Hearing of the Committee on Energy and Natural Resources

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Good Morning. I am very pleased to be here to discuss the science of climate change and to reflect on the very real challenge of making sound policy choices in the face of uncertainty. Climate change is perhaps the most worrisome global environmental problem confronting human society today. It involves a complex interplay of scientific, economic, and political issues. The impacts of climate change are potentially very large and will occur over a time scale of decades to centuries. The actions needed to respond to this challenge require substantial long-term commitments to change traditional economic development paths throughout the world. The ultimate solution to the challenge will require a fundamental transformation in the production and consumption of energy here in the United States and by developed and developing nations alike.

I want to address the bulk of my remarks to the threshold question: Do we know enough about climate change to act now and to start doing something serious to address this problem? Let me first comment on what I think the role of scientists should be in answering this question. Ultimately policy decisions about climate change have to be made by society at large, and more specifically by policymakers. Scientists do not have any special privilege to make such decisions, but science does play a fundamental role on this issue. The climate system is very complicated and science does not have all the answers: there are uncertainties in predicting when and to what extent will the climate change as a consequence of a given course of human activities. However, scientists can estimate the probability that the earth's climate will respond in certain ways. For simplicity the climate response is often represented as the increase in average global surface temperature of the planet say, by the end of the century. This information can be used by policymakers to assess the risks imposed by climate change and to device adequate responses to address the challenge.

Let me begin by simply summarizing what we know about climate change. I firmly embrace the view expressed in the recent Sense of the Senate Resolution that "there is a growing scientific consensus that human activity is a substantial cause of greenhouse gas accumulation in the atmosphere, " and that these accumulating gasses are causing average temperatures to rise at a rate outside of natural variability."

Simply stated, the world is warming.

- It is due to our emissions.
- More warming is inevitable -- but the amount of future warming is in our hands.
- Because CO2 accumulates and remains in the atmosphere, each generation inherits the emissions of all those who have gone before. Many future generations of human beings will wrestle with this issue.
- Modest amounts of warming will have both positive and negative impacts. But above a certain threshold, the impacts turn strongly negative for most nations, people, and biological systems.

While there is a growing scientific consensus around the science of climate change, there is of course much that we do not fully understand about the timing, geographic distribution, and severity of the changes in climate - and the economic, environmental, and social impacts of these changes - that will result if heat -forcing emissions continue to increase. However, not knowing with certainty how the climate system will respond should not be an excuse for inaction. Policymakers are frequently, indeed usually, in the position of making decisions in the face of uncertainties. Usually, the presence of uncertainty means that we build in extra insurance to protect against the risk that consequences may be worse than we expect. It would be better, of course, if we knew exactly where the perfect balance between cost, risk, and benefit lies. But the fact is that we never have that luxury. Nevertheless, policy makers and individuals both must manage public and personal risks all the time and we do. Most people buy car insurance even though they don't know with any degree of certainty what their individual risk of being in a car accident might be, just as most doctors would advise an individual with a history of heart trouble to choose low-fat foods and exercise despite the many complex and usually unknowable factors that go into determining any individual person's risk of having a heart attack.

If we apply the same logic in setting goals for limiting the risks associated with future climate change, it becomes very clear that our current course now places us far outside the kinds of risk thresholds we typically apply in other areas of public policy. Put another way, there is now an overwhelming consensus that failure to limit greenhouse gas emissions will produce a risk of significant adverse consequences that is far higher than we find acceptable in other arenas. When facing a substantial chance of potentially catastrophic consequences and the near certainty of lesser negative effects, the only prudent course of action is to mitigate these risks. And let us be clear -- when we speak of potentially catastrophic consequences in this context we are talking about devastating impacts on ecosystems and biodiversity; severe flood damage to urban centers and island nations as sea level rises; significantly more destructive and frequent extreme weather events such as droughts and floods; seriously affected agricultural productivity in many countries; the exacerbation of certain diseases; population dislocations; etc.

A reasonable target, in my view, is to attempt to limit the global temperature increase to less than about 4 degrees Fahrenheit. Recent estimates indicate that stabilizing the amount of greenhouse gases in the atmosphere at the equivalent of twice the pre-industrial value of 280 ppm carbon dioxide provides only a 10-20 per cent chance of

limiting global average temperature rise to 4 degrees Fahrenheit. Put another way, this means that the odds that average global temperatures will rise above 4 degrees is 80 to 90 percent. Unless society starts taking some aggressive actions now, we are well on our way to reaching perhaps even a tripling of pre-industrial carbon dioxide levels with far greater adverse economic and environmental consequences.

The risks to human society and ecosystems grow significantly if the average global surface temperature increases 5 degrees Fahrenheit or more. Such a large temperature increase might entail, for example, substantial agricultural losses, widespread adverse health impacts and greatly increased risks of water shortages. Furthermore, a very high proportion of the world's coral reefs would be imperiled and many terrestrial ecosystems could suffer irreversible damage. The risk of runaway or abrupt climate change also increases rapidly if the average temperature increases above about 5 degrees Fahrenheit. It is possible, for example, that the West Antarctic and Greenland ice sheets will melt, raising sea levels more than ten meters over the period of a few centuries. It is also possible that the ocean circulation will change abruptly, perhaps shutting down the Gulf Stream.

I applaud the Committee for its commitment to explore legislative proposals consistent with the Sense of the Senate Resolution and moreover commend you for beginning this exploration with a discussion of climate science. As you may know, I am one of sixteen members of the National Commission for Energy Policy (NCEP). You will hear more about the Commission from Jason Grumet, our Executive Director, shortly. One of my main contributions to the Commission's deliberations was helping the group understand the challenge of forging sound climate policy in the face of evolving scientific knowledge. Early on in our deliberations we agreed upon the following brief statement to guide our policy exploration. I offer it here for the Committee's deliberations:

"(1) We understand that a scientific consensus has emerged that (a) global temperatures have been increasing at a rate that is outside the range of natural variability, (b) human emissions of CO2 and other greenhouse gases have been responsible for a part of this increase, and (c) continuation of these emission trends along "business as usual" lines could produce changes in climatic patterns in this century that will produce significant adverse impacts on human societies.

(2) There are many uncertainties in the details of the timing, geographic distribution, and severity of the changes in climate – and the economic, environmental, and social impacts of these changes – that will result if "business as usual" prevails. There are, likewise, significant uncertainties about the availability and costs of energy-supply and energy-end-use technologies that might be brought to bear to achieve much lower greenhouse-gas emissions than those expected on the "business as usual" trajectory.

(3) These uncertainties are cause for further research and development to try to reduce them, but they are not proper cause for taking no other action to reduce the risks from human-caused climate change. What is already known about these risks is sufficient reason to accelerate, starting now, the search for a mix of affordable technical and policy

measures that will be able (a) to reduce greenhouse-gas emissions substantially from the "business as usual" trajectory in the aggregate over a relevant time frame, and (b) to adapt to the degree of climate change that cannot be avoided without incurring unreasonable costs. This is not the only major challenge in fashioning a sensible energy policy for the United States, but it is a challenge that no sensible energy policy can ignore."

I thank you for your attention and look forward to working with the Committee in the weeks and months ahead.