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**Craig Mundie**

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**CRAIG MUNDIE:** Good morning, everyone. It's great to be back in San Francisco again. I have been here many times, but I do go home to Seattle.

One might ask the question, why is a guy from Microsoft here talking to this group of people associated with the energy industry, and in part it stems from the fact that, as was said in the introduction, my job at Microsoft has several components. One includes technology policy. Another is the long term planning and incubation of many of the new businesses at Microsoft. And the third is the operation of what is really the largest software computer science research operation in the world.

When we look at many of the challenges that we face globally as a society, we come to the conclusion that computing and software in particular is going to play an important role or can play an important role in addressing many of these challenges.

A few years ago, I was on a stage in Europe with President Barroso when he rolled out their program around the Smart Grid, and their direction there. And we were in a question and answer session, and he said, you know, this is going to be a key part of the answer.

One of the points that I made was that I think that every time societies have faced these monumental challenges, whether we like it or not, the answer has always emerged from unknown directions through the work of really smart people, and a lot of good engineering effort.

And many times when I talk to people today about the policy challenges and the technical challenges we have, I often find that people who are focused on these questions are not really close to the forward leaning work that's being done globally in many areas of engineering and technology.

So, I think it's important to think about these future capabilities as we look to try to come up with the right business and policy solutions for the problems that we face today.

I think sustainable and scale solutions are going to require complex, interactive systems. This means that both the intrinsic generation or sources are going to have to evolve, but so will the systems by which we control them, and ultimately the way in which we get people to interact with them.

I think as a result we have a unique opportunity now to work together to build a cleaner, more sustainable way forward to transform our economic competitiveness in the United States, and to spark a new wave of investment in startups and green collar jobs that will focus on this.

So, why do we need to solve this energy problem? I think, of course, there are two key reasons. One is just the geopolitics and national security issues that surround the current way that energy is distributed around the world, and the second is the environment. To mitigate the climate change problems, we clearly need to reduce our carbon footprint.

If we faced either of these problems in isolation, it would be an interesting challenge in its own right. But today we face them with a need to solve them simultaneously, and that more than doubles I think the complexity of addressing them.

Then on top of that we now face an unprecedented, in recent memory, recession economically globally, and yet we know that economic evolution will result in the Third World countries having more and more of an appetite for power.

A few months back, maybe a year ago, Bill Gates and I were talking with Tom Friedman when he was still working on his book, *Hot, Flat, and Crowded*, and one of the things that we pointed out to him was that our belief is that many of these people around the world, who today are either sort of off the electric grid or have very minimal use of it, really have an entitlement to expect that over time they're going to come up and have the same interest and need to have access to energy as we do in the United States and the rest of the developed world.

And yet as we think about trying to solve the climate change problems, we really find most people are focused on just trying to manage the sources and uses that we have today, without even contemplating the likely doubling of aggregate global demand that will come as these other people come online.

I think that one of the challenges, of course, is that the most accessible fuel that's around today is all carbon based in one form or another, and has the most significant impact on the overall environment.

Some nations have chosen to move toward energy dependence by using their domestic sources of oil or natural gas or even coal, and this may solve for the energy security problem, but it certainly doesn't solve for the environmental crisis. And, of course, it does seem that relying strictly on carbon is unsustainable for the very long term in any case.

At the same time, the most environmentally friendly sources aren't really ready for deployment at scale, either because we have the wrong kind of infrastructure or because they're simply not yet mature enough to be able to meet the demand.

So, it's clear that we need to be on a path to some type of zero carbon energy ecosystem, and I think there's no other way for people to solve the compound problem that geopolitical, national security, environment, and increasing demand problems that we face simultaneously.

But I think we're simply not in a position today to completely replace our energy sources right now, to reduce our carbon footprint as much as we would like, and at the same time accommodate future growth and demand.

However, I do think we can take immediate steps now to conserve energy. No matter what your predispositions are about what the future sources of energy are, there's no question that if we can just intrinsically use less, that's just a good thing. And so I think an equal emphasis, perhaps a large emphasis in the short term has to be applied to this question of conservation, and how do we deal with that. So, I'll come back to that a little bit more in a few minutes.

At this time I think if we focus on some conservation issues, while we work to develop through engineering activities and business activities zero carbon sources, we'll be in a better position than we would if we only focused on the new generation capability.

I think many of these zero carbon sources may emerge but are clearly on a 10 to 20 year cycle, and so we have to do something in the interim to improve the situation.

I think one reason for optimism is that forthcoming advances in computing are greatly accelerating our engineering and scientific discovery capabilities. Individual computers, the ones you'll find on your desk or in your cell phone, over the next few years will go through a quantum change in the architecture of the microprocessor. There has not been a change of this magnitude in the computing environment since the microprocessor was invented about 30 or 40 years ago.

These changes will result in machines that are 50 to 100 times more powerful than the ones you use today that consume less than or equal power, and cost the same or less money than the ones we have today.

So, this kind of step function change represents an opportunity, both in terms of how we use that capability close to where people are, but when we aggregate them into these exoscale computing facilities, what people now call the cloud, we have the ability to gang them up literally by the thousands, potentially even the millions, and to create a computational capability the likes of which the planet has never known.

In the United States the country's preeminence in many fields actually has its roots in the ability to do computing in ways that other people can't. That was certainly true in the nuclear power and nuclear weapons era, but I think it's been true in many, many fields of endeavor. And I think that we have an opportunity in the United States to lead again in the use of these advanced computing capabilities to look for engineering solutions to these problems in ways that we really don't fully expect to find.

I think we clearly need to materially reduce the largest CO2 emitter, which is transportation, and this too will present us a huge challenge.

In the United States today transportation accounts for I think roughly about a third of CO2 emissions, and about 29 percent of all energy consumption, and it's two-thirds of all the oil that we consume. The majority of that consumption is by cars and other vehicles.

If we're going to move to a world of zero carbon sources, the most realistic medium term solution would be for all cars and trucks to convert to electricity and get rid of that pollutant component. But that would require a vast investment, too, both in terms of trying to retrofit the existing vehicles or build new ones, and also building out the infrastructure to service them. If we saw that amount of our energy require a shift to electricity today, we'd be hard pressed to meet that demand. And, of course, it's practically speaking unworkable to expect us to retrofit all the existing cars and trucks.

So, I think what we have to do is plan under the assumption that the conversion to more electric transportation is going to be a 10 or 20 year problem, one where the natural replacement cycle of the vehicles will largely drive the time over which that conversion could take place.

That hopefully may arrive just about the same time as we can bring on new lower carbon footprint sources, and that would be a happy outcome if we can engineer it. But making that all work will be a significant change from the way that operate today where people come home and at most they plug in their cell phone or a few other things with batteries to charge. When you come home at night and you plug your car into charge, it's going to be a completely different load problem.

In the meantime, I think software has the potential to make these cars more efficient, but it also has the ability to consider reducing the amount of travel that people take, and as such with things like ride sharing optimization, telepresence techniques, telecommunications as a substitute for transportation, we may be able to take some important steps along the way.

So, I think it's clear enough that the first crucial step we have to take across the board is conservation. We clearly can't conserve enough energy to solve the energy and environmental problems, nor can we achieve the reduction of consumption that we need by using just traditional sources of energy. But there are short term opportunities to achieve significant savings, perhaps as much as 20 to 30 percent, using some of these technologies.

I think software can help consumers to better understand their energy usage, and help them find ways to use less energy with minimal disruption on their lifestyle.

For example, one of the focuses at Microsoft is to be able to help the PC industry design personal computers and software that controls them that will dramatically lower their aggregate energy consumption.

Today, there are some estimates that say if just U.S. personal computer users had machines that universally put themselves to sleep or into a very low power state when people weren't actually actively using them, that it would save about $22 billion a year in electricity costs, and eliminate about 3 percent of the total U.S. CO2 emissions, just from the personal computers that are distributed around the United States.

If we could use teleconferencing or telepresence technologies to just eliminate one in seven business trips, we'd save about 65 million barrels of oil each year, or the equivalent of taking about 2 million cars off the road.

With these new computing and telecommunications capabilities it may, in fact, be more and more likely that people would find a satisfying experience using these type of telepresence techniques in lieu of face-to-face meetings, and so I think these are the things that people don't anticipate when they forecast what could happen down the road.

I think a bigger opportunity though is to use instrumentation and networking at the level that we now enjoy it to get a better handle on the load, and think about ways to control that load.

Clearly, finding the right technical and regulatory and incentive mechanisms to move people forward in this direction will require some significant work, but it's a place where I think the coming together of the technology industry and the electric utility industry really holds significant promise.

I think it does beg the question of whether the U.S. is really prepared to make the regulatory and policy changes necessary to enable a focus on radical conservation. I don't have the answer to that question, but it's clear that the Obama administration is focused on this question.

In April I was appointed, along with 19 other people, to President Obama's Advisory Committee on Science and Technology, and I can say that there's clearly a great focus in the administration to look to science and engineering capability in the United States for radical solutions to many of these challenges in education, health care, energy and the environment. So, I remain optimistic that we'll actually find some interesting answers, courtesy of the country's tremendous capabilities in this space.

I think another step we can take now is to accelerate the fundamental research needed to create zero carbon, scalable energy sources. I've had the pleasure of knowing some people who have been involved in the National Laboratories for some years, and one of the things that I found quite striking was that Edward Teller, who at the end of his career was the director of the Lawrence Livermore National Lab, was perhaps best known for his work on what became the atomic bomb. He went on later in his life to focus a lot on this question of energy and the environment, and the intersection of these two problems.

It's been interesting to realize that the country, through its talent like people like Edward Teller, Lowell Wood, and many others, and their investment in fundamental research, has oftentimes anticipated these problems and be able to forecast engineering solutions to them.

Back in 1996, Teller and Wood published a paper where they proposed a novel type of nuclear power, one that specifically solved for many of the things that had become a deterrent to the use of nuclear power in the United States, the concern over weapons proliferation, the concern over leakages and nuclear reactor safety. And they posited that there, in fact, was a form of nuclear power, built around fast neutron reactors and a concept called the traveling wave reactor, that doesn't have virtually any of these problems, is wildly more efficient than nuclear power as we currently deploy it worldwide today, and has virtually none of the traditional proliferation risks.

And yet even though these papers have been published by prominent people as far back as 10 or 15 years ago, there's really little focus on this within the industry.

I did read a news story today where Babcock and Wilcox announced that they were going to have more modular, small reactors that people could deploy, but they still don't employ this kind of technology.

Now, I know that there are people and companies who are making private bets that, in fact, these kinds of technologies can be brought forward, and would produce a fairly radical solution. The energy efficiency would be dramatically higher; the ability to deploy them globally without the threat of nuclear weapons proliferation would immediately alleviate many of the geopolitical tensions that we face in places like Iran and North Korea. And while they've been on the drawing boards for years, we really don't have a concerted effort underway in the country to make them real.

So, I think many times we have to look to places and to people that have thought about these problems, and be more aggressive in funding the fundamental, basic research that will lead to solutions in these problems.

Since the collapse of the Soviet Union, the United States has actually reduced by about 50 percent its actual investment in government funded, basic scientific research, and many of the great people who have been in these national laboratories are now essentially getting old and retired, we're not putting as much investment into their replacements, and I think that this is a real loss for the country and one that would jeopardize the long term ability for the United States to be preeminent in these technology based fields.

Sadly, Lowell Wood tells me -- he's a personal friend -- that just before Teller died in 2003, he said to Lowell, he says, you know, his greatest concern is that many of these breakthroughs, like the traveling wave reactor, will ultimately be deployed first and perfected outside the United States, and will only later find their way back here, because we were not forward looking enough in our willingness from a policy and an investment point of view to take the risks necessary to continue to lead the world. I think that's an important thing for us to bear in mind, and one that I would encourage people to think about.

I think we should obviously step up our investment in other sources, but not all of these are created equal. We should undoubtedly increase research and investment in alternative and renewable energy sources such as wind and solar, but equally we need to be clear, at least in my mind, that I don't think these are ever likely to be a substitute for today's primary sources, particularly if world demand at least doubles over the next 20 years.

A better short term bet might be to tap into in the United States new things like the proven reserves in natural gas as a way to help bootstrap ourselves forward in a somewhat reduced carbon footprint, but ultimately we're going to have to find very large scale, zero carbon sources.

Carbon sequestration may, in fact, be a possibility, but I think like some of the others it may turn out to be a significant investment, and would certainly be suboptimal if we could find other ways to do this.

Any of these potential solutions are going to require a lot of research and development, significant capital expense, and a long term rollout plan that transitions us from a world that today is dominated by coal and oil to a world that would be based on these other low or zero carbon sources.

All of these possibilities still raise the same fundamental questions about the grid, and our command and control infrastructure. And while, in fact, I think we have focused today on a command and control capability in the hands of the utilities and generators and distributors, at the end of the day a lot of the consumption occurs in the homes. The largest single consumer of electricity I believe is residential, followed by small commercial. And, of course, it's the big industrial users that have the most sophisticated arrangements for control and cooperation and pricing arrangements, but they don't actually represent the largest aggregate demand.

It really doesn't matter what you believe the long term sources of zero carbon energy may be; whether they're centralized though or fully distributed co-generation I personally believe as a software technologist will actually turn out to make a big difference. And it isn't clear that the country can afford to bet on both of them, given the magnitude of the investment and the different types of technical challenges associated with deploying them.

If it turns out you bet on the distributed co-generation strategy, then I think we will look at a number of interesting challenges. One, of course, because many of these sources like wind and solar, you can't spin them up on demand, they come and go with the wind and the sun, it puts a much bigger burden on the question of storage of energy, and I think storage is not improving, battery technology and other storage systems are not improving at the rate that semiconductor technology and other technologies are, and I think it would bring with it a demand for a distributed control system to effectively control the loads and to be able to aggregate this and ultimately dealing with the economics of it.

As someone who spends a lot of our time looking at the question of the Web, at the scale that it represents today, and knowing the challenges that we face in command and control of that with the cyber security issues, the economics of it, the need for standardizations, it is a daunting technological challenge in the computer hardware and software domain, and one that I think would be quite significant if we were really to try to say we're going to move to this very I'll say low scale, distributed co-generation model.

However, if you focus on the other strategy, I'm going to cut carbon sources at scale and find an alternative large scale way of generating power, then, in fact, you wouldn't need the same degree of complexity and sophistication that would be required in a fully distributed system.

So, to some extent when people talk about the Smart Grid, I always ask them, well, which one of these are you really focused on, and frankly I don't usually get a clear answer. People talk about a Smart Grid, but they have many different views of what that might comprise, and I think that as a country we're going to have to pick a few key scenarios and focus on them, and then we're going to have to bring forward the best people in the world in computing and communications and related software technologies in order to be able to get that to happen. I believe it will be a much more difficult problem than many people are estimating.

In conclusion, I think it's important to remember that at the end of the day we just -- if we thought it was -- you know, there were easy solutions to solving this environmental and demand footprint requirement, we'd have done it by now. It just isn't an easy problem. And when taken together, these challenges can be quite daunting.

It is clear to me that we need to be on a zero carbon source quest, and that the only long term path to solving the world's energy problem, with a planet that will ultimately end up with about 9 billion people on it, from 6.5 billion people, and a reasonable assumption that certainly over several generations all of those people will come to expect and even demand that they have access to energy just as people in the developed countries do.

I think in the short term what we can and must do is increase conservation and improve efficiency, which is an area where, in fact, we believe at Microsoft we can contribute.

In fact, today, this morning we actually announced that we're releasing a beta version of a new product called Microsoft Hohm. In this case Hohm is spelled H-O-H-M, which is sort of an inside joke for this group, but Microsoft Hohm is a free, online, Web scale service that is designed to help consumers identify what their energy consumption patterns look like, and identify and make suggestions for ways to save money and cut consumption.

We are partnering with the utilities as they are interested in bringing this technology to bear through their own portals and mechanisms for dealing with customers, and providing a two-way communication mechanism such that information that the utility has that could be used by the individual to assist in modeling or decision-making can be brought forward as well.

The goal with Microsoft Hohm was to provide a tool that would be available immediately to essentially every residential electric user in the United States or gas as well. And interestingly we two turned to the U.S. National Laboratories for help from their treasure trove of historical research work, and we licensed technology from the National Labs and then built it into the Microsoft Hohm service.

What we licensed was a set of models that allow us to characterize an individual residence in terms of all of its construction technologies, its surface area, its windows; ultimately 200 parameters go into these computational models. We prop them in a very large scale cloud service, and are able to bring many, many computing assets to bear on these problems.

We can run these computational models against the parameters for an individual's home in under 10 seconds now, and produce a fairly accurate estimate of where your actual energy consumption goes, and what your costs associated with that are. We allow you to compare it with other people in your area, and we make recommendations to you as to what the most cost-effective individual investments are that you can make in either behavioral change or actual investments in your home that would lower your energy consumption.

So, this is an example of where I think we can bring together the techniques and technologies that certainly the young people today are very familiar with -- cell phones, personal computers, social networking, online Web Services -- in order to get people who clearly are growing up with the idea that they want to be more green, and we need to give them some way to sort of capture that energy and let them start to focus on this.

Many other people are looking at ways to cut costs or to cut consumption, and Microsoft is focused in the future on those as well.

But when we stood all the way back, we wanted something that everybody could get involved with in the United States, and ultimately could be rolled out technologically on a global basis using the Web scale infrastructures of the Internet, and so Microsoft Hohm is our first offer in this space.

I think over time as we get more technologically advanced, we will be able to move from perhaps these passive and behavioral changes to a world where there can be active automation and ultimately even policy driven change in how people's consumption behavior in the home takes place, and I think in the very long term we may be able to find if we can get a large enough percentage of the population to adopt these kind of technologies and move to an intelligent, policy driven way of administering these within the home or the small business, that there may, in fact, be a way to bring together the generation distribution side with this consumption side in a large scale coalition to ultimately drive down the overall cost and requirement for energy production, and that would be our long term goal. But each of those successive steps, in my opinion, will require some infrastructure changes at a significant scale.

I know that we can do these things, but I also have a realistic view as to how long it takes. One of the lessons that Bill Gates and I learned in my early tenure at Microsoft, in the early 1990s, I went there to start non-PC computing, and the first thing we decided to focus on was interactive television and digital television distribution. And by 1994 we had a working system, we were ready to go, and we were out there talking to the world's telephone companies and cable companies. And 16 years later, this stuff is really just starting to get scale deployment.

So, it isn't a question of whether we know the right answers, it's a question of whether we can focus and find the business economics to allow us to make these changes. And I think that that's where we have to come together, the technologists, the businesspeople, the policy people, the regulators, in order to make sure that what money we can spend, particularly when we now face down the kind of deficits that were mentioned in the introductory remarks, I think makes this question even more pressing of really looking to spend every dollar in the optimal way, whether that dollar gets spent by an individual in their home, by a utility company or distribution company, or whether it's subsidies that we ultimately want to apply so that people, quote, do the right thing.

I think all of these things can be brought together but only through cooperation and communication, and through these new services we hope we can at least play some role in doing that.

So, let me stop there now, and I think we have just a few minutes left to do a Q&A, and I'd be happy to answer questions about my remarks or any other subject you care. Thank you very much. (Applause.) I think there are some microphones if anybody wants to ask a question. Everything is perfectly clear. (Laughter.) Nobody? Oh, there's one, one brave soul.

**QUESTION:** Hi. This is Joe Heinzman (ph) with Altair Nano (ph).

Probably a little bit off topic, just slightly, but just the energy usage of datacenters, and certainly as we look forward, part of that connectiveness that people want isn't just energy for light but energy to be able to get knowledge, information, right, from the Internet. And as you look at datacenters, the amount of CO2 that's produced through searches, what's that going to look like in the future?

**CRAIG MUNDIE:** We've been very focused, as I think a number of the other companies in the industry, Google -- the five biggest players in these Web scale datacenters now are Microsoft, Google, Yahoo!, eBay, and Amazon, and I think each in their own way is focused on this question of how do you provide this very, very high scale computing, and yet lower the energy costs and reduce the carbon footprint.

At Microsoft we have taken a multifaceted approach to that problem. The first is to actually completely re-architect the software system that controls this. The way we and most enterprises today historically would have deployed these services is each company, each product line, like in this case this Microsoft Hohm system, if we were doing this a few years ago, we would have designed a server farm for that particular thing, we would have gone into a traditional datacenter, we would have plunked it down, turned it on. It would have been provisioned at peak capacity, and it would just sit there and run waiting for the demand. It would be essentially like running your power generation capability just peaked up all the time. And that's essentially the way computers, both personal computers and datacenters, have always worked; they just sort of run at peak all the time.

And so we said we've got to break that model, and so, in fact, Microsoft Hohm is the first external product that Microsoft is offering that runs on a new thing that we call the Azure Fabric, and what it is, is it's essentially a sophisticated control network for these datacenter machines that essentially powers them up and down at a very low level in real time. So, when the load is very light, the machines are configured in a way to run the minimum amount of energy requirement to produce that answer, and then as the load builds, we essentially span many, many more machines, and we spin them up dynamically. So, it's just a kind of a bit like power generation.

The other thing that's happening, as I mentioned, is that the compute capability is declining at a very -- I mean, is increasing at very, very rapid rate. So, the cost per joule to produce any one of these answers is actually going to go down in the next couple of years by probably two decimal orders of magnitude.

So, I believe that we're going to be able to sustain the capability without dramatically expanding our power footprint, and in fact we may get it to decline.

A few years ago, our utilization level was very, very low, and today it's becoming very, very high. So, I think the combination of efficiency and the performance improvement in computers will ultimately make that a not much bigger problem than it is today.

Yes, sir?

**QUESTION:** Mike Biehler (ph) with Burns and McDonald.

You said that you are going to partner with utilities on Microsoft Hohm. Could you briefly outline how you're going to approach utilities with that concept?

**CRAIG MUNDIE:** Yeah, we actually have a number of them that have signed up and will be disclosed today, and right now the arrangement takes the form where the utility is going to provide a data feed to the Microsoft Hohm service of an individual customer's billing history, because one of the big issues that -- one of the things that's really valuable in running these big models and being able to correlate them is to know what your actual consumption is as an input to the model.

So, one of the really hard things is to ask consumers to go back and type in all of their historical billing information, but of course the utilities have all that. And so the first phase is to basically create a real time connection between the billing systems of the utility and the Microsoft Hohm service to allow that to go in.

Over time we want to seek to expand that. Once we get this data together over large things, and we can run these models over and over again, we think we're going to learn a lot, because no one has had this amount of data at this level of detail across very large populations before. And so much as we're learning in search and advertising and other areas, once we get these big aggregated data sets, our ability to mine interesting things out of them and then use that to inform future investment decisions and solutions that people might be able to cost-effectively deploy we think will be a lot better.

I guess we have time for one more question.

**QUESTION:** Tom Kume (ph) with Edison Electric Institute.

As you know, our industry pushes energy efficiency a whole lot, which is something that people find amazing since we're encouraging people to use less of our products, but one of the examples that you always get is that computers are often left on all the time, people don't turn them off, and what is the industry doing to address the issues of how to automatically kind of help customers more efficiently use the computing systems of the world?

**CRAIG MUNDIE:** At Microsoft what we're doing is changing the software that we provide, which is the basic operating software for the machine, and working in conjunction with the people who design the new machines to do two things. For old machines we're going to make it such that it's easier to establish policies that actually by default reduce the energy consumption of the machine. We've become very aggressive. At the end of this year in the fall we're going to announce the next version of Windows, Windows 7, and one of the big investments there is essentially this type of policy driven power management for the machines themselves. So, when a consumer takes the machine, a new machine that runs Windows 7 out of the box, and turns it on, he'll find it preconfigured with a set of defaults that are very aggressive in terms of lowering the energy consumption.

The other thing that will take a few more years but I think will happen is that in the past you could think of personal computers in particular as if they were a car that had a one-cylinder engine, and that engine just ran along all the time, and we kept it going in case you wanted to use it.

But the way computer architecture is changing, it's going to become a very, very parallel, special, heterogeneous architecture kind of machine, and with that you can think of it as sort of a car that has a lot of cylinders. But the ability to run can be gauged on how fast you want to drive and how big the hills are. So, we can turn on and off not the whole machine but individual parts of the computer, and we can do this in milliseconds, not seconds.

Today, if you wanted to save energy in your machine, you could say, hey, let it go to sleep if I'm not using it. All your laptops probably do that. If you just don't use it for a while, it goes to sleep. But that sleep state takes many seconds to enter and many tens of seconds historically to exit, and as a result people are reluctant to have it go on and off. And when it's plugged in at home, they don't have it go off at all.

So, in the future we're going to make it completely automatic such that the machine is sort of always awake, but it's operating at a very, very low power state, and yet it's awake enough to know when you approach it and want to do something, and we'll be able to fire up the whole machine literally in a matter of fractions of a second to answer your question, and then if the demand goes away, we can actually power it back down.

So, we're getting very, very aggressive, and that requires a change in both how the machines are designed but also the way in which we write the software and what the policies are.

So, I think you're going to see some pretty dramatic reductions just in the normal replacement cycle starting really in 2010. So, if most PCs are really replaced or upgraded in about a four-year cycle, certainly in business, over that one replacement cycle you're going to see all these machines exhibit much, much friendlier properties in terms of their power consumption.

Thank you very much. (Applause.)

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