from faraway states with better wind resources.

Let me give you an example. Between 2000 and 2004, the TVA constructed a thirty-megawatt wind farm at Buffalo Mountain at a cost of $60 million. It is the only wind farm in the Southeast. Now you'll read in the papers that having a thirty-megawatt wind farm means generating thirty megawatts of electricity, but this is only what they call its "nameplate capacity." That's not the real output. In practice, Buffalo Mountain has only generated electricity 19 percent of the time, since the wind doesn't blow very much in the Southeast. That means TVA will pay $60 million over twenty years to generate six megawatts of electricity. Multiply this out, and you'll see it means spending $10 billion



Two Options to Make Another 20% of U.S. Carbon-Free Electricity

	Nuclear	Wind
New Plant Needs	100 new reactors	180,000 1.5-megawatt turbines
Current Percentage of U.S. Electricity [1]	20%	1.3%
Type of Power	Baseload	Intermittent - can't be more than 20% of total generation
Actual Operating Availability (Capacity Factor)	90%	33%
Additional Infrastructure	Little - Mostly built on existing sites	Thousands of miles of new transmission lines
Subsidy Cost [2]	Up to $17.5 billion (over 10 years) including nuclear production tax credit	$170 billion (over 10 years)
Direct Jobs [1]	250,000 construction	73,000 construction
	70,000 permanent	77,000 permanent
Plant Lifetime	80 years	20 years
Levelized Cost per KWh [3]	$0.06-0.13 - includes financing and spent fuel disposal	$0.04-0.15 - does not include transmission or backup power
Visual Impact	100 square miles	25,000 square miles - covers an area the size of West Virginia

[1] Department of Energy

[2] Nuclear Subsidy: $100 billion loan guarantees scored at 10%, and nuclear production tax credit. Wind Subsidy: renewable production tax credit extended to 20% U.S. electricity production.

[3] The National Academies: America's Energy Future, July 2009.

to generate 1,000 megawatts, which makes Tennessee windmills more expensive than the costliest nuclear reactor. TVA considers Buffalo Mountain to be a failed experiment. In fact, looking for wind power in the Southeast is a little like looking for hydropower in the desert.

Nevertheless, Waxman-Markey will now force TVA and every other utility in the country to get at least 12 percent of its electricity from renewable sources. And that's a very narrow definition of "renewable." Hydroelectric dams, for example, are probably the best source of renewable energy we have, but they don't count because . . . . well, I'm not sure exactly why, but environmental groups have been opposing dams since the 1950s. Nuclear doesn't count as renewable either, even though we've got plenty of uranium and reprocessing the fuel could stretch it out for hundreds and hundreds of years.

Instead, TVA is already requesting bids for 1250 megawatts of renewable power that it doesn't really need and may not be able to use.

Wind now produces 1.3 percent of our total electricity, and 4.5 percent of our clean electricity. Yet according to the Energy Information Administration, wind turbines are being subsidized at thirty times the rate of all other renewables and nineteen times the rate of nuclear.

So instead of a clean, broad-based energy policy or even a clean, renewable energy policy, what we have in practice is a national windmill policy.

Green jobs versus red, white and blue jobs

"But wait a minute," they tell us. "All this isn't really about producing clean, cheap energy. It's about creating *green* jobs."

There are two problems with this argument.

- First, there must be at least as many welders, mechanics, constructions workers and engineers that would be employed in building 100 new nuclear power plants during the next twenty years as in all the so-called renewable energies together.

- Second, while there may be hundreds of thousands of green jobs, there are tens of millions of red, white and blue jobs in America that will be quickly lost because of rising energy prices.

Let's look at what has happened in California. The Golden State has been imposing renewable energy mandates for years. It has not built a base load coal or nuclear plant in more than twenty years. Meanwhile, it has built renewables, renewables and renewables – with plenty of expensive natural gas to back them up.

All of this contributed mightily to the California electricity shortage of 2000. Now the state has the highest electricity prices in the continental U.S., west of Washington, D.C. Manufacturers are leaving in droves. Even Google and Yahoo are building their server farms elsewhere. With all this job loss, the state had a 12 percent unemployment rate in July and, until recently, a $28 billion budget gap. Its bond rating, once the highest in the country, is now the lowest of the 50 states.

I can't believe that the high cost of electricity in California hasn't contributed to this.

Has all this tempered the state's enthusiasm for expensive renewable energy? Apparently not. California lawmakers are developing legislation to increase the current 20 percent renewable standard to 33 percent by 2020. State energy agencies have concluded it could cost $114 billion or more to meet the 33 percent mandate, more than double what the original 20 percent requirement cost. That comes to more than $3,000 per Californian.

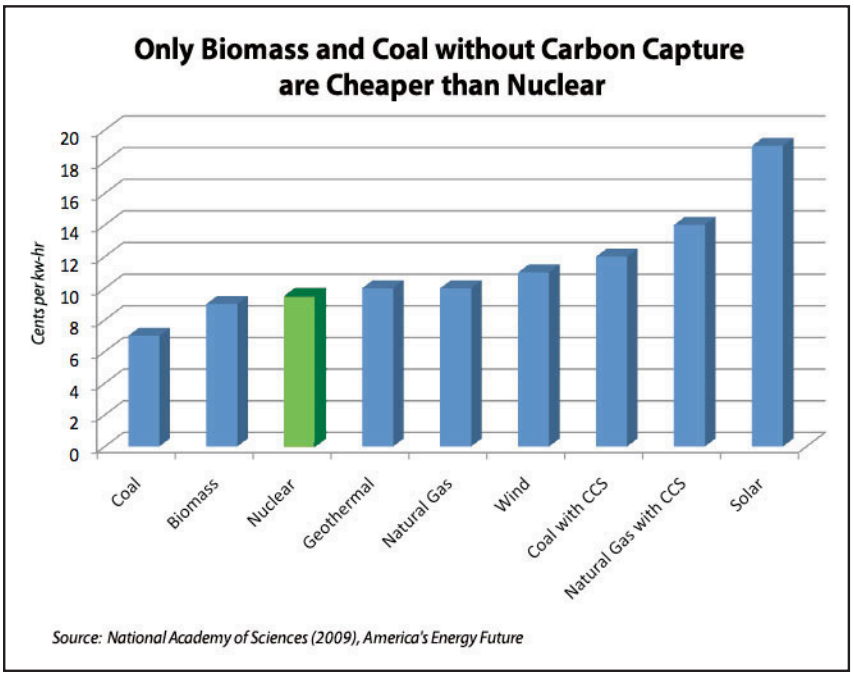
Yet, according to the *Wall Street Journal's* news page on July 3, 2009:

> *The state auditor warned this week that the electricity sector poses a "high risk" to the state economy. A staff report from the state energy commission also warns that California could find itself uncomfortably tight on power by 2011 if problems continue to pile up.*
>
> *Utilities complain that the ambitious renewable-energy mandates, combined with tougher environmental regulations on conventional plants, are compromising their ability to deliver adequate power. "Conflicting state policies are a problem," said Stuart Hemphill, senior vice president of procurement at Southern California Edison.*

Renewable energy is an intriguing and useful idea, but today it supplies only 4 percent of our electricity and faces many challenges. What many people forget is that wind and solar energy is only available on average about one-third of the time. And electricity can't be stored in commercial quantities with current technology. You either

use it or lose it. When you see 1,000 megawatts of wind and solar power reported in the newspaper, remember it's really only about 300 megawatts, because these sources only produce electricity 30 percent of the time – compared to American nuclear plants producing electricity 90 percent of the time.

Denmark, with the world's biggest percentage of wind power, claims to get 20 percent of its electricity from wind. Yet it still produces 47 percent of its power with coal and imports more than 25 percent of its consumed electricity from Sweden and Germany. Moreover, it's not clear that their carbon emissions have decreased at all over the last ten years. Worse yet, because of wind variability Denmark must export almost half its wind power to Germany at bargain rates and then import nuclear and hydropower back from Germany, Sweden and Norway.



The problem of "Energy Sprawl"

Then there is what conservation groups are calling "energy sprawl," which we are only beginning to come to grips with:

- One nuclear plant generates 1,000 megawatts and occupies one square mile.

- One big solar power plant with giant mirrors generating 1,000 megawatts in the western desert will occupy thirty square miles. That's more than five miles on a side.

- To generate the same 1,000 megawatts with wind, you would need 270 square miles of 50-story wind turbines. That's an area more than four times the size of Washington, D.C. Or, that's an unbroken line of turbines along our ridgetops from Johnson City, Tennessee, to Harrisburg, Pennsylvania. If wind farms move offshore, you would need to line the entire 127-mile New Jersey coastline with windmills two miles deep to replace a single nuclear reactor that sits on one square mile.

- We haven't even talked about when these wind farms outlive their useful life cycle of twenty years or so. Who is responsible for their removal? We have already seen this problem in Hawaii and Altamonte Pass in California. The developers should be required to put up bonds to ensure these turbines are taken down in case the developer walks away.

- To those of us in the Southeast, where the wind blows less than 20 percent of the time, they say use biomass – which means burning wood products in a sort of controlled bonfire. That's a good idea as far as it might reduce forest fires and conserve resources. But we'd need a forest one-and-a-half times the size of the 550,000-acre Great Smoky Mountain National Park to feed a 1,000-megawatt biomass plant on a sustained basis. And it would take hundreds of trucks each day to deliver the wood to the biomass plant. It is hard for me to see how this reduces carbon emissions.

"The Price-Anderson insurance program for reactors, often cited as a federal subsidy, has never cost taxpayers a penny."

Already we are beginning to see the problems. Boone Pickens, who has said that wind turbines are too ugly to put on his own ranch, recently postponed what was to be America's largest wind farm because of the difficulty of building transmission lines from West Texas to population centers. The Sacramento Municipal Utility District pulled out of another huge project to bring wind energy in from the Sierra Nevada for the same reason—the transmission lines were meeting too much opposition, particularly from environmentalists. The Green Path North Renewable Energy Transmission Line, proposed in 2006 to carry renewable energy from the deserts of southeastern California to Los Angeles, has not even gotten past the planning stages. It is being opposed by the Sierra Club, the Center for Biological Diversity, the California Desert Coalition, the Redlands Conservancy and just about every municipal government that lies in its path.

We hope that renewable energy can be reliable and low-cost enough to supplement, but when we talk about using wind energy as a substitute for base load energy, we haven't thought about what it's going to look like in practice.

What nuclear power has to offer.

Now let's take a look at a true source of base load electricity, nuclear power:

- Nuclear power already produces 20 percent of our electricity and 70 percent of our carbon-free electricity.

- It's so profitable that Connecticut recently tried to impose a windfall profits tax on reactors because they were making too much money.

- The TVA restarted its Brown's Ferry Unit I, damaged by fire in 1975, and said it would pay off the $1.8 billion construction debt in ten years. It now projects the debt will be retired in three years.

Nuclear power receives little in the way of federal tax subsidies:

- All 100 plants built between 1970 and 1990 were built with private funds.

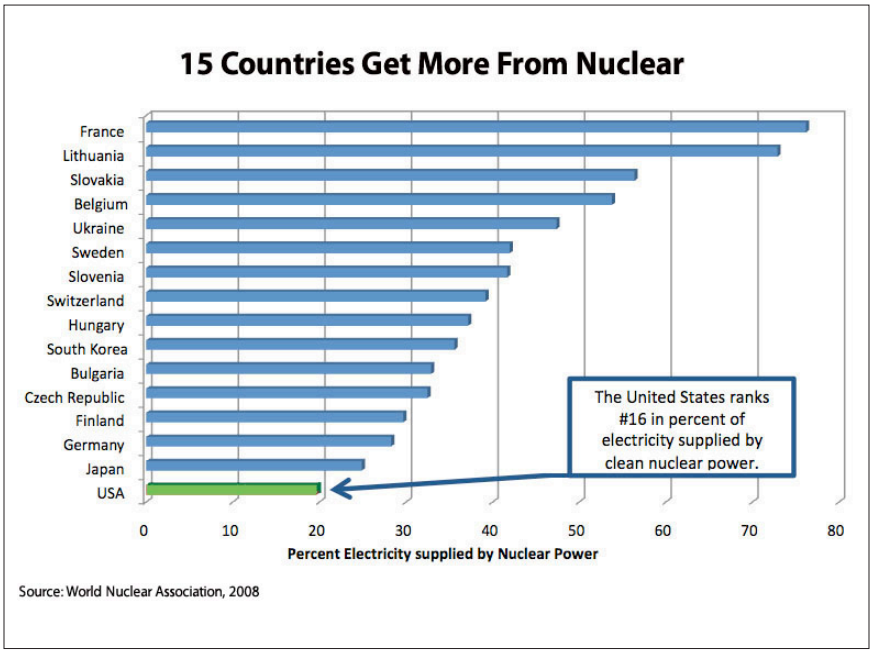
- The Price-Anderson insurance program for nuclear plants, which is often cited as a subsidy, has never paid a penny of

taxpayer money in insurance claims. Today all 104 nuclear plants are responsible for $100 million for accidents at another reactor. That's more than $10 billion in privately funded insurance that the government is not paying for. Price-Anderson has never cost the federal government a dime.

Dispelling other myths

There are other myths surrounding nuclear power besides subsidies, and we need to dispel those:

- Nuclear power plants are not bombs. The uranium in a power plant is very different from the uranium in a bomb. A nuclear power plant cannot blow up.



- While a nuclear plant can melt down if it loses its cooling water, Western reactors are designed with many safety systems to prevent a disaster. That's why, in the case of Three Mile Island, nobody got hurt even though the coolant was entirely lost.

- U.S. nuclear reactors aren't built like Chernobyl was, and the Chernobyl accident cannot happen at a U.S. reactor. Chernobyl was an unfortunate event and was caused by a variety of failures, most importantly the bad design of the reactor.

- Nuclear opponents claim we don't know what to do with the fuel. That's not true. Scientists tell us that we can store used fuel safely on-site for forty-sixty years, while we work out the best way to recycle the used fuel.

We can't wait any longer to start building our future with clean, reliable, and affordable energy. The time has come for action. We can revive America's industrial and high-tech economy with the technology we already have at hand. The only requirement is that we open our minds to the possibilities and potential of nuclear power.

As we do, our policy of cheap and clean energy based upon nuclear power, electric cars, offshore exploration, and doubling energy R&D will help family budgets and create jobs. It will also prove to be the fastest way to increase American energy independence, clean the air and reduce global warming.

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WHAT THE U.S. SHOULD REALLY FEAR ABOUT NUCLEAR POWER

Delivered at the US Chamber of Commerce: Institute for 21st Century Energy, September 21, 2009

Communications experts say that fear is the best way to get attention when you're trying to win an argument. Groups who oppose nuclear power have certainly mastered that technique by playing to economic, environmental and safety fears.

So I'd like to introduce a little element of fear into my argument here. I want to suggest what could happen if we *don't* adopt nuclear power as a more important part of our energy future – if Russia and China and a lot of other countries go ahead with nuclear, as they are now, while we get left behind. Are we going to be able to compete with countries that have cheap, clean, reliable nuclear power while we're stuck with a bunch of windmills and solar farms producing expensive, unreliable energy or, more likely, not much energy at all? The whole prospect of the United States ignoring this problem-solving technology that we invented is what I fear most about nuclear power.

China comes looking for advice.

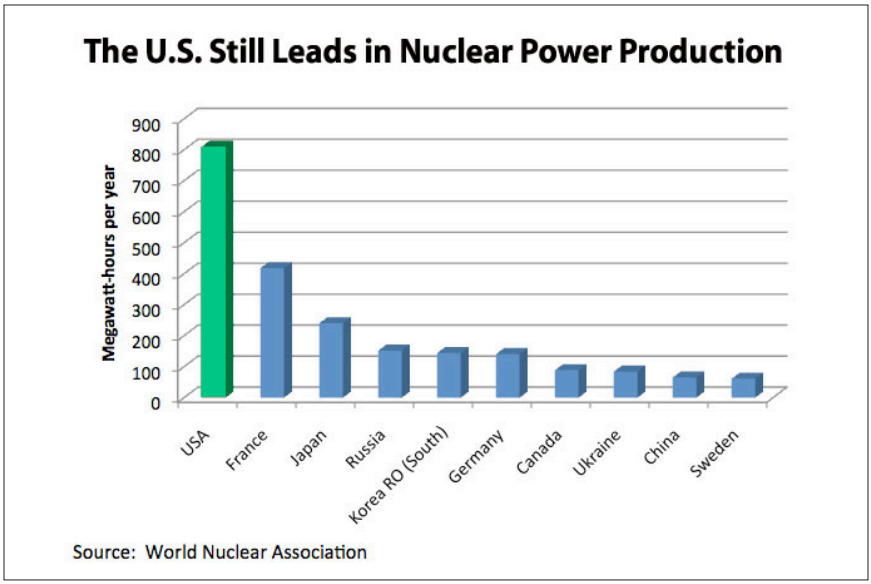
Let me give you an idea of what I'm talking about. A few years ago, in January 2006, the Chinese sent a delegation of nuclear scientists and administrators to the United States on a fact-finding mission. They toured the Idaho National Laboratory, the Argonne National Laboratory, and visited GE and Westinghouse trying to decide which technology to choose for their nuclear program.

Now you might wonder why anyone would be seeking our advice when we haven't issued a construction permit to build a new reactor in the past thirty years. But as Kathryn McCarthy, deputy director of the Idaho National Laboratory, said at the time, "The world still looks to us for leadership in this technology. They'd prefer to copy what we've already done. They don't like being on the cutting edge."

"China now has nineteen reactors under construction and 132 more on the drawing boards. They're in the nuclear business."

Well that may have been true in 2006, but it's not true anymore. The Chinese eventually chose Westinghouse technology for their first reactors. At the time Westinghouse was still headquartered in Pittsburgh but owned by British Nuclear Fuels, which had bought it in 1999. In 2007, Toshiba bought Westinghouse from the British, and it is now a Japanese company. When the Chinese got their first reactors from Westinghouse, they insisted on having all the specs so they could see how it was put together. That's what we call "reverse engineering." As you might have guessed, China has since announced that its next ten reactors will be of its own design.

By 2008 the Chinese had shovels in the ground. The first four Westinghouse reactors are scheduled for completion by 2011. They also bought a pair of Russian reactors, which should be finished around the same time. Now they've started talking about building sixty reactors over the next twenty years and just recently raised it to 132. They're in the nuclear business.



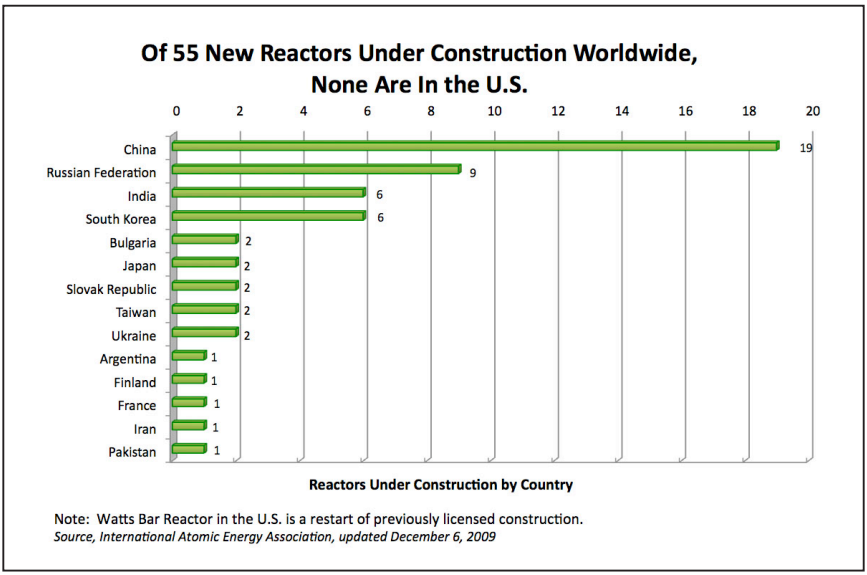
What have we accomplished in the meantime? Well, people have been talking about a "Nuclear Renaissance" in this country since the turn of the century. In 2007, NRG, a New Jersey company, filed the first application to build a new reactor in thirty years. They're still at the beginning of what promises to be at least a five-year licensing procedure before the Nuclear Regulatory Commission. No one really knows how long it will take, since as soon as the licenses are issued opponents will file a flurry of lawsuits and the whole thing will move into the courts. Other companies are following suit, and there are now thirty-three proposals before the NRC but nobody has yet broken ground. If we're lucky, we might have a reactor up-and-running by around 2020. The NRC has not even approved the ***design*** for the Westinghouse AP1000, even though there are already nineteen of them under construction in China. It isn't likely the Chinese will be coming to us anytime soon for more tips on how to build reactors. In fact, we'll probably be going to them.

Reactors are just the tip of the iceberg

That's one aspect of what's going on in the world today. Here's another. As countries began constructing new reactors, it quickly became clear that the bottleneck would be forging the steel reactor vessels. These are the huge, three-story-high steel units that hold the fuel assembly – the reactor core. That means forging steel ingots that may weigh as much as 500 tons.

In 2007, the only place in the world you could order a reactor vessel was at the Japan Steel Works. They were backed up for four years. Everyone started saying, "This is going to be what holds up the world's Nuclear Renaissance. They'll never be able to produce enough of those pressure vessels."

So what happened? Well, first Japan Steel Works invested $800 million to triple its capacity. They're going to be turning out twelve pressure vessels a year by 2012. Then the Chinese decided to build their own forge. In less than two years, they put up a furnace that can handle 320-ton ingots. They turned out their first components in June. Now they're building two more forges, so you won't see the Chinese standing in line in Japan anytime soon. The Russians are doing the same thing. They're in the midst of a big revival, planning to double the production of electricity from nuclear power by 2020. They're also building a forge and just cast their first 600-ton ingot in June. France, Britain, South Korea and India are all following suit. Very soon, every major nuclear country in the world is going to be able to forge its own reactor vessels – except one. And that's us.



No steel company in America is capable of forging ingots of more than 270 tons. We're still stuck in the 1960s. That means when it comes to building reactors we'll have to stand in line in Japan or maybe even in China. In fact, just about everything in our first new reactors is going to be imported. The nuclear industry tells us that at least 70 percent of the materials and equipment that go into those first few reactors will come from abroad. That's because we've let our nuclear industry wither on the vine. In 1990 there were 150 domestic suppliers making parts for nuclear reactors. Today there are only forty, and most of them do their business overseas. Of the thirty-three proposals before the Nuclear Regulatory Commission, sixteen are designed or will be built by Westinghouse, now a Japanese company, and seven are from Areva, the French giant. General Electric, the only American company left on the field, has now partnered with Hitachi.

Babcock & Wilcox is the one American company that stirred some excitement recently when it announced plans for a new "mini-reactor." This is a 125-megawatt unit that can be manufactured at the factory and shipped by rail to the site, where several units can be fit together like Lego blocks. People started saying, "Maybe we can't build big reactors but we can still find a niche at the small end of the market." But the complete prototype for the Babcock & Wilcox reactor is still two years away and it may take another five years to get design approval from the NRC. Right now the NRC won't even ***look*** at new designs for mini-reactors. Meanwhile, the Russians are already building new mini-reactors that will be floated on barges to supply power to Siberian villages. Fifteen other countries have already expressed interest. In spite of Babcock & Wilcox's fine effort – and I'm certainly proud of them - the Russians are already moving ahead of us.

In a tour d'horizon, America is not on the horizon

So let's take stock. There are fifty-three new reactors now under construction in fourteen countries around the world, none of them in the United States. In fact, only two are in Western Europe – one in Finland and the other in France, both built by Areva. Most of the rest are in Asia. Although we haven't gotten used to it, Asia may soon be leading the world in nuclear technology.

Japan has fifty-five reactors and gets 35 percent of its electricity from nuclear energy, almost double the 19 percent we get here. The Japanese have two reactors under construction and plans for ten more by 2018. They are finding they can build a reactor, start to finish, in less than four years. That's less time than it is taking to

get a reactor through licensing procedures at the Nuclear Regulatory Commission.

"Seventy percent of the materials and equipment that will go into the first few reactors will come from abroad."

South Korea gets nearly 40 percent of its electricity from nuclear and is planning another eight reactors by 2015. So far they've bought their reactors from the Japanese, but now they have their own Korean Next-Generation Reactor, a 1,400-megawatt giant evolved from an American design. They plan to bring two of these online by 2016. Taiwan also gets 18 percent of its electricity from nuclear and is building two new reactors.

In September, Bloomberg News reported that Japan Steel Works' stock had risen 8 percent on the Tokyo Stock Exchange because of China's decision to double future construction from sixty to 132 new reactors. They figure they'll have all the work they can handle. Much of China's $586 billion stimulus package is going toward developing nuclear power. "While China had been focusing on building new coal plants, it has now shifted its focus to nuclear because of the environmental issue," said Ikuo Sato, president of Japan Steel Works, to Bloomberg.

Meanwhile, India is embracing thorium technology, which many people believe may one day replace uranium as nuclear fuel. Thorium is twice as abundant as uranium and it doesn't produce the plutonium that everybody worries will be used to make a bomb. There's a lot

of enthusiasm for thorium among scientists in this country, but India is the country moving ahead, with six reactors under construction and ten more planned. They began with a Russian design but are also trying some American technology they acquired in signing their 2005 agreement with the Bush administration.

"Russia is using nuclear to replace natural gas, which they can then sell to Europe for six times the price."

What about Russia? Haven't they been stymied by Chernobyl? Well, like everybody else, the Russians halted all construction of new reactors after that horrible accident. But they learned their lesson and started designing much safer reactors in the 1990s, completing the first new project in 2001. Now they have plans to expand along the lines of France, building two reactors every year from now through 2030. They have a very good reason. Russia has huge natural gas supplies but is now using them to produce one-third of its electricity. They could get six times the price by selling that gas to Western Europe. So they're replacing gas generation with nuclear – which is exactly the opposite of what we're doing here. Since 1990 every major power plant built in this country has burned natural gas. We now get more of our electricity – 21 percent - from natural gas than we get from nuclear - 19 percent – and that number is still climbing. That's a waste of a very valuable resource.

And be aware, all these countries that are developing nuclear aren't just building for themselves. They're selling to the rest of the world as well. Areva is building reactors in Finland, China, India, Italy,

Brazil and Abu Dhabi. Korea is coming along so fast that they are now challenging Areva and Westinghouse for a $40 billion contract to build five reactors in the United Arab Emirates. The Russians have signed deals with China, Iran, India, Nigeria and Venezuela. They are even selling to us! In July, Tenex, Russia's uranium enrichment corporation, signed a long-term contract to supply fuel to Constellation Energy, which has reactors in Maryland and upstate New York. It was the sixth contract Tenex signed with an American utility in the past two months.

How did the Russians end up supplying us with uranium? It's an interesting story. In 1996, Senators Sam Nunn, Pete Domenici and Richard Lugar pioneered a remarkable deal with the post-Soviet government where we would buy highly enriched uranium from old Soviet bomb stocks. The uranium would be sent to France, where it would be "blended down" from 90 percent fissionable material to 3 percent to be used in American reactors. For the last two decades, old Soviet stockpiles have supplied half our nuclear fuel. One out of every ten lightbulbs in America is now powered by a former Soviet weapon - one of the greatest swords-into-plowshares efforts in world history, although few people seem to know about it. Now the Russians have learned to do de-enrichment themselves. They've decided they don't need France anymore. They've said, "Hey, we'll just produce it ourselves." Producing things is the way countries grow rich.

Once upon a time we were pioneers in nuclear technology. Forty years ago we were the only people in the world who knew how to deal with the atom. That's not true anymore. We've shied away from nuclear technology while everyone else has forged ahead. Even Europe is coming back. The British have announced they're going to go nuclear

– they just hired the French national electric company to help. *[On November 10th the British announced they would build ten new reactors, most of them at existing nuclear sites. The government will give the British equivalent of the NRC one year to review each proposal.]* Italy closed all its reactors right after Chernobyl but ended up importing 80 percent of its electricity at a huge cost. Now they've announced they're going back to nuclear. France already gets 80 percent of its power from nuclear and has the cheapest electricity in Europe – not to mention the second-lowest carbon emissions (behind Sweden, which is half nuclear). France also sells $3 billion worth of electricity every year to the rest of Europe. Did you notice how well France is doing in the latest downturn? They've barely gone into recession. That's not because the French spend less on government bureaucracy or work harder than us and take fewer vacations. It's because nuclear power is keeping their entire economy afloat.

"One out of every ten lightbulbs in America is now powered by a former Soviet weapon."

So does that mean we've fallen completely behind? Not at all. In fact there's a great irony to all this. We still know how to *run* reactors better than anyone else. Our fleet of 104 plants is up and running 90 percent of the time. No one else even comes close. France, for all its experience, is still at 80 percent. Other countries are even lower. We still understand the technology better than anyone else in the world. We just aren't allowed to *build* reactors anymore. And that's what scares me. We're gradually losing our economic place in the world.

"Nuclear power is keeping their entire French economy afloat."

Now a lot of people say, "Well, what's the difference? So what if we fall behind on nuclear technology? We'll just forge ahead with something else." Well, there are several reasons to be concerned:

1) First, there's *energy security*. America already spends $300 billion a year importing two-thirds of our oil from other countries. If we remain on the current path of no new nuclear power or start depending on other countries to build our reactors and supply us with fuel, we're going to be even more vulnerable than we are now. The best way to reduce imported oil, aside from ramping up domestic production, will be to use electricity to power cars and trucks. At first we can plug our electric vehicles in at night, when there is much unused electricity. After that, we should be using nuclear. We can't have Americans going to bed every night hoping the wind will blow so they can start their cars in the morning.

2) Second, there's *technological leadership*. Americans produce year in and year out 25 percent of all the wealth in the world. Most of that wealth has been driven by new technologies. We were the birthplace of the telephone, the electric light, the automobile, the assembly line, radio, television and the

computer. But nuclear energy – perhaps the greatest scientific advance of the 20th century – is passing us by. The 21st century is going to run on clean, cheap greenhouse-gas-free nuclear power. How can we criticize India and China for not reducing their carbon emissions when we refuse to adopt the best technology ourselves?

3) Then there's *weapons proliferation*. In the 1970s we gave up on nuclear reprocessing in the hope that by not dealing with plutonium we would prevent nuclear weapons from spreading around the world. That has turned out to be a fruitless idea. France, Britain, Russia, Canada and Japan went right on reprocessing, and no one has stolen plutonium from them. Instead, rogue countries such as North Korea and Pakistan have found their own ways to getting their hands on nuclear material. The technology is no big secret anymore. The real problem is that by reneging on world leadership we have left the field to others. For instance, right now the Russians are building a commercial reactor for Hugo Chavez in Venezuela. He's not exactly friendly toward the United States. Just to make things more interesting, Manhattan district attorney Robert Morgenthau recently wrote in the *Wall Street Journal* that his office has uncovered evidence Iran may be providing Venezuela with missile technology. Does that mean we may be headed for another Cuban Missile Crisis with Chavez? I certainly don't know. But I wish those were American technicians down there and not Russian ones.

But what really worries me are these two things:

- First, if we move toward a nuclear-based economy and we have to import 70 percent of the technology and equipment, how are we any better off than when we're importing two-thirds of our oil? We'll just be creating jobs for steel workers in Japan and China instead of in the United States.

"If we don't move toward a nuclear-powered economy, we're going to be sending a lot of American jobs overseas looking for cheap energy."

- Second, if we *don't* move toward a nuclear-powered economy but try to do everything with conservation and wind and solar, we're going to be sending American jobs overseas looking for cheap energy.

What we need to do to catch up

So to insure we have enough cheap, clean, reliable electricity in this country to create good high-quality, high-tech jobs, here's what we have to do. The United States should double its production of nuclear power by building 100 nuclear reactors in twenty years.

- Nuclear today provides 70 percent of our carbon-free electricity. Wind and solar provide 5 percent.

- Nuclear plants operate 90 percent of the time. Wind and solar operate about one-third of the time.

- The Obama administration's Nobel Prize-winning Energy Secretary, Steven Chu, says nuclear plants are safe and that used nuclear fuel can be safely stored on-site for forty-sixty years while we figure out the best way to recycle it.

- Producing 20 percent of electricity from wind, as the Obama administration proposes, will require building 186,000 fifty-story turbines, enough to cover an area the size of West Virginia – plus 19,000 miles of new transmission lines to carry electricity from remote to populated areas. 100 new nuclear plants could be built mostly on existing sites.

- To produce 3-6 percent of our electricity, taxpayers will subsidize wind to the tune of $29 billion over the next ten years. The 104 nuclear reactors we have today were built basically without taxpayer subsidies.

- It will cost roughly the same to build 100 new nuclear plants (which will last sixty-eighty years) as it would to build 186,000 wind turbines (lasting twenty-twenty-five years). And this does not count the cost of transmission lines for wind.

- There will be twice as many "green jobs" created building 100 reactors as there would be building 186,000 wind turbines.

An America stumbling along on expensive, unreliable renewable energy, trying to import most of our energy from abroad, is going to be an America with fewer jobs and a lower standard of living.

Nuclear opponents continue to prey on fear of nuclear power. The truth is that if we want safe, cost-effective, reliable, no-carbon electricity we can no longer ignore the wisdom of the rest of the world. My real fear is that we Americans are going to wake up one cloudy, windless day when the light switch doesn't work and discover we've forfeited our capacity to lead the world because we ignored nuclear power, the great energy technology that we ourselves invented.

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THE PERILS OF "ENERGY SPRAWL"

Delivered at Resources for the Future, October 5, 2009

First, I would like to thank Congressman Phil Sharp and Resources for the Future for organizing this forum and to salute your leadership, especially in coordinating the recent Outdoor Resources Review Group's report recommending permanent funding for the Land and Water Conservation Fund.

"I believe the paper sponsored by the Nature Conservancy entitled 'Energy Sprawl' will occupy an honored place in the conservation movement."

Last week I spent several hours watching Ken Burns' film on our national parks and reading Douglas Brinkley's new book, *The Wilderness Warrior: Theodore Roosevelt and the Crusade for America*. Doing this reminded me that the men and women we honor today in the conservation movement and who founded most of the organizations you represent were not always so honored when they first spoke up. Many of those who spent the last century protecting our landscapes, air and water, and wildlife habitats were once regarded as trivial, eccentric, or went unnoticed. John Muir was an obscure hermit when he began to "preach nature like an apostle." To some, Roosevelt must have seemed a little daffy when he declared he would protect pelicans and warned a country enamored with Manifest Destiny that we should "keep nature unmarred." Lyndon Johnson made jokes about Lady Bird Johnson running around the White House, as he put it, "protecting flowers."

But today we honor these and many others for having had the wisdom and the courage to recognize that preserving our natural heritage is essential to the American Character. Italy may have its art, India its Taj Mahal, but we have the Great American Outdoors.

The Nature Conservancy sounds the alarm.

I believe the scientific paper sponsored by the Nature Conservancy, entitled "Energy Sprawl or Energy Efficiency: Climate Policy Impacts on Natural Habitat for the United States of America," will one day occupy a place among the pioneering actions that we honor in the conservation movement. The paper warns that during the next twenty years new energy production, especially biofuels and wind power, will consume a landmass larger than the state of Nebraska. This "energy sprawl," as the authors call it, will be the result of government cap-and-trade and renewable mandate proposals designed to deal with climate change. The paper should serve as a Paul-Revere-ride warning against the coming renewable energy sprawl. There are negative consequences, as well as positive effects, from producing energy from the sun, the wind and the earth. And, unless we are as wise in our response as the authors have been in their analysis, our nation runs the risk of damaging the environment in the name of saving the environment.

All this makes me think of my own experience as governor twenty-five years ago when Tennessee banned new billboards and junkyards on a highway over which two million visitors travel each year to the Great Smoky Mountains National Park. Then, that decision attracted little attention. Today, it helps to preserve one of the most attractive gateways to any national park. But, as all of us know, if the billboards

had gone up then, it would be almost impossible to take them down today. The same will be true with wind turbines, solar thermal plants, and other new forms of energy production.

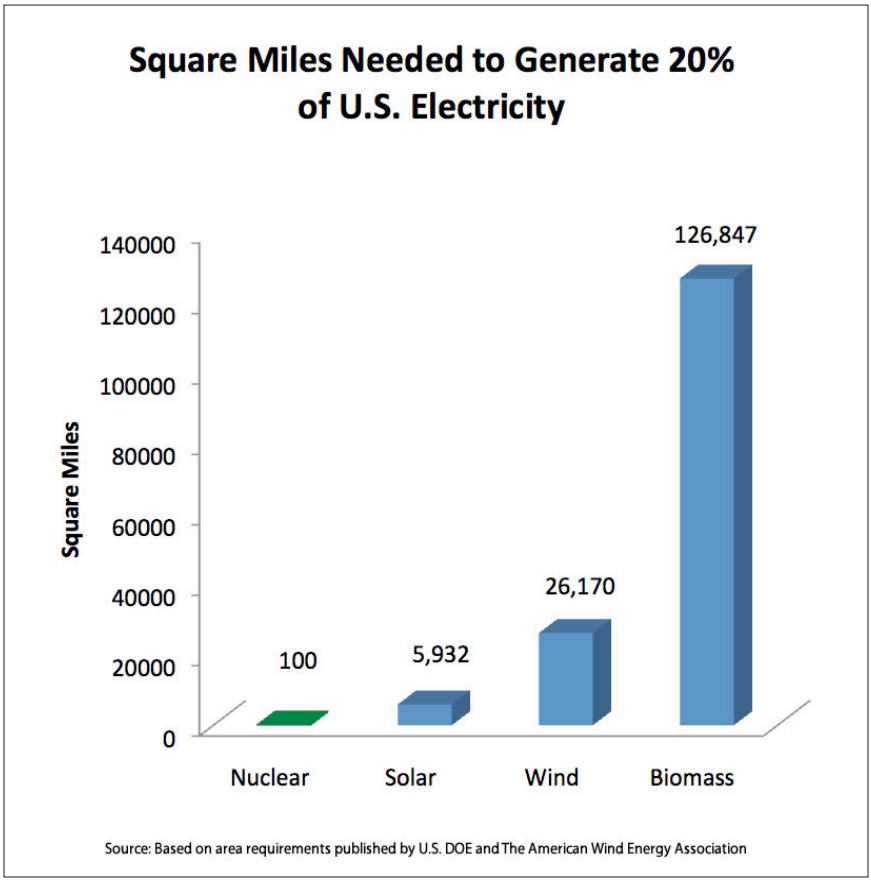
My purpose here today is to challenge you and the organizations that have traditionally protected our landscape, air and water, and wildlife habitat to do the same with the threat of energy sprawl. To ask you, first, to suggest to governments and policy makers and landowners before it is too late the best choices and the most appropriate sites for low-carbon or carbon-free energy production. And, second, I want to ask you to do something that gives many conservationists a stomachache whenever it is mentioned – and that is to rethink nuclear power, because as the Nature Conservancy's paper details, nuclear power produces the largest amounts of carbon-free electricity with the least environmental impact.

I learned a long time ago that it helps an audience to know where a speaker is coming from. Well, I grew up hiking and camping in the Great Smoky Mountains where I still live two miles from the park. As a senator I have fought for strict emission standards for sulfur, nitrogen and mercury because many of us still breathe air that is too polluted. I have introduced legislation to cap carbon from coal plants because I believe that human production of carbon contributes to global warming. I have helped to create 10,000 acres of conservation easements adjacent to the Smokies because it preserves views of the mountains and wildlife needs the space. I drive one of the first plug-in electric hybrid cars because I believe electrifying half our cars and trucks is the quickest way to clean the air, keep fuel prices down, reduce foreign oil use, and help deal with climate change. And I object to fifty-story wind turbines on top of mountains for the same reason I am co-sponsor of legislation to end the coal mining

practice called mountaintop removal—not because I am opposed to coal plants or wind power in appropriate places, but because I want to save our mountaintops.

America's landscape under renewable energy

Let me offer a few examples to paint a clearer picture of what this energy sprawl might look like in twenty years. As the Nature Conservancy paper notes, most new renewable electricity production will come from wind power, which today provides about 1.5 percent of our country's electricity. Hydroelectric dams produce about 6 percent of our electricity, and some of them are being dismantled. Solar



"To produce 20 percent of America's electricity with wind would require covering an area the size of West Virginia with 186,000 turbines."

and all other forms of renewable electricity produce less than 1 percent today. President Bush first suggested that wind power could grow from 1.5 percent to 20 percent by 2030, and President Obama has set out enthusiastically to get this done. In fact, the combination of presidential rhetoric, taxpayer subsidies and mandates has very nearly turned our national electricity policy into a national windmill policy.

To produce 20 percent of America's electricity from wind turbines would require erecting 186,000 1.5-megawatt wind turbines covering an area the size of West Virginia. According to the American Wind Energy Association, one megawatt of wind requires about sixty acres of land, or in other words, that's one 1.5 megawatt wind turbine every ninety acres. These are not your grandmother's windmills. They are fifty stories high. Or, if you are a sports fan, they are three times as tall as the skyboxes at the University of Tennessee football stadium. The turbines themselves are the length of a football field, they are noisy and their flashing lights can be seen for up to twenty miles. In the eastern U.S., where the wind blows less, turbines would work best along scenic ridgetops and coastlines. National Academy of Sciences says that up to 19,000 miles of new high voltage transmission lines would be needed to carry electricity from these 186,000 wind turbines in remote areas to and through population centers.

Wind turbines can create real threats to wildlife. The governor of Wyoming has expressed concern about protecting the sage grouse's di-

"The gold standard for land usage is nuclear. You can get a million megawatt hours of electricity a year from one square mile."

minishing population in his state as a result of possible habitat destruction from wind farms. The American Bird Conservancy estimates that each wind turbine in this country kills as many as seven or eight birds each year. Multiply that by 186,000 wind turbines, and you could predict the annual death of close to 1.4 million birds. The only wind farm in the southeastern United States is on the 3,300-foot tall Buffalo Mountain in Tennessee. The wind there blows less than 20 percent of the time, making the project a commercial failure. Because of the unavailability of wind power, renewable energy advocates suggest that we Southeasterners use biomass, a sort of controlled bonfire that burns wood products to make electricity.

Then there are the solar thermal plants, which use big mirrors to heat a fluid and which can spread over many square miles. Secretary of the Interior Ken Salazar recently announced plans to cover 1,000 square miles of federally owned land in Nevada, Arizona, California, Colorado and New Mexico and Utah with such solar collectors to generate electricity. Senator Dianne Feinstein of California, who has spent most of her career trying to make the Mojave Desert a national monument, strongly objected to a solar thermal plant in the desert on federal land just outside the Mojave National Preserve that would have covered an area three miles by three miles. Plans for the plant were recently canceled.

Biomass has promise, to a point. Paper mills can burn wood by-products to make energy. And clearing forests of dead wood and then burning it not only produces energy but can help to avoid forest fires. According to the Conservancy's paper, biofuels and biomass burning of energy crops for electricity take the most space per unit of energy produced. For example, the Southern Company is building a new 100-megawatt biomass plant in Georgia. Southern estimates it will keep 180 trucks a day busy hauling a million tons of wood a year to the plant. One hundred megawatts is less than one-tenth the production of a nuclear plant that would fit on one square mile. To produce the same amount of energy as one nuclear plant would require continuously foresting an area one-third larger than the 550,000-acre Great Smoky Mountains National Park. You can make your own estimate of the number of trucks it would take to haul that much wood.

Different technologies require varying amounts of land.

That is the second important insight of the Nature Conservancy report: a careful estimate of the widely different amounts of land each energy-producing technique requires. The gold standard for land usage is nuclear power. You can get a million megawatt hours of electricity a year—that's the standard unit the authors chose—per square mile, using nuclear power. The second most compact form of energy is geothermal energy. To generate the same amount of power, coal requires four square miles, taking into account all the land required for mining and extraction. Solar thermal takes six square miles. Natural gas takes seven square miles and petroleum seventeen. Photovoltaic cells that turn sunlight directly into electricity require fourteen square miles, and wind is even more dilute, taking twenty-eight square miles to produce the same unit of electricity.

These differences in land use are pronounced even though the paper's analysis is conservative. The authors include upstream inputs and waste disposal as part of their estimate of an energy producer's footprint. They add uranium mining and Yucca Mountain's 220 square miles to the area our 104 nuclear reactors actually occupy. Taking only the energy plant's immediate footprint into account, producing 20 percent of U.S. electricity would take either 100 nuclear reactors on 100 square miles or 186,000 wind turbines on 25,000 square miles. Visualize the difference this way. Thru hikers regularly travel the 2,178 miles of the Appalachian Trail from Springer Mountain in Georgia to Mount Katahdin in Maine. A row of fifty-story wind turbines along that entire 2,178-mile trail would generate the same amount of electricity produced by four nuclear reactors on four square miles.

So, because of these wide differences, policy makers have the opportunity to choose carefully among the various forms of producing carbon-free electricity as well as to think about where such energy production should or should not go.

What can we do to minimize the problem?

These are the four ways that the Nature Conservancy suggests we approach those decisions:

First, focus on energy conservation. This is the paper's preferred alternative to energy sprawl – and it is hard to see how anyone could disagree. To cite just one example, my home state of Tennessee leads the nation in residential per capita electricity use. If Tennesseans simply used electricity at the national average, the amount of electricity we would save each year would equal that amount produced by four nuclear power plants. Oak Ridge National Laboratory scientists have

said that fuel efficiency standards are the single most important step our country can take to reduce carbon emissions.

"The Nature Conservancy suggests we focus first on energy conservation."

The second recommendation for dealing with energy sprawl is end-use generation of electricity, which usually occurs on already developed sites. One example of this is the co-generation that occurs at a paper factory that uses waste product to produce electricity and heat to run its facility. The most promising example is likely to be solar power on rooftops. In other words, since rooftops already exist, covering them with hundreds of square miles of solar panels would create no additional sprawl. There is the obstacle of aesthetics. But companies are now producing solar film embedded within attractive roofing materials—although this costs more. And there still is the problem that solar power is only available when the sun shines, and like wind, it can't be stored in large quantities. But unlike wind, which often blows at night when there is plenty of unused electricity, the sun shines when most people are at their peak power use. As former Energy Secretary James Schlesinger wrote in the *Washington Post*, because of their intermittency, wind and solar systems have to be backed up by other forms of electricity generation – which adds to cost and land usage.

The third recommendation is to make carbon regulation flexible, allowing for carbon recapture at coal plants, for nuclear power and for international offsets. So far the sponsors of climate and energy bills in the Congress haven't heeded this advice. In fact, both the Waxman-Markey bill in the House and the Bingaman energy bill in the Senate

contain very narrowly defined "renewable electricity" mandates. Instead of allowing states to choose their methods of producing the required amount of carbon-free electricity, the legislation heavily tilts toward requiring wind power. For example, the legislation allows existing and new wind turbines, but only new hydroelectric. It does not count nuclear power, municipal solid waste or landfill gas as "renewable." In the same way, 75 percent of the so-called "renewable electricity" subsidies enacted since 1978 have gone to wind developers. A study by the Energy Information Administration shows that wind gets a subsidy thirty-one times that of all other renewables combined. These policies have created a heavy bias toward the form of renewable electricity—wind power—that could consume our treasured mountaintops and can be very destructive to wildlife. And a national policy that also encourages wind power in the Southeast where the wind barely blows makes as much sense as mandating new hydroelectric dams in the western desert where there is no water. It is my opinion that if we were truly seeking to reduce our carbon output, the policy that would create the least energy sprawl would be a "carbon-free electricity standard," allowing for the maximum flexibility for those renewable electricity techniques that consume less land and require fewer new transmission lines.

"One wind farm near Oakland, California estimates its turbines kill 80 golden eagles a year."

Finally, the Nature Conservancy suggests paying attention to site selection for new energy projects. This is where those of you who represent organizations who have spent a century protecting wildlife and treasured landscapes could be of the greatest help in asking the

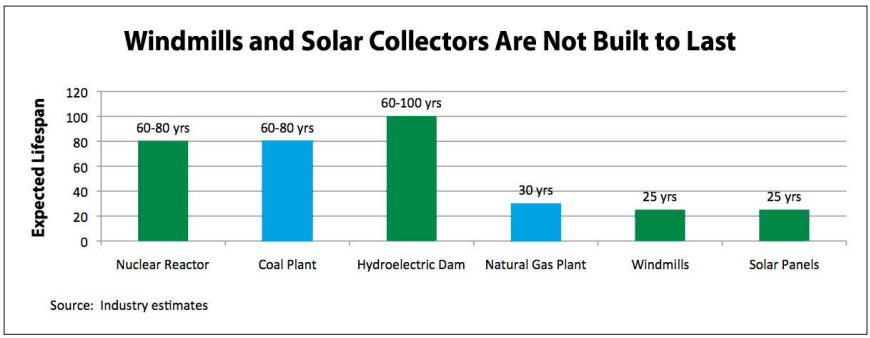
right questions and providing wise answers. For example, should energy projects be placed in national parks? In national forests? If so, which forests and which energy projects? Should there be generous taxpayer subsidies for renewable energy projects within twenty miles of the Grand Tetons or along the Appalachian Trail? What about the large amounts of water needed for solar thermal plants or nuclear plants? Should turbines be concentrated in shallow waters twenty miles or more offshore where they can't be seen from the coast and transmission lines run underwater? Couldn't turbines be located in the center of Lake Michigan instead of along its shoreline? Should there be renewable energy zones, such as the solar zones Secretary Salazar is planning, where most new projects are placed—and where are the most appropriate locations for those zones and their transmission lines? In a recent op-ed in the *New York Times*, the Massachusetts Secretary of Energy and Environmental Affairs asked, "Wouldn't it make more sense to place wind turbines offshore in the Atlantic and run transmission lines underwater than to build new transmission lines to carry wind power from the Great Plains to Boston?" Should the subsidies for cellulosic ethanol be larger than those for corn ethanol, or should there be no subsidies at all? Should there be a special effort to encourage conservation easements on private lands that protect treasured viewscapes and habitats?

Should renewables be held to the same standard?

According to the *Wall Street Journal*, on August 13 Exxon Mobil pleaded guilty in federal court to killing eighty-five birds that had come into contact with crude oil or other pollutants in uncovered tanks of wastewater facilities on its properties. The birds were protected

by the Migratory Bird Treaty Act, which dates back to 1918. The company paid $600,000 in fines and fees.

Should the migratory bird law be enforced against developers of windmills and other renewables? One wind farm near Oakland, California estimates that its turbines kill eighty golden eagles a year. The American Bird Conservancy estimates that the 25,000 wind turbines in the United States kill between 75,000 and 275,000 birds per year. "Somebody is getting a get out of jail card free," Michael Fry of the Bird Conservancy told the *Journal*. And what would be the fine for the almost 1.4 million birds that 186,000 turbines might eventually kill?



This raises the question of whether there should be some parity among all energy companies in the application of laws and policies. For example, oil and gas companies receive taxpayer subsidies, but they bid to lease and drill on federal land or waters and then pay a royalty for the privilege. Should taxpayer-subsidized renewable energy companies also be required to pay a royalty for the privilege of producing electricity on federal lands or waters? And, if so,

could this be a source of permanent funding for the Land and Water Conservation Fund or other conservation projects on the theory that if the law allows an environmental burden it ought to require an environmental benefit? Based on estimates from the Joint Committee on Taxation and the Congressional Budget Office, taxpayers will pay wind developers a total of $29 billion in federal subsidies over the next 10 years to increase wind power production from 1.5 to 4 percent of our total electricity.

There are an estimated 500,000 abandoned mines in our nation, 47,000 in California alone. To date, Congress has allocated a total of about $4 billion for their cleanup, and the end of the cleanup is nowhere in sight. Would it not be wise before the energy sprawl occurs to require bonds on federal lands for the removal of energy equipment that is not used anymore? Wind turbines wear out in twenty-twenty-five years. Solar thermal farms can cover hundreds of acres. Policies, subsidies and prices can change. In Germany, for example, a prominent maker of solar equipment recently suggested cutting the government subsidy for solar equipment because it is permanently raising prices of German-made products and Germans are buying cheaper panels made in China. In other words, the Germans are subsidizing Chinese manufacturing. If the large U.S. subsidies for wind power were to disappear—as was promised when they were created—it might be a good idea if someone were required to take away any abandoned equipment.

This brings me to my last point, which is to ask you to rethink nuclear power.

What is it that is holding us back?

In our country, fears about safety, proliferation and waste disposal have stymied the "atoms for peace" dream of large amounts of low-cost, clean, reliable energy from nuclear power. Twelve states even have moratoria against building new nuclear plants. Still, the 104 U.S. reactors built between 1970 and 1990 produce 19 percent of America's electricity and, as I have said, *70 percent of our carbon-free electricity*. I believe that what Americans should most fear about nuclear power is this: the rest of the world will use it to create low-cost, carbon-free electricity while we—who invented the technology—will not. That would send our jobs overseas looking for their cheap energy. And it would deprive us of the technology most likely to produce large amounts of carbon-free electricity to help deal with climate change—and to do it in the way least likely to harm the landscape and wildlife habitat.

"France gets 80 percent of its electricity from nuclear and has among the lowest electricity rates and carbon emissions in Western Europe."

Look at what the rest of the world is doing. Of the top five greenhouse gas emitters, who together produce 55 percent of the carbon in the world, only the U.S. has no new nuclear plants under construction. China, the world's largest carbon emitter, recently upped its goal for nuclear reactors to 132. Russia, the number three emitter, plans a new reactor every year until 2030. Of the next two emitters, India has six reactors under construction and ten more planned. Japan already has fifty-five reactors, gets 35 percent of its electricity from nuclear, and has two under construction and plans for ten more by 2018.

According to the International Atomic Energy Agency (IAEA), worldwide there are fifty-three reactors under construction in eleven countries, mostly in Asia. South Korea gets nearly 40 percent of its electricity from nuclear and plans another eight reactors by 2015. Taiwan gets 18 percent of its power from nuclear and is building two new reactors.

"Energy Secretary Stephen Chu, the Nobel Prize-winning physicist, says nuclear reactors are safe and he wouldn't mind living near one."

In the West, France gets 80 percent of its electricity from nuclear and has among the lowest electricity rates and carbon emissions in Western Europe (behind Sweden and Switzerland, which are both half nuclear). Great Britain has hired the French electric company EDF to help build reactors. Italy has announced it will go back to nuclear. *[As previously noted, the British are now planning ten new reactors. They have given their equivalent of the Nuclear Regulatory Commission one year to review each application.]*

So where does this leave the United States? Well, we still know how to run reactors better than anyone else; we just don't build them anymore. Our fleet of 104 plants is up and running 90 percent of the time. We have thirty-four applications for new reactors pending before the Nuclear Regulatory Commission but haven't started construction on any new ones – and the 104 we currently have in operation will begin to grow too old to operate in twenty years.

That is why I believe the U.S. should build 100 new nuclear plants in twenty years. This would bring our nuclear-produced electricity to more than 40 percent of our total generation. Add 10 percent

for hydroelectric dams, 7-8 percent for wind and solar (now less than 2.5 percent together), 25 percent for natural gas (which is low-carbon), and you begin to get a real clean—and low-cost—electricity policy.

Renewables and nuclear: Adding up the score

According to the National Academy of Sciences, construction costs for 100 nuclear plants are about the same as for 186,000 wind turbines. New reactors could be located mostly on sites with existing reactors. There would be little need for new transmission lines. Taxpayer subsidies for nuclear would be one-tenth what taxpayers would pay wind developers over ten years. As for so-called "green jobs," building 100 nuclear plants would provide four times as many construction jobs as building 186,000 turbines. And, of course, nuclear is a base load source of power operating 90 percent of the time, the kind of reliable power that a country that uses 25 percent of the energy in the world must have. Wind and solar are useful supplements, but they are only available, on average, about one-third of the time and can't be stored in large amounts.

And what about the lingering fears of nuclear? Obama administration Energy Secretary Dr. Steven Chu, the Nobel Prize-winning physicist, says nuclear plants are safe and he wouldn't mind living near one. That view is echoed by the thousands of U.S. Navy personnel who have lived literally on top of nuclear reactors in submarines and Navy ships for fifty years without incident. The Nuclear Regulatory Commission agrees, and its painstaking supervision and application process is intended to do everything humanly possible to keep our commercial fleet of reactors safe.

"Energy Sprawl"

On the issue of waste, Dr. Chu says there is a two-step solution. Step one is store the waste onsite for forty-sixty years. The Nuclear Regulatory Commission agrees this can be done safely, perhaps even for 100 years. Step two is research and development to find the best way to recycle fuel so that its mass is reduced by 97 percent, pure plutonium is never created, and the waste is only radioactive for 300 years instead of one million years.

That kind of recycling would take care of both the waste and the third fear of nuclear power, the threat that other countries might somehow use plutonium to build a bomb. One could argue that because the U.S. failed to lead in developing the safe use of nuclear technology for the last thirty years, we may have made it easier for North Korea and Pakistan to steal or buy nuclear secrets from rogue countries.

Doing the least damage to the environment

Now, let me conclude with this prediction: taking into account these energy sprawl concerns, I believe the best way to reach the necessary carbon goals for climate change with the least damage to our environment and to our economy will prove to be (1) building 100 new nuclear plants in twenty years, (2) electrifying half the cars and trucks in twenty years – we probably have enough unused electricity to plug these vehicles in at night without building one new power plant – (3) putting solar panels on our rooftops. To make this happen, the government should launch mini Manhattan Pojects like the one we had in World War II: for recycling used nuclear fuel, for better batteries for electric vehicles, to make solar panels cost-competitive, and in addition, to recapture carbon from coal plants. This plan should produce the largest amount of electricity with the smallest amount of carbon at the lowest possible cost, thereby avoiding the pain and suffering that comes when high-cost energy pushes jobs overseas and makes it hard for low-income Americans to afford their heating and cooling bills.

My fellow Tennessean Al Gore won a Nobel Prize for arguing that global warming is the inconvenient problem. If you believe he is right, and if you are also concerned about energy sprawl, then I would suggest that nuclear power is the inconvenient solution.

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"...I know it's been long assumed that those who champion the environment are opposed to nuclear power. But the fact is, even though we've not broken ground on a new power plant – new nuclear plant in 30 years, nuclear energy remains our largest source of fuel that produces no carbon emissions. To meet our growing energy needs and prevent the worst consequences of climate change, we'll need to increase our supply of nuclear power. It's that simple."

– President Barack Obama, February 16, 2010

"If we were going to war, the United States would not think of putting its nuclear navy in mothballs. Yet, we did mothball our nuclear plant construction program – our best weapon against climate change, high electricity prices, polluted air and energy insecurity. Although 107 reactors were completed between 1970 and 1990 producing 20 percent of our electricity today – which is 69 percent of our carbon-free electricity – the United States has not started a new nuclear reactor in thirty years."

– Lamar Alexander