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Chairman Kerry, Ranking Member Ensign, and Members of the Subcommittee, I am pleased to appear before you today to discuss "Coal Gasification Technologies and the Need for Large Scale Projects." My remarks will focus on some contextual factors that make coal gasification technologies particularly relevant to our climate strategy.

Fossil fuel energy production is the primary factor in the dramatic increase of atmospheric CO_2 since the beginning of the industrial revolution. A basic understanding of the science of climate change would suggest that in the short run, we should seek to produce fewer greenhouse gases and increase absorption of those already in the atmosphere. In the long run, we should aim to limit releases to an amount much smaller than current values. And we should get on this path immediately, because Earth's heat balance is already tilted and some effects of massive CO_2 production are already evident. As you know, since 2001, the Administration has taken many actions to confront this challenge, and we are continuing to make progress both domestically and internationally.

As we contemplate these actions, however, here are some numbers to keep in mind. The U.S. consumes more than 20 million barrels of oil per day, 60 billion cubic feet of natural gas per day, and 3 million tons of coal per day. This is about a fifth of the world's energy consumption. World-wide, coal accounts for about 45 percent of electricity production, natural gas about 24 percent, nuclear about 12 percent. Oil is used mainly for transportation and as a feedstock for the chemical industry. The current annual release from the world's energy sector, by far the largest contributor to increased atmospheric CO_2, is about 28 billion tons of CO_2 – 40 percent from coal, 40 percent from oil, and most of the remaining 20 percent from natural gas.[1]

Suppose you wanted to reduce global emissions by just one billion tons – less than 4 percent of the current global total. That would require building 136 new 1000-MW nuclear plants (equivalent to one-third the existing world-wide nuclear capacity), or 150,000 2-MW wind turbines (about 3 times the current world capacity), or 300 new coal gasification plants (500-MW each) with carbon capture and sequestration (CCS), in place of conventional coal plants. Today, there are several carbon sequestration projects that each remove about 1 million tons of CO_2 per year. This sounds like a lot, but is just one-thousandth of the billion we are looking for to achieve our 4 percent reduction. And international forums are talking about reductions on the order of 30 to 50 billion tons CO_2 per year by 2050.[2]

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[1] Energy Information Administration, International Energy Outlook 2007, www.eia.doe.gov/oiaf/ieo/emissions.html.
[2] Japan has proposed a global 2050 goal to reduce greenhouse gas emissions to 50 percent of current levels (i.e., reducing energy-related CO_2 emissions to 14 billion tons-CO_2 per year), while the EU has called for a 2050 goal of

These numbers are sobering. Fossil fuels have made modern economies and the incredible advances in standard of living over the last century possible. The economic development path has been paved with fossil fuels. For any given economy, CO_2 production has been roughly proportional to Gross Domestic Product (GDP). The coefficient of proportionality is sensitive to technology; recently developed or developing economies are significantly more "carbon intensive" than older, developed economies. This is good news. It means that introducing modern energy technologies in the rapidly developing parts of the world can slow the growth of fossil CO_2 relative to the historical development path. In fact, the objective of a CO_2 mitigation strategy should be to eventually reduce the carbon intensity of the world's economy toward zero, at the lowest possible socio-economic cost.

A dramatic reduction in global energy emissions intensity will require deployment of advanced technology at a rate much higher than projected in baseline scenarios. The Energy Information Administration (EIA) projects that under current policies U.S. CO_2 emissions from energy use will increase from 5.9 billion metric tons in 2006 to 6.9 billion metric tons in 2030, an increase of 16 percent,[3] primarily as a result of increased emissions from coal power plants and vehicle emissions. Total electricity consumption is expected to grow 30 percent over that time period – an average growth rate of 1.1 percent annually (which is much slower than the historical average, largely as a result of expected efficiency gains).[4] In that timeframe, the EIA projects that about 100 gigawatts of new U.S. coal-fired generating capacity will be built (in addition to maintaining the existing capacity of 300 GW), including 30 gigawatts of integrated gasification combined-cycle (IGCC) plants without CCS.[5] From 2006 to 2030, new coal power plants are expected to increase power sector CO_2 emissions by 700 million metric tons per year, representing about three-quarters of the net increase in U.S. emissions over that time period.

Globally, the rate of emissions growth is expected to be much more rapid. In 2005, global energy-related CO_2 emissions amounted to 28 billion metric tons, of which the United States' emissions represented 21 percent.[6] By 2030, global emissions are projected to total 43 billion metric tons.[7] The EIA projects that the United States will account for about 16 percent of total global CO_2 emissions in 2030, and about 7 percent of the growth in emissions from 2005 to 2030.[8] By comparison, about 60 percent of the increase from 2005 levels is expected to come from China, India, and other non-OECD (Organization for Economic Cooperation and Development) Asian nations. U.S. coal-fired generation is projected to be 6 percent of global

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50 percent of 1990 levels (i.e., reducing energy-related CO_2 emissions to 10 billion tons-CO_2 per year). Others have proposed even more aggressive goals. Many baseline, medium- to high-growth scenarios project global emissions in the range of 50 to 70 billion tons-CO2 per year by 2050 (e.g., see the IPCC Special Report on Emissions Scenarios, http://www.grida.no/climate/ipcc/emission/005.htm).

[3] AEO2008 Revised Early Release (available at http://www.eia.doe.gov/oiaf/aeo/excel/aeotab_18.xls), which includes the expected emissions reductions resulting from the Energy Independence and Security Act of 2007.

[4] In the EIA reference case, U.S. electricity consumption, including both purchases from electric power producers and on-site generation, grows from 3,814 billion kilowatthours in 2006 to 4,974 billion kilowatthours in 2030, increasing at an average annual rate of 1.1 percent. In comparison, electricity consumption grew by annual rates of 7.3 percent, 4.2 percent, 2.6 percent, and 2.3 percent in the 1960s, 1970s, 1980s, and 1990s, respectively. [AEO2008 Revised Early Release]

[5] http://www.eia.doe.gov/oiaf/aeo/excel/aeotab_9.xls

[6] http://www.eia.doe.gov/pub/international/iealf/tableh1co2.xls

[7] http://www.eia.doe.gov/oiaf/ieo/emissions.html

[8] http://www.eia.doe.gov/oiaf/aeo/excel/aeotab_18.xls

emissions in 2030, [9] while globally, emissions from coal combustion in all forms will grow by two-thirds, amounting to 18 billion tons-CO_2 per year (43 percent of total CO_2 emissions) by 2030.[6]

The global trends of rapid emissions growth in developing nations and a dramatic expansion of coal-related emissions have been obvious for some time. As early as 2001, it was clear that a major factor in climate policy had to be a realistic strategy for recruiting large developing economies into an international framework. It was equally clear that climate policy is strongly linked to energy policy, and that the scale of the problem would require a campaign that would have to be maintained over the better part of a century. And it was clear that the already polarized nature of the public discourse was obscuring the scale and nature, not so much of the reality of anthropogenic climate change, but of the societal response that would be required.

In 2002, the President set a target of cutting our greenhouse gas intensity by 18 percent through the year 2012. When announced, this commitment was estimated to result in about 100 million metric tons of reduced carbon-equivalent emissions in 2012, with more than 500 million metric tons of reduced carbon-equivalent emissions in cumulative savings over the decade. Today, we are well ahead of the interim milestones to achieve that target. According to Environmental Protection Agency data reported to the United Nations Framework Convention on Climate Change (UNFCCC), U.S. greenhouse gas intensity declined by 2 percent in 2003, 2.5 percent in 2004, 2.2 percent in 2005, and 4.2 percent in 2006 – a 10.4 percent drop in those four years alone.

Why shouldn't the goal be simply to reduce the absolute carbon emissions toward zero? Why bring in the notion of "intensity”? Because the cause of our climate anxiety in the first place – the root cause – is the overwhelming desire of people everywhere to improve their lot. That desire will not be denied. From all I have ever read or seen of human behavior, the will to better human circumstances must be accommodated in any social plan of action, and especially one designed to persist over decades, perhaps centuries. If we are to make any progress in mitigating anthropogenic climate change, it will be necessary to break the link between economic development and fossil fuel emissions. Economic development – i.e. growth in GDP – and simultaneous CO_2 reduction implies reducing carbon intensity. This is a point of the utmost importance in crafting a successful global climate strategy.

The link between GDP and fossil fuel CO_2 emissions is technology. Technology choices in a society, especially pervasive ones like energy technology, are dictated by cost. So what are the prospects for reducing the cost of low-carbon-emission technologies to the point where they will replace high-emission technologies in rapidly developing economies? I phrase the question this way to emphasize that dictating limits on carbon emissions to such a country is a fruitless exercise unless alternative, low-emission technologies are commercially available and feasible at scale. And let us be clear that if we are serious about combating anthropogenic climate change, fossil-related carbon emissions must be reduced in ALL major economies. It is not enough for only the "old rich" economies of Europe and America and Japan to eliminate their emissions. ALL major economies must eventually adopt low- or zero-carbon energy technologies. This poses a vexing economic conundrum, because adjustments in energy technologies must occur during precisely that epoch in post-cold war history – our epoch – when a major transformation

[9] http://www.eia.doe.gov/oiaf/aeo/excel/aeotab_18.xls

in global patterns of trade, wealth, and economic power is also occurring. Any country that intervenes in its own economy to increase the price of low-cost, high-carbon-emitting energy in order to make higher-cost, lower-emitting technology more competitive, would likely put itself at a competitive disadvantage with countries that do not have similar policies, at least in the short term. And it is likely that there will always be dissimilar policies as long as significant differences in standards of living exist among economies around the world.

The cost associated with altering the energy technology of a large economy is very large. Economists come to widely different conclusions about the cost, and frankly I do not know how to evaluate the different claims. What I do know is that today – as we speak – very few low-carbon technologies exist that can be expanded to the necessary scale in the near term. I can think of only one, nuclear fission, that is sufficiently mature and sufficiently scalable to be a serious contender with low-cost coal plants. In the short term, renewable energy technologies such as wind and solar may help slow emissions, but we do not have low-cost versions of the ancillary technologies of electrical storage and transmission that are needed to scale these up even to their current potential. Biomass looks promising for transportation fuel, but is not yet very effective in reducing CO_2 emissions overall, and is not obviously scalable to the larger electrical power industry. Nuclear power is carbon-free, but the subject of such public concern, justified or not, that its substantial expansion will come only with concerted effort.

Coal, natural gas, and petroleum will continue to be the primary energy feedstocks for decades to come. We have, however, very few full-scale demonstrations of the technologies for capturing the carbon emissions of fossil-fuel combustion. Coal is the fuel we have to worry about most, especially on the global scale. It is currently the cheapest, most ubiquitous source of energy for stationary power generation, and it releases the greatest amount of CO_2 when burned. The U.S. has vast coal reserves and about half of its electricity is generated from this fuel. Meanwhile, China already uses 2.5 times as much coal as does the United States, and is adding, on average, more than one large coal-fired power plant every two weeks. Other developing nations such as India and the transitional Eastern European nations are also expected to rely heavily on coal for their economic growth. Thus it is clear that development of low-cost, commercially feasible CCS technologies for coal plants is an essential component of any long-term strategy to address climate change.

The Administration has committed enormous resources for the advancement of low-carbon coal technologies. The President's 2009 Budget, when combined with the private match, will result in over $1 billion of investment for research, development and demonstration of these technologies. This is just the most recent addition to the already existing $1.6 billion in tax credits and at least $8 billion in loan guarantees for advanced coal projects, industrial gasification activities at retrofitted and new facilities that incorporate carbon capture and sequestration, and advanced coal gasification facilities.

The Department of Energy (DOE) recently restructured the FutureGen program in order to focus government resources on carbon capture and storage. The new FutureGen will include multiple facilities, as opposed to just one, generating power at a commercial scale. This revamped initiative is expected to double the amount of CO_2 sequestered compared to original FutureGen concept that was announced in 2003.

The Administration has implemented a broad array of strategies – including partnerships, consumer information campaigns, incentives, and regulations – that are directed at developing and deploying cleaner, more efficient energy technologies, conservation, biological sequestration, geological sequestration and adaptation. The President's 2009 Budget includes $8.6 billion for climate-change-related activities and tax incentives – an increase of 9 percent from the enacted Fiscal Year 2008 (FY08) level. Since 2001, we have spent almost $45 billion on climate science, technology development, tax incentives and international assistance. Funding for the U.S. Climate Change Technology Program (CCTP), a multi-agency R&D portfolio led by DOE, is $4.4 billion in the FY09 budget (3 percent higher than FY08 and 27 percent higher than in FY07). This represents a large increase since the CCTP program office was formally established at DOE: the CCTP portfolio in FY03 was about $2.5 billion. Also, the President's Advanced Energy Initiative (which includes the Coal Research Initiative, nuclear energy R&D, basic energy research, and energy efficiency and renewable energy R&D programs, all of which are within the CCTP portfolio) has increased 80 percent over three years, with $3.2 billion in the FY09 request (vs. $1.8 billion in FY06).

The Administration is implementing mandatory regulations that will reduce carbon emissions. After calling for a renewable fuel standard and a large increase in vehicle efficiency standards in his 2007 State of the Union Address, President Bush signed into law in December the Energy Independence and Security Act of 2007, which includes substantial, mid-term requirements for vehicle fuel efficiency (40 percent improvement), renewable fuels (36 billion gallons annually by 2022), and efficiency of appliances, lighting systems, and government operations. The EIA estimates that this law will result in some of the largest emission cuts in our Nation's history, between 3.9 and 4.9 cumulative billion tons of CO_2 emissions reductions through 2030.

Internationally, President Bush has launched a Major Economies Process (MEP) to reach agreement on key elements of a post-2012 energy security and climate change arrangement under the UNFCCC, including the identification of a long term global goal for emissions reductions. The MEP will also focus on key sectors to help accelerate the development of advanced energy technologies. Japan currently outspends every other country on energy R&D – more than $3.5 billion in 2006. The U.S. was second in that year with more than $3 billion. No other country comes close. All the EU25 nations together contribute about $2.7 billion.[10] Most of Japan's energy research is on nuclear power, while most of the U.S. budget is for non-nuclear energy technology. There is much to do. Other countries can and should do more.

The Administration is pursuing global cooperation in many forums. The United States is working with other countries on a new international clean technology fund to help accelerate the use of cleaner, lower-carbon technologies and infrastructure. The United States and EU have jointly proposed in the Doha negotiations in the World Trade Organization to rapidly eliminate the tariff and non-tariff trade barriers that impede investment in clean technologies and services. The Administration has played a leadership role in the recent, legally-binding agreement with key developing countries to accelerate the phase-out of hydrochlorofluorocarbons under the Montreal Protocol, which will reduce emissions of greenhouse gases by at least 3 billion metric tons over the coming decades. Other significant efforts include the Asia-Pacific Partnership on Clean Development and Climate with China, India, Australia, South Korea, Canada, and Japan; joint efforts to combat deforestation, which accounts for roughly 20 percent of global greenhouse

[10] International Energy Agency R&D Statistics, http://www.iea.org/Textbase/stats/rd.asp

gas emissions; and international collaboration on monitoring and adaptation tools, such as the Global Earth Observation System of Systems, a 72-nation collaboration that can help communities plan and prepare for the effects of climate variability and change.

In the domestic arena, many of the actions by this Administration with respect to climate change have been taken in the name of energy security. The two goals are not quite the same, the points of divergence being the increased domestic production of oil and the use of coal without carbon sequestration. That is why it is so important to invest in CCS technologies. For both climate change and energy security, technology development must focus on scalable sources – nuclear and coal, while maintaining progress in other areas such as renewable power and efficient end uses. Of course, there is no reason to delay picking the low-hanging fruit of low-carbon technology. We can increase the efficiency of cars, and convert them first to run on biofuels and later on electricity or hydrogen. We can capture the energy of wind when it blows and sun when it shines, and later when we have better batteries we can use such transient sources more effectively. We can reduce the energy consumption of lighting, of buildings, of domestic machinery and appliances, and of industrial processes, with existing technology. None of these measures, however, addresses the very large share of emissions from stationary power sources that burn fossil fuels, and particularly coal.

The above discussion suggests that reducing carbon emissions from coal power plants ought to be a high priority for federally funded R&D. Recognizing these realities, the President's request for Fossil Energy research, development and demonstration in FY09 is $754 million, which is focused almost exclusively on coal. Funding for the Coal Research Initiative (CRI) has grown by 87 percent over the past three years, and the research, development, and demonstration activities within this Initiative are now almost entirely focused on CCS technologies. The $588 million for CRI in FY09 compares with $170 million when the President first took office in 2001, or more than 3 times as much spending. As a result of these efforts, in partnership with industry and with other nations, coal gasification technology could enable low-cost capture and storage of a significant portion of the projected global carbon emissions over the next fifty years. But there are some big hurdles to overcome. While the United States and other coal-producing nations appear to have an abundance of potential geologic storage capacity, the stunningly large fossil fuel consumption numbers I quoted earlier highlight the immense challenges inherent in building the CCS infrastructure. Any industrial scale process has potential environmental impacts, and there are few greater industrial scales than that of power generation. The sequestration industry would have to be of comparable scale. Another challenge is cost. DOE estimates that IGCC power plants with CCS, if successfully implemented using today's technology, would generate electricity at a cost 40 to 70 percent higher than conventional coal plants. Most of that incremental cost derives from the energy penalty in capturing CO_2 from the gasified coal. Clearly, such excessive costs will inhibit the deployment of these technologies, especially on a global scale. Furthermore, the reliability of commercial-scale IGCC plants with CCS has not been suitably demonstrated.

The Coal Research Initiative (CRI), which includes the FutureGen program and Clean Coal Power Initiative (CCPI), seeks to reduce the cost and demonstrate the commercial feasibility of coal gasification and CCS technologies. The CRI funds a full range of R&D activity, including applied research, advanced technology development, pilot-scale testing, public and stakeholder outreach, and large-scale demonstrations in partnership with industry. Funding for the CRI is $588 million in the FY09 budget (an increase of 27 percent, or $124 million, above FY08), with

$156 million for the FutureGen program (vs. $74 million in FY08). Specific activities under the CRI include carbon sequestration research and demonstrations as well as R&D on advanced turbines, advanced gasifiers, and other IGCC technologies, such as those for gas cleaning, conditioning, and separation. Meanwhile, the recent refocusing of FutureGen will enhance its usefulness as a demonstration (actually, several demonstrations) of the commercial feasibility of these technologies.

In summary, the Administration remains strongly committed to a goal of enabling cost-effective, coal-based power generation with near-zero atmospheric emissions. Coal gasification – and the associated carbon capture and sequestration technologies – are an essential part of our global vision for a low-carbon future.

Thank you for the opportunity to speak with you today. I am prepared to answer any questions you have.