STATEMENT OF

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Mr. Chairman, members of the Subcommittee, I am Dr. Joseph Romm, the founder and Executive Director of the non-profit Center for Energy & Climate Solutions, working with leading U.S. companies to develop strategies that reduce energy use and greenhouse emissions through investments that reduce pollution while increasing both profits and productivity.

I am delighted to appear before you to discuss how solutions to the global warming problem, particularly how these solutions might impact our economy, or – more to the point – how the dramatic changes in our economy over the past five years may impact global warming solutions. I will describe how the Internet appears to be dramatically reducing the amount of energy America needs to propel its economy, and how U.S. companies are increasingly using the explosive growth in information and energy technology to slash both energy use and emissions of greenhouse gases and other pollutants, all while bolstering their bottom line.

At the Center, and in my earlier role as Acting Assistant Secretary of Energy for Energy Efficiency and Renewable Energy at the U.S. Department of Energy, I have studied these questions closely. While I have long believed the U.S. can achieve greenhouse emissions cuts consistent with the targets set forth in the Kyoto accord without disrupting the economy, I am especially heartened by dramatic new data – data that gets stronger with each passing month – indicating that the fundamental relationship between energy use and economic growth in the United States has been changed permanently by the spread of New Economy technology to every corner of our lives. I have labeled this fundamental change a "New Energy Economy." If it is a true and lasting change, then the challenge of limiting our greenhouse pollution will be even more manageable than before.

A Fundamental Change Unfolds: A New Energy Economy

The story begins with a few simple, but truly amazing facts. Since 1996 – a period that corresponds with the tremendous growth of the Internet and e-Commerce – the nation experienced remarkable economic growth, on the order of 4 percent per year, driven to a significant extent by industries that produce information technology (IT). The overall productivity of the economy appears to have increased substantially, driven by the IT sector.

What is startling is that the nation's overall productivity gains have been accompanied by an equally impressive gain in energy productivity. From 1987 to 1996, U.S. energy intensity, measured in energy consumed per dollar of gross domestic product (GDP) declined (i.e., improved) by less than 1 percent per year. From 1996 through 2000, it improved by over 3 percent per year– an unprecedented change.

If we consider what might be called the immediate pre-Internet era (1992-1996), GDP growth averaged 3.2 percent a year, while energy demand grew 2.4 percent a year. In the Internet era (1996-2000), GDP growth is averaging over 4 percent a year, while energy demand is growing only 1 percent a year. This is a remarkable change – higher GDP growth and lower energy growth. From the point of view of greenhouse gases, the immediate pre-Internet era saw 2 percent annual rises in carbon dioxide emissions, while the Internet era has seen rises of slightly over 1 percent. In 1998, U.S. emissions of greenhouse gases grew just 0.2 percent, the smallest rise since 1991, when the economy was in the throes of recession.

Hoping to better understand the reasons for the dramatic shift in U.S. energy intensity, the Center last year completed the most comprehensive analyses to date on the nature and scope of the Internet's effect on energy consumption and greenhouse gas emissions. That report "The Internet Economy and

Global Warming: A Scenario of the Impact of E-commerce on Energy and the Environment," is available online at www.cool-companies.org.

Contrary to speculations by some that the Internet is increasing our dependence on fossil fuels – thereby making it harder and more costly to curb greenhouse emissions – we at the Center for Energy & Climate Solutions believe strongly that the Internet and Internet technology will be the keys that unlock unprecedented savings of energy and emissions. Indeed, the evidence suggests that this process has already begun, and that the long-standing relationship between fossil energy use and the economy has changed significantly.

Analysis by EPA and the Argonne National Laboratory suggests one third to one half of the recent improvements in energy intensity are "structural" – that is to say, gains that occur when economic growth shifts to sectors of the economy that are not particularly energy intensive – such as the IT sector, including computer manufacturing and software – as opposed to more energy-intensive sectors, including chemicals, pulp and paper industry, and construction.

More importantly, the remaining one-half to two-thirds of the improvement in our economy's use of energy comes from overall efficiency throughout the system as a whole, occurring when businesses change their activities in ways that reduce energy use relative to their output of goods and services. For example, a factory might use more efficient motors on its assembly line or better lighting in its buildings, or a chemical manufacturer might redesign a process for making a chemical to cut the energy used per pound of product.

According to our findings, the Internet economy itself seems to be generating both structural and efficiency gains. If companies put their stores on the Internet, rather than constructing new retail buildings, which would represent an Internet structural, gain. If that same company used the Internet to more effectively manage its existing supply chain, it would be an efficiency gain.

Internet Technology Cuts Energy Use in New, Old Economy

Clearly, both sorts of activities are taking place, with major energy implications. In business-to-consumer e-commerce, for instance, a warehouse holds far more product per square foot than a retail store, and uses far less energy per square foot. We calculated the ratio of building energy per book sold in traditional bookstores versus on-line retailer Amazon.com to be 16-to-1. Internet shopping uses less energy to get a package to your house: Shipping 10 pounds of packages by overnight air – the most energy-intensive delivery mode – still uses 40 percent less fuel than driving roundtrip to the mall. Ground shipping by truck uses just one-tenth the energy of driving yourself.

Business-to-business e-commerce, estimated at 5 to 10 times the size of business-to-consumer trade, may yield even bigger savings. As traditional manufacturing and commercial companies put their supply chain on the Internet, and reduce inventories, overproduction, unnecessary capital purchases, paper transactions, mistaken orders, and the like, they achieve greater output with less energy consumption.

Analysts at Ernst & Young, for example, estimate that collaborative planning systems between manufacturers and suppliers could reduce inventories by $250 to $350 billion across the economy, roughly 25 to 35 percent of finished goods stock. IBM says its e-commerce solutions are delivering inventory savings as high as 50 percent for some of their customers.

This is more important than you might think, because the energy used to create and transport the raw materials that a company uses may vastly exceed energy they use directly. For instance, Interface

Flooring Systems calculates this "embodied energy" in raw materials for its carpet tile outstrips the energy needed to manufacture it by a factor of twelve. That means a 4 percent cut in wasted product could save the equivalent of fully half the energy used in manufacturing.

The resulting impact on energy use and global warming pollution would be dramatic. By 2007, business-to-consumer and business-to-business e-commerce together could avoid the need for 1.5 billion square feet of retail space – about 5 percent of the total – and up to 1 billion square feet of warehouses. Internet technology may also eliminate as much as 2 billion square feet of commercial office space, the equivalent of almost 450 Sears Towers, along with all the lighting, heating and cooling that goes with it.

Energy savings from operations and maintenance alone for these "unbuildings" total 53 billion kilowatt hours per year, about 13 percent of total electricity growth projected under old, business-as-usual scenarios. That equals the output of 21 average power plants, plus 67 billion cubic feet of natural gas. Expressed in terms of the global warming issue, this Internet "unbuilding" scenario would prevent the release of 35 million metric tons of greenhouse gases.

Avoided construction of all those buildings saves the equivalent of 10 more power plants worth of energy, and another 40 million metric tons of greenhouse pollution. By 2010, e-materialization of paper, construction, and other activities could reduce U.S. industrial energy and GHG emissions by more than 1.5 percent.

New Economy Means Rethinking Cost of Climate Protection

At this point, the Committee should note that all of this good news does not in any way mean that the U.S. can sit back and let the global warming problem solve itself. We think the challenge will be much easier to meet than even some optimists believe, but it will not happen without concerted action.

If, indeed, the Internet is already reducing energy intensity, then it is likely to have a very big impact in the years to come. The Internet economy is projected to grow more than ten-fold – from its current level of tens of billions of dollars today to more than $1 trillion in a few years. Moreover, while the Internet economy remains a small share of the total U.S. economy, it represents a much higher fraction of the *growth* in the economy.

We believe the combination of trends described above makes it likely that this decade, will not see the same low-level of energy intensity gains that the 1987 to 1996 period saw, which were under 1 percent per year. We expect annual improvements in energy intensity of 1.5 percent—and perhaps 2.0 percent or more.

If this comes to pass, most major economic models used in the country will need to be modified. For instance, EIA uses a figure of 1.0 percent for its projection of annual energy intensity improvements. If the actual number is closer to 1.5 percent to 2 percent, the related forecasts – such as the number of power plants the United States will need, or the cost to the nation of achieving greenhouse gas reductions – must change accordingly.

The Environmental Protection Agency recently did a preliminary analysis of potential impact of structural economic changes driven by rapid growth in the IT-producing industries. The results suggest mainstream forecasts, such as those by EIA, may be overestimating U.S. energy use in the year 2010 by as much as 5 quadrillion BTUs, wrongly inflating carbon dioxide emissions by up to 300 million metric tons. This equals about 5 percent of the nation's projected energy use and GHG emissions.

What About Energy Use BY the Internet?

As to the important question whether the Internet itself is consuming vast amounts of electricity, the facts simply – and irrefutably – fail to support such a conclusion. To begin with, the rate at which U.S. electricity demand is growing has *slowed* since the start of the Internet boom. The pre-internet era saw electricity demand rise 2.9 percent per year. Since 1996, electricity demand has risen only 2.2 percent per year. And this has all occurred in spite of higher GDP growth since 1995, hotter summers (1998 was the hottest summer in four decades in terms of cooling-degree days; 1999 was the second hottest summer), and less support by utilities for demand-side management, all of which would normally lead to higher growth in electricity demand. We suspect this has much to do with the trends already discussed here. Still, it is worth examining this question in more detail.

In particular, the arguments presented by analysts Peter Huber and Mark Mills and repeated widely in both the news media and policy-making circles demand close scrutiny. Mills and Huber argue the Internet has become a major energy *consumer* because it supposedly requires a great deal of electricity to run the computers and other hardware powering the Internet economy.[1] In fact, according to recent research, they appear to have significantly overestimated the energy consumption of most critical pieces of equipment.

Scientists at Lawrence Berkeley National Laboratory (LBNL) examined in detail the numbers underlying a Mills and Huber analysis, and found that the estimates of the electricity used by the Internet were high by a factor of eight.[2] Major overestimates were found in every category, including their calculations of energy used by major dot-com companies, by the nation's web servers, by telephone central offices, by Internet routers and local networks, and by business and home PCs.

Mills and Huber assumed, for instance, that a "typical computer and its peripherals require about 1,000 watts of power." In fact, the average PC and monitor use about 150 watts of power; this dips to 50 watts or less in energy-saving mode. Laptop computers, a key growth segment, are particularly low energy users, with some using under 30 watts. Moreover, computers are getting more energy-efficient every year because of steady improvements in technology driven in part by the growing market for portable equipment (and by the IT sector's desire to reduce its environmental impact).[3] New flat screens typically use about a quarter of the energy of traditional video display terminals with cathode ray tubes.

These basic mistakes are reflected in their conclusions. Mills and Huber claim that from 1996 to 1997, the *increase* in electricity consumed by all computers used for the Internet constituted more than 1.5 percent of all U.S. electricity consumed that year. Yet total electricity consumption for all purposes grew slightly less than 1.4 percent during that period, which would imply that electricity growth for everything else equaled zero – despite economic growth 4.5 percent. While we believe that the Internet reduces energy intensity, we don't believe it has quite that dramatic an effect.

But mathematical and data errors are only part of the problem. Indeed, I believe Mills and Huber have the entire Internet energy story almost completely backwards. One of the reasons why energy intensity declined so slowly from 1987 through 1996 is likely that businesses in particular purchased a great many computers and other IT equipment that consume electricity, yet generated little accompanying productivity gains to offset that increased energy use. But Internet changed all that, unleashing a storm of new productivity in every sector of the economy. By then, of course, most desks already had computer. The added energy needed to shift PCs from traditional uses to the Internet is modest compared to its overall benefit.

A Few Unknowns About the Internet & Energy Use

There are aspects of the Internet that will probably entail more energy use, such as greater small-package delivery by truck. These cases may not, however, result in a net increase in energy use; relatively efficient package delivery by truck may replace at least some relatively inefficient personal driving to malls, supermarkets, bookstores and the like – particularly if most of the packages are delivered by the Post Office, which already drives past virtually every home in the country daily.

The great unknown question in this regard is whether or not a significant fraction of Americans will change their driving habits over the next few years once it is possible to make a critical mass of cyber-trips on the Internet. That is, will the Internet be the mall of the 21st Century? We suspect the Internet economy will be no worse than neutral in the transportation sector, but could well have a large positive impact. Already, in the last two and a half years, the growth rate in vehicles miles traveled (VMT) has slowed, and the VMT to GDP ratio has dropped dramatically.

Computers and the Internet may well lead to more home electricity consumption. This is part of a long-standing trend, as homes have for some time been getting bigger and more stocked with electronic equipment. But the question is, if people spend *more* time on the Internet, *what are they spending less time doing*? Some will be watching television less; others reading newspapers less; some may be printing individual items of interest to them rather than receiving entire printed catalogs or directories in the mail; others will be working at home rather than in an office building; and, potentially, some may be not be driving to work or to malls as often as before. These are all activities that would normally consume a great deal of energy and their potential displacement by home Internet use is the subject of our recent analysis.

Changes in Energy Technology Meet Changes in Information Technology

The application of New Economy information technologies to traditional energy-use technologies has resulted in quantum improvements even in two classical sectors that are responsible for most electricity consumption: lighting and electric motors. The result is more energy savings in parts of the economy not traditionally considered "high-tech."

We have seen steady advances in solid-state electronic ballasts for running fluorescent lamps, which not only save considerable energy compared to magnetic ballasts, but also eliminate the annoying flicker and hum. Further, these ballasts can be run with highly sophisticated, low-cost controls that automatically dim the lights to offset daylight in the room. These lamps can also be controlled even at the desktop by remote controls or through a PC. Greater control over the workplace environment in general, and lighting in particular, has been linked to productivity increases.

Similarly, computer-controlled adjustable speed drives for motors can simultaneously reduce energy consumption and improve process control, achieving significant direct cost savings as well as productivity gains. Even boilers and hot water heaters can cut energy consumption 25 percent or more through the installation of microprocessor-based controllers.

Digital energy management control systems (EMCS) can continuously gather data about what is taking place in a building and how its equipment is operating, feeding it into a central computer used to control building systems and optimize energy performance. Energy experts at Texas A&M have shown in two dozen Texas buildings that using such an approach can cut energy use 25 percent with an 18-month payback in buildings that have already received on upgrade with the latest energy-saving equipment.[4]

Increasingly, such technologies will operate over the Internet itself. We know of one major energy service company pursuing the installation of digital EMCS's in the buildings they manage, so they can operate them over the Internet very efficiently and at low cost. A similar arrangement is already operating in Singapore.

Many utilities have begun exploring Internet-based home energy management systems, which would give individual homeowners more control and feedback over their home energy use, or the ability to have an outside energy company or expert software system optimize their energy consumption. Early trials of remote controlled home energy management systems suggest the savings in energy bills could be as high as 10 percent.

Spreading the Gospel: Rousing Corporate America to the Energy Challenge

As *Fortune* magazine noted in 1998, "only a third of U.S. manufacturers are seriously scrutinizing energy usage, where savings in five areas can move billions to the bottom line."[5] Thanks to low energy prices and the benefits of energy efficiency investments in the 1970s, energy in mid-1980s became a much lower fraction of the cost of doing business. Naturally, companies reduced investments in energy-saving technologies. During the downsizings of the early 1990s, corporate energy staffs were often sharply reduced or eliminated entirely.

As a result, most companies have lacked both the motivation and the management expertise to improve energy performance for most of this decade. Many companies, including some of our largest and most energy intensive, have been making investments in energy-savings technologies only if they paid for themselves within about a year.

There are exceptions. Some companies, including IBM and Johnson & Johnson, have instituted corporate wide policies to adopt energy-saving technologies. They have been able to sustain steady improvements in their corporate energy intensity (energy per dollar of output) of 4 percent per year and 3 percent per year respectively throughout the 1990s. Though virtually every company could do what IBM and J&J have done, they are still the exceptions.

Outsourcing – another New Energy Economy trend – is starting to change this. Soon it may revolutionize corporate energy efficiency investments. Because most companies typically consider energy issues as secondary to core business concerns, they typically pursue only simplest, most obvious solutions, which means investments in energy-efficient equipment only with a payback of a year or so. To an outside contractor, energy is the core business. That means they have more expertise and longer investment horizons that allow them solid returns on energy investments with five- to seven-year paybacks (or sometimes as high ten years).

This means greater energy savings, and more time for companies to do what they do best. Some companies have turned over their entire power supply needs to outside contractors. In March 1999, Ocean Spray announced a $100 million deal with the energy services division of Enron, a major natural gas and utility company based in Houston. Enron will use its own capital to improve lighting, heating, cooling and motors and to invest in cogeneration (the simultaneous generation of electricity and steam onsite, which is highly efficient). Ocean Spray will save millions of dollars in energy costs, have more reliable power and cut pollution, without putting up any of its own capital. In September 1999, Owens Corning, the fiberglass insulation manufacturer, announced a similar $1 billion deal with Enron.

Many other energy service companies are taking a similar approach. Some, like Sempra Energy Solutions, have even gone so far as to finance, build, own and manage the entire energy system of a

customer. Substantial investments in such outsourcing deals are relatively recent phenomena. But I believe these deals will grow very rapidly in the next few years, and are likely to ultimately achieve savings well beyond that achieved by utility demand-side management (DSM) programs, which have scaled back dramatically with the onset of utility restructuring.

This is especially true for two reasons. First, traditional DSM often focused on retrofitting individual electricity-using components, whereas outsourcing encourages a whole systems approach to efficiency covering all fuels, an approach that can achieve deeper savings at lower cost. Second, traditional DSM did not in general encourage cogeneration, as the outsourcing deals do. And cogeneration combined with energy efficiency can cut the energy consumption of a building or factory by 40 percent or more in a period of just a few years.[6]

Climate Commitments Put Smart Companies Ahead of the Pack

Finally, there is one other business trend that has significantly accelerated since industrialized countries signed the Kyoto pact in December 1997 that will have lasting impact on the economics of global warming solutions. Increasingly, major corporations are making company-wide commitments to reduce their greenhouse gas emissions.

As the *Wall Street Journal* noted in an October 1999, article:

> In major corners of corporate America, it's suddenly becoming cool to fight global warming.
>
> Facing significant shifts in the politics and science of global warming, some of the nation's biggest companies are starting to count greenhouse gases and change business practices to achieve real cuts in emissions. Many of them are finding the exercise is green in more ways than one: Reducing global warming can lead to energy-cost savings.[7]

In 1999, Kodak announced in 1999 that they would reduce their greenhouse gas emissions 20 percent by 2004. DuPont – one of the biggest energy users in the United States – pledged publicly to reduce greenhouse gas emissions 65 percent compared to 1990 levels by 2010. Two thirds of those savings will come from reducing process-related greenhouse gases; the rest will come from energy. They pledged to keep energy consumption flat from 1999 to 2010 even as the company grows, and to purchase 10 percent renewable energy in 2010.

This year, Johnson & Johnson and IBM each joined the Climate Savers partnership with the World Wildlife Fund and Center for Energy a Climate Solutions, pledging to make substantial energy and greenhouse emissions cuts. Several other major companies are expected to join Climate Savers in Coming months. For its Climate Savers commitment, Johnson & Johnson has pledged to reduce greenhouse gas emissions by seven percent below 1990 levels by the year 2010, with an interim goal of four percent below 1990 levels by 2005. IBM, having *already achieved an estimated 20 percent reduction in global CO2 emissions through energy conservation efforts from 1990 through 1997*, is now pledging to achieve average annual CO2 emissions reductions equivalent to four percent of the emissions associated with the company's annual energy use through 2004 from a baseline of 1998. Even major oil companies including BP and Shell have committed to make major emissions cuts, at least some of which will come from efficiency investments in their own facilities.

It may well be that two trends – energy outsourcing and corporate climate commitments -- combine. The Center is working with a major energy service company to demonstrate that virtually any Fortune

500 company can make an outsourcing deal to reduce its energy bill, its energy intensity, and its greenhouse gas emissions, without putting up any of its own capital. Should concern over global warming continue to grow, this type of deal may become commonplace.

An Optimistic Prognosis

In conclusion, we find great cause for optimism over the prospects for reducing greenhouse emissions while maintaining a strong and vibrant economy. Indeed, it is that very vibrancy that has improved this prognosis substantially in recent years. And we challenge those pessimists who consider the Internet a problem, rather than a solution, to rethink their interpretation. With or without them, the New Economy is changing the way America uses energy; in concert with sound climate policies, we can count on the Internet revolution to help us protect and preserve our environment as well.

I thank the committee for its time.

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[1]Peter Huber and Mark Mills, "Dig more coal—the PCs are coming," *Forbes*, May 31, 1999, pp. 70-72.
[2]Jonathan Koomey, Kaoru Kawamoto, Maryann Piette, Richard Brown, and Bruce Nordman. "Initial comments on *The Internet Begins with Coal*," memo to Skip Laitner (EPA), Lawrence Berkeley National Laboratory, Berkeley, CA, December 1999, available at http://enduse.lbl.gov/Projects/infotech.html. The underlying analysis is Mark Mills, *The Internet Begins with Coal: A Preliminary Exploration of the Impact of the Internet on Electricity Consumption*, The Greening Earth Society, Arlington, VA, May 1999.
[3]Typical home Internet users are online 5 to 10 hours a week (under 500 hours a year). So they consume under 100 kWh a year on the Internet, more than a factor of 10 *less than* the estimate of the *Forbes'* authors of 1000 kWh a year. And this does not even include any of the myriad potential offsets discussed in our study, such as a reduction in television watching, which would save a considerable amount of electricity. Long before the Internet was popular, PCs have been used at home for word processing, games, and the like. It is therefore methodologically flawed to ascribe all or even most of the electricity consumed for home PCs in general to the Internet (for a discussion of this "boundary" issue, see Koomey et al, "Initial comments on *The Internet Begins with Coal*"). Internet telecommuters and home-based businesses use the Internet considerably more than the average home user, but, as discussed in our analysis, they are probably displacing far more electricity consumption by not working in an electricity-intensive office building.
[4]Joseph Romm, *Cool Companies: How the Best Businesses Boost Profits and Productivity by Cutting Greenhouse Gas Emissions* (Washington DC: Island Press, 1999), pp. 28-30, 57-63, 77-99, 140-156.
[5]*Fortune*, May 11, 1998, p. 132C.
[6]See, for instance, Romm, *Cool Companies*, pp. 117-118 and 159-162.
[7]Steve Liesman, "Dropping the Fight On Science, Companies Are Scrambling to Look a Little Greener," *Wall Street Journal*, October 19, 1999, p. B1.