"A Clean Energy Revolution"

Remarks by

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Introduction

Thank you all for your support of this great organization—the central purpose of which is education and awareness about environmental and conservation issues. This idea, that this kind of communication can lead to better participation and positive changes in policy, politics, and our society, is a testament to faith in our democratic republic. And the record of success of Colorado Conservation Voters is proof not only of the effectiveness of this organization, but also of the character and quality of people and politics in this great State.

It is a great pleasure to be back in Colorado again, and an even greater pleasure to see what government and businesses and others have been doing here over the past few years. The dramatic expansion of clean energy development in this state is a model for the rest of the country. I am particularly impressed by what has been happening along the Highway 36 and IH 25 corridors; the way that the state is leveraging the strong foundation of the National Lab and Wind Technology Center, as well as universities, to create an effective and efficient cluster phenomena around which business and development and the economy can flourish. It is no surprise that great companies like Vestas and ConocoPhillips, and many others, are increasing their bets on Colorado when you have this kind of strategic vision and action. Of course, it can't happen without leadership, and from the Governor on down, Colorado has great leadership.

I would also like to personally applaud the Governor's Amendment 58 Initiative. Money for scholarships and the other activities proposed is seed corn for the State's clean energy future. And that money has to come from somewhere to maintain fiscal discipline, so budget offsets are required. We could use some of that thinking in Washington, DC, these days as the federal production tax credit debate continues.

Again, congratulations on the great work you are doing. One of my most precious treasures, my beautiful and brilliant daughter, Kara, lives right here in Denver and she benefits directly from the Clean Energy Revolution you are launching here in Colorado.

I thank you, also, for the opportunity to share some thoughts and observations drawn from my so far interesting and varied career in clean energy and sustainability. I try to always keep an eye on the industries and issues from several viewpoints at once. So while my bias is today from a business perspective, I also draw on my view from an NGO, from within a National Academies Study Panel, and from work with advocacy organizations operating in Washington, DC.

In the interests of proper disclaimer, I do not speak on behalf of those entities, but merely as a participant observer.

A Clean Energy Revolution

I want to talk to you today about the imperative of a clean, low- or zero-carbon energy revolution—a Clean Energy Revolution.

What do I mean about a Clean Energy Revolution?

"Revolution"—as in fundamental, transformational. What needs to happen is huge—a reordering and restructuring and transformation of our energy system—in electricity and liquid fuels. In this State, this Nation, and ultimately across the globe—a revolution that in scope and scale dwarfs anything we have ever done before. Bigger than the biggest energy transition previously undertaken, the global transition over the last 100 years from a biofuels to fossil fuels global economy. Bigger than that by many orders of magnitude and even more challenging still because this new revolution must build upon or displace a now vast and pervasive existing system—by many accounts the largest industry in the world.

"Imperative"—as in we must start now. I will not recite the data or trends and projections that lead me (among so many) to conclude that the time for action, significant action, is now. I will only note that even if you disagree with that urgency, you should and can safely accept the idea that action, significant action, now is the least cost and least risk path forward in light of the scientific consensus that has emerged and strengthens every day.

Of course, the easiest way to step into that mindset is simply to adopt a belief that there really will be a tomorrow; a future in which our children and grandchildren will have to live. Once you do that, and begin to appreciate the challenge before us, I believe you will realize both that we simply cannot go on as we have before—prudence demands a change of course—AND that we must start the change now, even with imperfect information about what lies ahead.

An Issue of Scale

To get a bit of a sense of the scale of the clean energy revolution required, consider just a few numbers—to get just ten percent of our electric demand from non-hydro renewables, we will need a five-fold increase. And ten percent is not enough to support a move to steady-state atmospheric concentrations of 450 ppm of CO2 or less (and maybe we need to get to 350 ppm).

The American Wind Energy Association, AWEA, estimates that a 20% contribution of wind to our national grid—10 times more than we have today—means that we will need more than 300 GW of wind farms. That is more than a 1,000 new 300 MW wind farms. The industry have fairly well mastered the process of adding 10 GW per year, and is expert at building 300 MW wind farms. Our technology is capable, but right now our policy is weak.

But we will need new technology, vastly greater sums of capital and strong, consistent policy in order to transition to adding wind in meaningful increments—we need to start building 1,000 MW wind farms. At least 15 GW more each year for 20 consecutive years. And 15 GW is just a little less than the total we have installed right now. And 20% is only the down payment on a clean energy economy—just one of the few first best things we can do on the supply side of the equation.

Liquid Fuels – A Short Aside

The scale issues apply to every aspect of our energy economy—I will make only one point here about liquid fuels. That is this—to the extent that plug-in vehicles are part of a solution to the petroleum problem, and I think they are, that only adds to the task before us.

The total resource available—the renewable energy flux—is vastly greater than we need to satisfy all the energy demands of our world, but the best resources are unevenly distributed, and have relatively poor correlation to our population distribution. We that wind now, and we need to build the solar industry at the same time, and we need to continue work on EGS, tidal, and other renewables. And we need a grid that can move the energy from the resource to the place it works.

Energy Efficiency

This would be a good time for a few words on energy efficiency. The efficiency resource is fully distributed throughout our society, and also offers a first best bet—like wind and solar—but as Amory Lovins likes to say, of lot of it resembles the sweet bits of meat in the nooks and crannies of the lobster's shell—worth the effort, but harder to get.

From a business perspective, I am really excited about the potential for carbon credit creation as a way to pull those bits of value from the system—we have written a protocol for quantifying greenhouse gas credits from residential and commercial efficiency measures, as well as all the other traditional carbon credit source technologies—but a working business model that profitably harvest the many bits of efficiency savings out there still eludes all of us. DSM programs and building codes are a good platform, but we have to take this efficiency effort to a whole new level.

And on a point not often made by the efficiency advocates, a huge lot of the efficiency resource is locked inside our built and industrial infrastructure. The opportunity is still great in my own house, for example, even though I live in an "Energy Star" home, use compact fluorescent bulbs everywhere, sprayed in a radiant barrier, adjust my thermostats, and own horizontal access laundry appliances.

You see, provided that Hurricane Ike or some future major hurricane doesn't change my outlook and reality, much greater efficiency improvements in my house will require major renovations—or even full reconstruction. But under traditional economics, if the payoff is greater than 5 years—the average duration of ownership for homes in this country—that kind of major project is a non-starter. As the green building experts have long told us, our homes and buildings stand as durable monuments to our best design mistakes.

We need real change, dramatic and transformational, in our building stock and practices. We can't afford to install so much inefficiency any more, no matter how cheap it is; it just costs too much. And we have to undertake this transformation at the time that we fix the financial crisis impacting the housing markets. We can't wait for that fiasco to be resolved. Somewhere there must be a "three-fer"—a solution set that ensures safe, adequate and affordable housing; dramatically increases the efficiency of our housing stock; and sobers the reckless practices of the mortgage and financial industries of the last few years.

Solar PV

Solar PV is also growing rapidly from its small base, but the record pace needs to accelerate even further. Global PV production capacity is at less than 15 GW today—to get another 20% of the total pie just in this country, global solar would have to ramp up to at least

double current capacity and churn out modules ONLY for the US market for several decades. With some important differences, almost everything I just said about wind plays out for solar PV, too. Solar thermal, too, and from an even smaller base.

Infrastructure and "Going Long"

Let's switch our attention back to the wind energy challenge for a minute longer. Try to wrap your head around that 300,000 MW figure again. That is more than 100,000 turbines, towers and pads, and 300,000 blades. It is cranes and roads and crews and maintenance teams. It is trailers and manufacturing facilities and hundreds of component suppliers—all of which means jobs, of course. But little of that infrastructure is in place and ready to go right now. Assuming that wind is largely sited in the west and Midwest, it means nearly doubling the amount of existing capacity on the grid, which means cable, substations, towers, rights of way, environmental assessments, system controls, balancing and ancillary services. All these things have to come together, all mean jobs and spending in the community and related industries; and there are at least 20 countries around the world competing to offer a better deal to the developer who can deliver and operating wind farm. It is not just about solving a complex problem with every farm, it is about competing to do so.

Think with me for a minute about how that competition manifests inside a company like AES Wind Generation. The best prices and security of delivery of turbines requires going long on machine orders, tower orders and blade orders. Hundreds of millions of dollars have to be at risk until the moment when the machines start flying. And so a company has to also "go long" on project sites, especially with see-saw incentives and siting regimes—we have to go long on policy, too.

It is no surprise, therefore, that the industry has seen great consolidation in recent years. More is likely to come. The balance sheets and financing vehicles necessary to maintain the kind of growth that the market expects grow every day, and while money seems happy, now, to move to clean energy tech today (perhaps because other choices are not so good), our American model faces stiff competition from many a global competitor.

More importantly, the challenge of siting and developing wind farms grows as the optimal resource sites are developed. The move to scale comes exactly at the time that we need the flexibility, creativity, and ingenuity of small developers.

All of the mega-farms, whether wind or solar or something else, need infrastructure—and infrastructure needs corridors. Just as unit trains were fundamental to the corn economy, so large capacity transmission is fundamental to the new clean energy economy. We can build wind generation faster than the transmission to serve it. Think about that for a minute, and what a dramatic impact that has on the traditional regulatory approach.

In Texas, after several tries at the Public Utility Commission and the legislature, we finally had to invent the CREZ (Competitive Renewable Energy Zone) process to break down the barriers to long-term transmission planning that hampered the development of ERCOT, not just for wind, but for the benefit of all Texans. I know this sounds familiar here in Colorado.

Finally, please consider for a moment the fundamental contrast between the scale of the solution we need and the mode of energy and capacity we need to tap. This may be the ultimate paradox of distributed energy solutions—at the heart of the clean energy revolution—the ore clean energy we need, the smaller we need to work. We need to turn much of our ordinary energy

thinking inside out.

We need to permeate our entire society and occupied geography, ultimately, with efficiency and distributed generation. From a current business perspective, the transaction costs of such an undertaking are just too high. Somehow we need to find a way to ensure and maintain the integrity of each individual replication of the act of saving energy and generating clean energy AND at the same time, enable millions of replications. Not just in the technology, but in the policy and in the provision of capital.

A Search for Solutions

In order to avoid being declared insane for trying the same thing over and over again while expecting a different result, it may be time to start trying some new things. But if the energy sector can't find all the solutions, where do we look?

The answer, of course, is everywhere.

Information Technology

Where, for example, might we find a model for a system that can conduct millions and even billions of transactions with a suitably high level of quality control? It is not surprising that many think it is in the intersection of information technology and computer processing power with the energy sector that we will start getting there. Mass production and mass customization, the displacement of the dumb, one-way electron delivery system with a smart, cybernetic, interactive, self-teaching and self-healing grid that interconnects supply, demand, delivery and management of electricity.

A transition from a policy and incentive system that rewards growth for growth's sake to one that rewards the provision of serve at least added cost. Creative self-destruction, accelerated innovation, Moore's Law, virtual utilities—all these concepts have been discussed and batted around from more than a decade now. And perhaps their full time has come. But it won't be cheap. While clean tech seems to have captured the attention of the VC community, experts counsel that trillions of dollars, not just billions, are needed in order to fuel the clean energy revolution. Still, energy may push IT to its greatest social contribution.

Lessons from Nature

Given the remarkable success of life on this planet Earth, I have also given a lot of thought to whether living systems, at the large and even down at the molecular scale, might offer insights in conducting our own transformational clean energy revolution.

Systems Thinking

So my first observation, inspired by thinking about ecological principles, is that we need to keep our attention focused on systems and systems impacts. As anyone who has ever endured a utility rate case knows, the detail work—necessary to be sure—creates the impression that every component of the existing system is sacred. But all too often, this attention to detail deflects our perspective from the system itself—losing sight of the forest for the trees.

(How else, for example, could we explain that not until the EPA completed its analysis of the pre-mark Lieberman-Warner Bill did it become clear that implementation costs could be a full 71% lower if the bill had allowed unlimited domestic and international offsets?)

Integrated Resource Planning processes have been the leading strategy for getting around

the specificity bias, and we will need tools like that and many more—because now we have a climate criterion overwhelming the decision matrix. To succeed in the clean energy revolution, we have to integrate and properly prioritize this criterion first among all the others—while avoiding the kind of jurisdictional grid-lock like we now see afflicting the federal government as it wrestles with the seemingly conflicting agendas of the Clean Air Act under Massachusetts v. EPA and the CAIR rulings, pending federal carbon legislation, regional and state initiatives, and international efforts to renew and extend the Kyoto Protocols.

What we see emerging in Washington, campaign politics aside, is the context for the proverbial Christmas tree legislation package. The US Chamber of Commerce mocked the complexity of the Chairman's Mark of the Lieberman-Warner bill for its now-Byzantine structure—and a fair bit of that mockery seems well deserved. The problem is that the legislative process is challenged to keep the big goal in mind as it addresses constituent concerns.

From a systems view, then, we can see that our energy system is structured and driven by policy, technology and capital. The most important part of this point is that progress occurs at the confluence of all three, and that any approach to understanding requires an appreciation of the system as a whole.

Complexification

Another idea arose as I consider the life sciences, particularly genetics. It is about a lesson we should NOT be taking from living systems. Living systems, I would observe, seek to perpetuate. Life even often values replication over efficiency in many cases, piling complexity upon complexity, adding incrementally to the structure and organism—even down to the cellular DNA—over millions of years of evolution. While this often contributes to successful replication (consider the Peacock), there is an efficiency penalty.

It also means that nearly all our DNA is similar among relatively similar species, and most of it is really just junk—a legacy of our past and progress to get to the point where we are today. To be sure, the end result is pretty dandy—humans are remarkable in so many ways as the pinnacle of all the evolution that has happened so far. And there are some real treasures buried in all that junk, for example, extremozmes—enzymes from extremophile bacteria living in the deep ocean that could be harnessed for highly efficiency conversion of cellulose to ethanol or hydrogen.

Our electricity system also is a pretty dandy thing and provides great value and service to society. But it, too, has been driven to replication and incremental growth along a model that has, with relatively few interruptions, focused on accretive growth and in many cases unnecessarily duplicative replication. That means that there is some "junk" in the system, slowing down the change that occurs in the system. How many times have we heard that the electricity system is like an oil tanker, slow to respond to steering changes.

But we now know that we can no longer wait for evolutionary, epochal transformation to perfect the system—the environment has changed too quickly. And we can't count on random mutations, even if intentionally directed, to drive the massive level of reorganization required.

The urgency and scope of the challenge before us confirms that the least we can do is engineer into our revolution avenues of influence for external forces—the invisible hand, if you will of system change. Directed mutations and the threat of competition can impose discipline on systems that move too slowly or too much into stasis, or worse, into the trap of the pursuit of

embellishment for its own sake—goldplating—something our utility industry has fallen victim to in the past. We must, at the very least, create avenues for the constant introduction of new ideas—to splice new code into the old system.

The Myth of Large Solutions

There are, however, no simple large solutions. I am not an advocate of the nuclear option, primarily because of opportunity costs. In fact, we do need to evaluate all our alternatives against whether they can provide the best solutions to the climate problem AND the demand for energy, and at a cost that we can afford to pay, both today and tomorrow. For every complex problem there is usual a simple solution, and it is usually wrong.

The Subtle Bigotry of Low Expectations

As we embark on the radical transformational change that we must undertake, clarity of purpose articulated through public policy will be of absolute importance. This policy must guide technology development and send important signals to the financial community as well. So at the same time that we must not be seduced by the false comfort of large solutions, we must also be guard against something I call "the subtle bigotry of low expectations."

Here is my point—what we are trying to do is nothing less than drive the transformation of the largest industry on the planet. Subsumed within that agenda are dozens, hundreds of subservient objectives and goals. We want to reduce toxics pollution, conserve water resources, promote and secure national security, increase employment, enhance justice, and many, many others. But we need to keep our eyes on the ultimate goal.

As a specific example, I would draw from the current debate on carbon law and policy. For some in the environmental community, the carbon-constrained economy is the long-awaited day of reckoning for one particular sector of the energy industry—coal-fired power plants. For some of these advocates, "cap and trade" is just a politically correct way to say "shut them down."

It may well be that coal-fired power plants will play a much smaller, or even no role in our energy future. But they play a big part in our present, and that will not change without consequences. And anyone with a view to the global future knows that carbon capture and sequestration may be a huge game-changer.

The key point is that this agenda focused as it is on shutting down coal distracts from the primary objective—getting global greenhouse gas emissions down to a point that allows the atmosphere to stabilize at 450 or 350 ppm—they are NOT exactly the same thing right now. The anti-coal agenda makes enemies where we need collaboration; it distorts our policy into a narrow advocacy fight. It leads to positions that narrow our options, rather than expand them—like limiting international offsets or all offsets, and subjective tests of financial additionality.

The potential for reducing GHG emissions is huge, and extends well beyond the emissions from coal plants, of course. In fact, even if we completely meet the requirements of the most stringent legislative proposals in Congress, we will still emit more than 150 billion tonnes between now and 2050. That means that in the area UNDER the compliance curve lies a well of potential innovation and opportunity. It can be harvested with offsets and efficiency and distributed clean generation and sequestration and other ideas not yet perfected—if we organize the market to encourage that innovation and pursuit. Going after that resource economically is exactly the kind of thing the business sector can do well.

Offsets and efficiency delay the "day of reckoning" for coal. For that reason, we see some environmental advocates actually arguing against cost-effective offsets, profitable offsets, and even carbon credits for energy efficiency and renewable energy. This can't be right.

My simple prescription for carbon policy, therefore, is this: We should go to science for the right target—the cap level and date. After that, we should tap every tool and resource at our disposal, especially including the innovative skills of the business sector, to obtain our climate objectives at the lowest societal cost.

Conserve and Conservative

My musings about the natural world also finally led me to thinking about conservation and its root, the word conserve. In the natural world, conservation is another central organizing principle. In our policy world, conservative is an orientation espoused by probably half our population. But somehow, conservative energy policy has come to mean "drill, baby, drill!," among other things. Squandering resources and depriving future generations of their benefits through wasteful consumption and the expenditure of a scarce taxpayer dollars and a depleted public trust doesn't strike me as conservative. Sometimes, the natural and political definitions of "conservative," strike me as polar opposite views of the same concept. Can both be simultaneously true? (I reject, of course, the notion that we need to adopt a third definition—that we should be conservative by changing nothing and merely doing more of the same.)

Consider this quotation, please:

... The earth is finite. Fossil fuels are not renewable. In this respect our energy base differs from that of all earlier civilizations. They could have maintained their energy supply by careful cultivation. We cannot. Fuel that has been burned is gone forever. Fuel is even more evanescent than metals. Metals, too, are non-renewable resources threatened with ultimate extinction, but something can be salvaged from scrap. Fuel leaves no scrap and there is nothing man can do to rebuild exhausted fossil fuel reserves. They were created by solar energy 500 million years ago and took eons to grow to their present volume.

In the face of the basic fact that fossil fuel reserves are finite, the exact length of time these reserves will last is important in only one respect: the longer they last, the more time do we have, to invent ways of living off renewable or substitute energy sources and to adjust our economy to the vast changes which we can expect from such a shift.

Fossil fuels resemble capital in the bank. A prudent and responsible parent will use his capital sparingly in order to pass on to his children as much as possible of his inheritance. A selfish and irresponsible parent will squander it in riotous living and care not one whit how his offspring will fare. ...

I would commend to you this quote along with a rhetorical question, a koan, if you will. "Is there hope for society if we a adopt a conservative energy policy?"

"Is there hope if we do not?"

The quote, by the way, comes from May 14, 1957, just a few months before I was born. It is by Rear Admiral Hyman G. Rickover, U.S. Navy.

And as I was pasting this quote into my text, imagine the irony I felt when an email hit my in-box, carrying a story from the August 4, 2008 Virginian-Pilot about Navy ships on detail in the Persian Gulf. In the on-line version of the paper, it said:

HEADLINE: Navy wonders, just how do you trim a $3.8 billion fuel bill?

Dateline: Norfolk, VA; August 4, 2008.

For Navy vessels, operating at sea has taken on a different feel.

Some nights, sailors cut the engines and the warship just floats.

"We did a lot of that on deployment," said Cmdr. Michael Junge, skipper of the Whidbey Island.

The practice helped make Junge's amphibious ship, which spent six months in the Persian Gulf region, one of the most fuel-efficient in the fleet, he said.

With fuel prices reaching record heights, the Navy has looked for creative ways to curb costs without compromising missions. Conservation efforts are expected to save the Navy about $325 million this year.

But in July, the military bumped up oil prices to $170 per barrel from $127 to reflect true costs. The increase will wipe out the Navy's entire annual savings in just three months. Fuel costs are an issue for all the service branches.

The military is the country's largest single consumer of energy. It spent $13.6 billion in 2006, almost double the amount since 2003, the start of the Iraq war. Every $10 increase for a barrel of oil costs the Department of Defense $1.3 billion, according to military statistics.

The Air Force is the top consumer within the military, and the Navy is second.

The Navy expects to spend $3.8 billion to power its ships and aircraft this fiscal year, a 42 percent jump from last year.

Enough said. Energy is one of the top security issues facing our Nation.

Conclusion: Where Our Record is Written

I will close with one more reflection inspired by a very interesting story about human DNA that appeared in a recent issue of Scientific American magazine. The article told about how scientific tools and techniques have improved our understanding of how humans have spread around the world.

You may recall the debate from school—are Native Americans descendant of Siberian travelers, or did they get to this continent another way? Was Africa the source of modern humans, or did we spring up in several places around the globe at more or less the same time? For decades, all we had to go on was the fossil record, and a scant record it was. Sadly, our incomplete understanding left us to fill in the gaps—often the hypotheses fashioned for that purpose, extending from the prejudices of the time, sometimes reflected racial bias and helped strengthen unnecessary divisions between us all.

Well, the article tells about how the ability to map the 16,000 nucleotide pairs of the mitochondria—the energy factories of our cells—helped us improve our understanding several years ago. But now we have new tools, new approaches, better data and better conclusions—one of them is that we are all very much alike.

Science, as I said, has progressed. Now we know much more about the genome, having mapped and catalogued much more of the information. And scientists can compare groups of

thousands of nucleotide pairs across thousands of samples taken from people around the world. Our image of the path of our human progress across the surface of the Earth has dramatically improved as a result. We are now much more confident that we are all “out of Africa,” and that we share a common human heritage of relatively recent origin. Homo sapiens with modern traits began migrating out of Africa some 50 or 60 thousand years ago to become all the peoples of the Earth that we know today.

We know all this about ourselves because it is written in our genes, and we finally have the tools and techniques to see it. That is what struck me, and this is my final and most important point about our transformation to a clean energy economy.

You see, like the archeologists of old, we have often proceeded under the presumption that our energy culture will be known by what we build. In some states, power plants are even named after utility executives!

To complete the task before us, the great, revolutionary, transformational task of meeting the energy needs of all our peoples without compromising the very Earth on which we live and the ability of future generations to meet their needs, we must develop better tools and techniques, formulate better policies, and marshal even more capital to build even more things, to be sure.

But it is also and more importantly true that a great revolution must occur in how we see, use, and view energy. The greatest change must be in each of us.

In the end, as with our genetic/geographic history, we will not be known so much by what we build or by what we leave behind; we will be much better understood by what we, in the very fabricate of ourselves and our societies have become.

Here’s to change that w can all proudly live with.

Thank you!