

TRANSCRIPTS

SUSTAINABLE ENERGY DEVELOPMENT IN EMERGING MARKETS*

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1. INTRODUCTION

DEE SPAGNUOLO** AND MICHAEL FITTS***

MS. SPAGNUOLO: Good morning, everyone. Welcome to the University of Pennsylvania Law School. For those of you who have traveled to join us today, welcome to Philadelphia, and welcome to our symposium. Our symposium concerns "The Sustainable Energy Development in Emerging Markets," and it's brought to you today by the *University of Pennsylvania Journal of*

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International Economic Law in conjunction with the Institute for Law and Economics ("ILE") here at the University of Pennsylvania.

My name is Dee Spagnuolo, and I'm the outgoing editor-in-chief of the *Journal*, or "JIEL" as it's commonly known around the Law School. And among you today, you'll find other board members of the *Journal*, both the outgoing board and the incoming board. We encourage all of you to ask questions of our board, and, if you need anything, please don't hesitate to contact one of us.

JIEL is one of four scholarly journals here at the Law School. We are a team of seventy-five students who work throughout the year to publish four academic issues. We were founded in 1978, and, over the past twenty-five years, we have grown in both our size, in our number of issues and in our aim and scope. Currently, we publish in the area of international economics and law. We accept submissions from legal practitioners, from business people, academics and government officials. We also oversee the writing of student comments, the best of which are selected for publication in one of our four issues.

A symposium is an opportunity for all of us to pull ourselves away from the researching and the editing, put on our public faces, and get to interact with the people in this field. And, it's a wonderful opportunity for all of us. And, to this end, I would like to thank our symposium editors, the two people who have made today possible, Alex Patchen and Heidi Sachs. Alex and Heidi have been working for almost a year to make today possible. So, kudos to them. We're in for a treat today.

Our symposium is also an opportunity for us to interact with people who might submit publications for our symposium issue, which begins its production process in the fall. So, I'd like to actually direct your attention to the back of our program, where you'll see information on how you might submit proposals for publication. The information is there, and we're more than happy to answer questions about it. So, we hope that today's event will produce a lot of work that we can publish next year.

As I mentioned, today's event is also brought to you in part by the Institute for Law and Economics, here at the University of Pennsylvania, so I would like to thank the leaders of the Institute, Professors Rock and Wachter, for their sponsorship of today's event.

At any rate, any symposium is only as great as the speakers, the panelists and the participants, and for that reason I have no doubt today is going to be a phenomenal event. Alex and Heidi

have taken a multi-disciplinary approach to today's topic and have gathered academics and legal practitioners from some of the best law firms in the country, members of the United Nations, the World Bank, representatives from the U.S. Department of Energy, folks from the private sector and private sector utility companies, and energy investment corporations, and beyond. And so, we are thrilled to have everyone here today, and we know that the discussion that will come out of today's sessions will, I think, be enlightening for everyone, and we're thrilled to have you all here today.

Personally, I'm very interested in today's topic. As a Peace Corps volunteer in the Dominican Republic from 1997 to 1999, I experienced firsthand what it means to live in a country without reliable resources, reliable energy sources. Living in a village that had electricity, on a good day, possibly for one to two hours, I saw what the lack of sustainable energy does to a community economically, what it does in terms of education, students not having lights at night by which to do their homework. Entrepreneurs who are limited in the goods and services they could provide to the people of the communities. The health and sanitation challenges that arise when you can't properly prepare food, when there are low levels of hygiene because of the lack of water supplies, and how this leads to increased disease and infection, and how this stunts the development on the grass roots level, and on a more macro level.

Today's symposium will examine the issue through both the macro and the micro. Speakers will share their experience in the field and debate current issues, will connect current technology, financial policies, politics, the legal environment, and the cultural aspects of the current global policy in this field. It's a hot topic. It is on the cutting edge of what influences our international politics today; oil supplies in the Middle East and in Venezuela affect the cost of heating our homes today in Philadelphia, and I think that what we hope to do today is look at some of these aspects and bring it all together. For the practitioners in the group, or the budding practitioners like myself, we hope that you will gain valuable insight from these issues. For those academics in the crowd, we hope that today's discussion will inspire your writings, inform your policies and influence your teachings. For the business people and environmentalists, we hope that you'll walk away with new information to guide your project planning and your long-term goals.

Just a bit about the format today. We have keynote speakers who will speak anywhere from thirty to forty-five minutes, and then we will have a group of panelists who will comment on the keynote's comments. And each panel will be moderated by our symposium editors, Alex and Heidi, who will also field questions from the audience. We welcome active participation from everyone today, so feel free to jump in.

Without further ado, I would like to introduce the Dean of the Law School, Michael Fitts.

DEAN FITTS: Thank you very much, Dee. It really is a pleasure to be able to welcome you to this conference today on examining the future of sustainable energy. I have to say, as I drove in this morning, and the snow was coming down, and I stopped off at the pump, and they charged somewhere close to \$1.80 a gallon, I realized that there is no more important topic right now than sustainable energy. I also have to say that the University of Pennsylvania has a long history of coming up with timely topics for its symposia. In the last few years, we held a bankruptcy symposium the day the largest non-profit bankruptcy in United States history was announced. We had a labor law symposium the day they had the largest strike in the history of Philadelphia. We had a corporate governance symposium the day the Enron disaster seemed to be unraveling. There is a rumor that JIEL for next year is going to hold a symposium on stock market crashes. If they do, I promise to let everybody know right after I've sold all my stock.

In any event, I think it's no accident that JIEL has been really in the forefront of a whole variety of issues over the year. The *Journal* was started twenty-five years ago, by Bob Mundheim, who held appointments both in the Law School as well as the Wharton School. And Bob realized that, for issues arising in a world economy, you really had to approach it from, as we said, a multi-disciplinary perspective. I think that's a given now, but back twenty-five years ago, it was a quite novel proposition. And Bob set up the *Journal* and was also very active in the Institute of Law and Economics, because he saw that Penn had a special place in examining these issues. The *Journal* has gone through a number of permutations, in terms of names—it's expanded from a name of business to economic, it's become much more international. But, through it all, it's had a board that combined faculty, both from the Law School and the Wharton School. It's had, as well, on its board practitioners and businesspeople from around the globe, who advised it on topics and supported it financially, in really

examining some of the cutting edge issues in the area of business and law. I have to say this approach of the *Journal*, as well as the Institute of Law and Economics, is a hallmark of this university. The University of Pennsylvania, I think, is the most interdisciplinary cross-professional university, at this point, in the world. The reasons for that are, in part, because of the quality of the various professional schools that can be found on one campus. Within four blocks of where you're sitting, we not only have one of the premier business schools, but we have one of the premier communications schools in the world, a health care complex, and policy bioethics, which is second to none in the world. We have a biotechnology group, again, within a block of here, second to none in the world. All of these different schools and institutes share faculty, they share students, they share programs. There is a culture and a connection between them that really is unmatched anywhere within the United States. Within the Law School, we have an exceptional amount of cross-disciplinary activity that goes on both on a scholarly level as well as a student level. We probably have, as a percentage, more faculty with joint appointments in other schools within the university than any other law school in the country. We also have a student body that moves back and forth in its classes across the university. I just got the count: We had 1500 hours of classes that students took which involved faculty from elsewhere in the university. And, I just got the numbers, the graduating class this year, close to fifteen percent of those students, as part of their law degree, received a certificate of study at the Wharton School.

So, we really are, as a law school, and as a university, I think, leading the way in connecting up with the rest of this university and exploring the legal issues from across the professional perspective. Behind this is the view that the problems of the twenty-first century are going to be understood and solved by being able to cross fields, and approach problems from a multi-faceted viewpoint. I think this conference is a perfect example of that approach. The topic, I don't need to tell you, is one of the most, if not the most important issues facing this globe and this country, and we have assembled here—I shouldn't say "we"—the *Journal* has assembled a group of stars to discuss this particular issue. Again, I want to thank Heidi, as well as Alex, for supervising this symposium, as well as Dee, for overseeing the student journal so well over the last year. I also want to thank all of you for participating. You honor us by your presence and I am

looking forward I know, as many others are, to hearing the discussions that occur.

So, without any further ado, I guess I should call to order the first panel, and again, thank you very much for coming to the University of Pennsylvania Law School today.

2. ENERGY INFRASTRUCTURE FOR CLEAN DEVELOPMENT

DANIEL KAMMEN*

What I'd like to do today is to illustrate two aspects of real-live markets, and instead of doing the broad overview—although I'll do that for a minute or two—of what clean energy markets are and where they're going, I'm going to get into two cases. I'll try to go through a fair amount of those, for a couple of reasons that I hope will become clear to you quite soon.

Before I begin, though, I probably should say a word about the laboratory that I direct at Berkeley, called the Renewable and Appropriate Energy Lab ("RAEL"), where there's a whole range of projects: working on understanding and building clean energy markets, looking at distributing clean power systems, looking at renewable energy technologies in particular—but we certainly do not imply or believe that we are focused only on renewables, hence the "and appropriate energy" part of the title of this laboratory—doing quite a bit of work on energy policy, and frequently looking at the tensions between environmental issues and economic issues and what we tend to usually call the false dichotomy when you actually get past some of the problems in the way. And, we also look at ways to think about dramatically deep cuts in carbon emissions, not the one, two, three, four percent sort of levels of the carbs, but deep cuts in the arms-control sort of sense, talking about thirty, forty, fifty, sixty percent cuts in carbon emissions, and how those sorts of transitions might be obtained. Then we do a fair amount on the social impacts of energy systems, across ethnic groups, across gender issues, across communities. And so, RAEL is really a lab that integrates students in the same way that Dean Fitts

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described Penn as very interdisciplinary. There are students who come from engineering, legal, the business school at Berkeley, social science programs, as well as the natural sciences. So, it's a very interesting mix of people doing different projects, and all the projects I'll describe here today are ones that this lab has carried out over time.

So, what I will talk about today will be what I tend to call the twenty-first century energy revolution, where dramatic change is going on in energy markets, and the ways that those can be gleaned. The thing I'll start off with is a case study of cookstoves, biomass and health issues in East Africa. Then we'll look at the East African photovoltaic market for a variety of interesting reasons. And then, at the end, and hopefully we'll have time for all of that, we'll look at both independent power producers and the RPS process (Renewable Portfolio Standards) to the, in my opinion, most dramatic changes in energy economies that I would argue five and ten years down the road are going to be the hallmarks of the new energy economy.

So we'll get to those, and as we go, the one sort of overriding theme I'm going to illustrate throughout is the role of what I would call soft subsidies. So many of the subsidies that you see for energy projects in the past have been subsidies on hardware. More solar ovens. More towers. More transmission lines. A whole variety of subsidies that go directly to the hardware aspects of problems.

We also have a fairly long history of areas in which hardware subsidies have caused more problems in markets than they've solved, and so we'll look at a variety of cases where again these sort of soft subsidies—subsidies on the evolution, development and management of energy markets—how those things have come into play.

Of course, these transitions to a new energy economy are unfortunately not ones that are going to come without some real struggle. The real struggle I was illustrating here is really the very strong, very well-financed existing fossil fuel economy that will not give up its place very easily.

I will do one slide to summarize a little bit some of the emerging markets, to give a feel for the numbers. So, there are roughly fifty million people who receive lighting, TV, radio from microgrids, frequently microhydro systems; roughly ten million biogas systems around the world, over a million photovoltaic systems. And perhaps ten thousand microgrids that are hybrid

systems, a mixture of a diesel and wind turbine, a solar system and a diesel—a whole variety of systems. So, it's not a trivial number of these renewable energy systems in operation around the world.

In terms of commercial applications, there's something like a million photovoltaic power water pumps and sixty thousand minigrids that are providing power for small-scale commercial operations, be those small artisanal shops, hotels, a whole variety of operations. The estimates actually come out of the World Bank, of the ESMAP¹ group—it's roughly 48,000 megawatts of grid-connected power, of grid-connected renewable power, largely thermal energy systems and wind, in operation around the world. And, some twenty-five nations have independent power providers allowed in the market in various ways that are not dead-end roles, where there's a real opportunity for them to sell power in, again, non-trivial numbers.

Roughly 180 million people live in nations with mandated ethanol or methanol mixtures in gasoline. And, some 14 billion liters of biomass drive ethanol are used per year. Again, non-trivial numbers. When I began teaching renewable energy courses, now a little over a decade ago, I could make arguments why I felt renewables and energy efficiency were great things, and why they were, at some point down the road, going to be a real critical player. But I could only make the case that those technologies—energy efficiency aside, that has proven its worth in a whole variety of settings—were going to be useful some day, but that none of them were in fact in significant economic use. Today, that situation has changed. Wind power is now cost-competitive in a variety of settings. Biomass-derived power is competitive in a variety of settings. Photovoltaics, always the most expensive of the technologies, is now, in certain applications, competitive. It's a dramatically changed market where these technologies are at, or beyond, that point of cost-competitiveness. That lesson, in my view, has not fully disseminated through utility planners, both in the U.S. and around the world. So, a critical aspect of the story is understanding what the new opportunities are, and finding ways to bring down the barriers, to even the playing field, so that those decisions we make economically can really be based on which technology system we prefer, not based on how massive the subsidy is for, for example, the existing fossil fuel sector, or for a

¹ Energy Sector Management Assistance Programme.

given project in a given renewable energy context. So, some fairly dramatic issues out there.

Roughly 200 million people around the world use improved cookstoves, and some ten million use solar water heaters. Of those 220 million improved cookstoves, roughly 150 million of those are in China, about another 25 million of those are in India, and the rest are distributed around the world. I will take you through the case of Kenya, and I'm going to skip this one, just showing the investment—the global investment in renewables, which has ramped up fairly considerably with now about 90 billion invested in the last seven years. So again, not trivial any more the way, for a long time, one had to really claim it was.

Let me do the cookstove case because it's a fascinating example of the evolution of the market with lots of interesting mistakes and lots of successes that happened over time. And, let me just highlight a view of this market today. When work on cookstoves began, arguably forty years ago in India, then thirty years ago in parts of East Africa, and thirty years ago in parts of Central America, the argument for improved stoves was largely an engineering one. It was that traditional stoves—three-stone fires, very simple metal stoves—are very inefficient, with people using dramatic amounts of wood. With population growth going up and wood reserves going down, it was a Dr. Strangelove sort of argument—we must prevent the wood fuel gap!!—and you saw engineer after engineer making this claim, and in fact, we found out today that while deforestation is certainly, in some cases, caused by excessive wood-use harvesting, that is almost never the dominant reason for deforestation. It is almost always land clearing for agriculture and forestry.

That left the improved wood stove business in a bit of a shambles. They didn't quite have a mantra and a mission to push them forward, while at the same time designers of these improved stoves around the world recognized that a traditional stove may be as efficient as only five percent efficiency, in terms of the energy and the emission of fuel, wood or the charcoal going into actually heating the food; whereas the improved stoves, if used well under the huge literature about what's used well and what's not used well, could be up to thirty-five percent efficient. That's a dramatic efficiency gain to be captured, but again, without this deforestation mantra, it wasn't clear where to go with it.

About eight years ago, a range of research came up that looked at what are the global burdens, the major global burdens, on

health. And so, this graph is a World Health Organization standard. "DALYs" are Disability-Adjusted Life Years. Basically, one healthy year is one year, that's not disability-adjusted, but, if you're laid up in bed for half the year, you get half of a year of healthy life out of that. There are roughly 1.4 billion DALYs of illness, of adjusted illness years around the world each year, and the red indicates those that relate to respiratory issues in various kinds. Exposure to wood fuel and wood smoke inside developing country homes is the largest feature of this largest single section of the pie. So, wood fuel stoves in rural homes—which many people hadn't really put together—could be the key issue, because, of course, most of our monitoring of air pollution was outdoors in urban areas in developed countries, whereas it turns out that the largest fraction of exposure is indoors in rural areas in developing countries. So, that shift was quite a shock to the system, but it also revived the work, in some sense, on cookstoves because they are directly in that environment.

So, the picture of the process that was generally thought of was something like this, and this is a often-criticized but crudely useful matter called the Energy Ladder, where you think about moving from very inexpensive rural collected fuels—like dung, cork residues, wood—up the ladder towards more advanced or cleaner fuels, and, at the same time, you get a commensurate movement of the stoves themselves to cleaner burning stoves. So, the simplest rung on the ladder would be burning dung or wood in an open fire, and you can see, we move up on the ladder along here. This is a traditional unimproved stove, that's an improved stove, another improved stove, and this is the stove I'm going to talk about for the remainder of the session—the section right here on cookstoves. That's the famous Kenya ceramic jiko—jiko means stove—and we'll look at what's evolved with this process over time.

The first thing to know—and this is work that we've been doing in Kenya now for just about a decade—was to look at what are the pollution exposure levels that we observe around stoves, or in homes with different stoves in operation. So, here is a three-stone fire, a simple ceramic wood stove, an unimproved old charcoal stove, and a new charcoal stove. And, what's indicated are average pollution levels for fairly reasonable numbers of measurements of each kind of stove. Notice what the units are along the y-axis. This is in thousands of micrograms per cubic meter of pollutant exposure. Well, just to put it into perspective, the U.S., Japanese and Europeans do not exceed standards for

particular pollution matter—and right now they're being shifted from 10-micron size, or PM-10, down to PM-2.5—in the 50-150 microgram range. Beyond that, you're not supposed to be exposed to that. OSHA² gets involved; EPA³ gets involved. But we routinely observe pollution levels hundreds of times that in indoor environments in all the countries. So, this is a dramatic exposure burden that should also suggest that there really is a role for these stoves to clean up the process.

The first thing that we did in examining this was to find a community where we could do a long-term exposure study for a large population, and then introduce new and improved stoves to the community and observe the effect. Well, we were lucky because, as we were doing this process, we went from what I would call the Stone Ages of doing cookstove monitoring work, where every time you wanted to do an indoor air sample, you had to take a little paper filter and suck air through it, and then weigh the filter before and after. You don't get many measurements per unit of time, they are very coarse, you can't move it all around—that was a painful and not very productive process. But, as we began this work, two commercial groups, one in Massachusetts, one in England, developed laser-based real-time meters, so we could do point-of-exposure around indoor homes. And so, knowing the value of meters and of graduate students, I sicced a fairly large army of graduate students to work doing incredible monitoring, where they basically followed around each family member all day long, and they complained to me the next day, and did their real-time exposure budget all day long.

Lesson one that came out of it—and this is the demographic breakdown for girls and boys, females and males, zero-to-five, five-to-fifteen, fifteen-to-fifty and over fifty years old—and what you see is a dramatic feature, and that is the shaded lines indicate what exposure levels we observe, if you simply put a central station monitor in somewhere near the hearth in a home. And the levels vary somewhat, but they're more or less even.

Then, we did these personal monitors on the boys and girls, the men and the women, and lo and behold, what you see are the solid lines indicating that the exposures of the people who do the cooking—surprise, surprise, primarily women and girls—were outlandishly high, if you actually did this real-time monitoring.

² Occupational Safety and Health Administration.

³ Environmental Protection Agency.

So, it was an exceptional opportunity to discover, in fact, what we sort of all knew all along, but no one had been able to prove, and that was that if you cook and you put your face over the fire, you are exposed to a dramatically higher burden. It shouldn't come as a surprise, but it hadn't been a recognized result until this time.

The next piece of the result was to develop a dose response curve for the exposure to smoke and illness, and this involved even more grad students, so even more measurements. Basically, it involved following people around all day long and doing a physical exam for every member of this 500-person community every ten days for four years. The value of doctoral students! When we began the process, remember, those exposure levels that we had seen in developed countries, in the 50-100-150 microgram per cubic meter range, were ones that we knew were many, many times over that. So, thinking that cookstoves might bring down exposure levels by, if they're doing well, maybe a factor of a third, or maybe a half, my thought at the beginning was, okay, we'll bring people down from a terribly polluted level to a very polluted level, with no discernible health impact, because we're way beyond the place where the dose-response relationship shows any significant behavior. Lo and behold! We see something quite different. The top curve in blue is all cases of acute respiratory illness, and the red cases are acute lower respiratory illness. And, if you just look at the top blue curve for a second, you'll notice how it comes down fairly steadily and it drops quite dramatically in the lower range. There's a rough knee in the curve. So, the range of exposures that we observed in people using three-stone fires is the old story about the three-stone fire line, ceramic wood stoves have a smaller range lower down, and using charcoal stoves has a range even further down. Translation for me, if you can get people to transition from a three-stone fire being used in this traditional way that's fairly high-polluting, and get down to using charcoal stoves, you can effectively drop their incidence of respiratory illness, the number one health issue in most developing countries, by a factor of two. A dramatic result that has now been taken on by a whole range of the cookstove and health development organizations, notably USAID,⁴ GTZ⁵ in Germany, DFID⁶ in the United Kingdom

⁴ United States Agency for International Development.

⁵ Gesellschaft für Technische Zusammenarbeit GmbH.

⁶ Department for International Development.

("UK"), and WHO,⁷ as further motivation to support new cookstove programs that, as I've said, were falling on hard times. The result in Kenya now is that half of all urban homes use these improved jikos, these improved cookstoves, and about twenty percent of the rural population have used them. And there are now renewed efforts to develop, in conjunction with community groups, rural inexpensive stoves to bring these same benefits back to the community.

So, it was an interesting case of the evolving science of the stoves having a fairly dramatic impact on the ability of people to utilize the information to assist these markets. The Kenyan ceramic jiko, either the program to introduce it, or the stove design itself, has now become the norm in over thirty African countries. It's been exported to India. The Kenyan ceramic jiko itself is an import from Thailand, and the Kenya stove now as redefined has been re-exported to Thailand and Indonesia. So, there is a very interesting dynamic I would call, you know, to some extent, a south-south technology transfer, building these markets for these improved stoves.

I'll leave the cookstove case for there and I'll move on to the solar photovoltaics case. Again, I'm going to use the East African market, because, for a variety of reasons I'll describe now, it is arguably the most interesting photovoltaic market in developing countries. It is certainly the largest. Per capita, more people have photovoltaic systems in Kenya than in any other developing country. In fact, the only country on earth that has more photovoltaic systems installed per capita is Norway, and that's a bit of an odd case, because Norway has a great deal of offshore PV (photovoltaics) on the state oil platforms. Kind of an interesting picture. But, Kenya has the highest penetration rate of photovoltaics, and I'll describe the interplay with the World Bank in this market in a second, but it is large—it is generally thought of as a completely unsubsidized Wild West sort of market. That's, in fact, not totally the case, and I'll get back to that aspect of the story in a second.

The global sales of photovoltaics, like wind, have been showing dramatic increases. Global sales of photovoltaics over the last thirteen years have shown a roughly twenty percent increase annually. In 2001, photovoltaic sales globally hit the whopping

⁷ World Health Organization.

number of 400 megawatts, which sounds wonderful for the photovoltaic market, but you have to remember that means global photovoltaic production is roughly forty percent of one big fossil power plant. So, the growth numbers are great, but, as some people say, when you're doubling zero a lot of times, it takes a long time to get anywhere.

So let me argue why this is in fact an important case of growth and I will argue, even on the physics later on, that I do not believe that energy is conserved, and I'll explain that as I get down the line. The Kenyan market—per capita income is about \$300, that's \$1,000 of purchasing parity adjusted. Two percent of the rural population is served by the grid. It is, as I said, the largest PV market, and we've worked with the group in Nairobi for about fifteen years on examining the evolution of this market. The Kenyan market has a very interesting feature. Kenya has a relatively affluent rural middle class, due to a variety of productive industries and, in the Kenyan market, we saw two things. There was the classic crystalline solar panels that are used—the kind of the blue ones that you see with the big crystal in modular sections—and then there is an upstart, an amorphous photovoltaic panel, and I've shown the growth in these features here in the blue for the crystalline and in the red for the amorphous. The argument has always been that amorphous panels are cheap, nasty knock-off panels that are very low efficiency—you think of a good crystalline panel as fourteen to fifteen percent efficient, amorphous panels are often four to five percent efficient, but they're dirt cheap. Because we saw this dramatic increase in sales in these amorphous ones, we plunged into the market to figure out what was going on, and was there going to be sort of a bad technology backlash once you bought your systems and we saw them not performing up to capacity. And, when I talk about a photovoltaic system in Kenya, you've got to remember what I'm talking about is typically a panel like this woman is holding. That's an amorphous panel, that's probably a 14-watt panel, and she is most likely to buy that panel and one of these batteries, no inverter, and a couple of light points. That's about like—remember Apollo 13, when Gary Sinise is in the module, trying to see if they could bring them back to earth using 12 watts. He says, "Goddammit, this is like running the whole thing on a toaster!" That's what's going on here. These are tiny systems. So, while there's the highest rate of photovoltaic system use in the world in Kenya, it adds up to a very small amount of kilowatts. That's part of our argument why a kilowatt is not a

kilowatt, energy is not conserved. One watt in a rural community is very much different than one watt in a developed community. And, that's why one should pay attention to this sort of market.

So, this is the amorphous panels, and we were concerned about what's going on. Before we even got to do our field work, we noticed this wonderful event—if you're a researcher—in that in the Kenyan papers, and I've only given you the English not the Swahili papers here, advertisements were popping up arguing for Solartech cells amorphous panels, Solagen cells amorphous panels. And in this KenyaTel ad, which I fear you might not be able to read too well, this is a more technical advertisement in the local Kenyan paper that I actually give in my Intro to Energy in Society class. It says, "Monocrystalline panels are the oldest in the market. They are industry standard since the sixties. To date, they have the best efficiency record. Their life span is twenty-five years. Amorphous solar panels are much lower quality than a crystalline." Why would there be such an intricate and detailed and overly technical advertisement in local papers? Kind of a surprise. Here's that ad blown up, so I can read it to you a little more, but in the interest of my twenty minutes, I'll skip onwards.

Okay. The Kenyan market is this Wild West, in the sense that there are several, about ten, major import-export companies, fifty large-scale vendors in Nairobi, more than five hundred town-based ventures, and in the low thousands of solar technicians that roam the country installing systems. This is a wide open, very interesting, very contentious market where the average solar installer has no inventory. When he gets an order, generally from someone in his own tribe, he goes to town, gets the equipment, takes it and installs it. That is not a way to build a whole lot of market base for the individual consumer. And, in fact, one of the interesting things that we have found, unlike much of the training that people were talking about giving to vendors, these are not solar specialists. These people selling panels are doing a whole range of things—fixing bicycles, doing minor house wiring, a whole variety of informal sector activities. They might like to do solar full-time, but they don't, for all of these various market barriers.

Now, my story about the World Bank. When we were beginning this work in the early nineties, the then-director of ESMAP confided to me one day, and he said, "Ah! Our investments in the PV market in Kenya, that was just a waste." In the early eighties, they began to invest in a number of training

courses for photovoltaics in East Africa, and five years later, ten years later, nothing had come of it. The program was discontinued after four years, but there was no clear sign of success. In fact, while it's fun to criticize the World Bank—we don't always, but sometimes we do—this is a case where the World Bank deserves amazing kudos for having done this. The only thing they didn't do was keep their books open long enough to reap the rewards of this program. In fact, if you look at many of these import-export companies and the major solar vendors in Nairobi, twenty years ago they were involved in those World Bank programs and that's where they got their edge to learn about importing systems, building systems, marketing systems, a whole variety of features, and our current numbers are about sixty percent of the key individuals came through that program, or were directly related to people in that program. So, I think it's a rousing success, but it's not one that shows up in the World Bank books. So I'm delighted to have seen it evolve, and I'll push onwards.

Back to the amorphous versus crystalline debate. We set up a lab on the roof, a section of the roof of Energy Alternatives Africa Limited, our partner group, where we're testing panels. We've developed some hardware to basically look at their efficiency, called the voltage current curve, and we hopped in our trucks and we cruised the countryside for panels. Whenever we saw a panel, we jumped out of the truck like one of those lottery winner things, ran to the home, said, "Can we test your panel?" We got quizzical looks. We had tea. We measured panels. Lo and behold, what's plotted here for the four main types of panels being sold in Kenya is how much of its rated power is each panel putting out whenever we found it. Some of these panels were a year old, some were eight years old. Koncar, a company here, their 12-block panels are doing pretty well, over eighty percent of their rated power. All solar panels are rated, some number plus-or-minus generally five percent. I've never met a panel that was over—that was 105. I meet them ninety-five percent and down. And I'm talking about not just our own panels, but the United States' as well. So, these panels, and the Free Energy Europe ones that are at ninety percent, these are wonderful. Because these are Indians, rural communities—there's cow dung on some of them, there's barbed wire wrapped around them, they are under trees; a remarkable performance. [X Company] is doing terribly. Now, remember what I said, these are tiny panels—12-to-14 watt panels. Take a tiny panel, put a poor battery connected to it, and you get basically

no power route. This is a panel that, if it's allowed to persist in the market, really could spoil an interesting, evolving market. And, for comparison, the panel type that everyone thought was just perfect, way out of bounds, much better than the amorphous ones, were a set of crystalline panels that are measured here. Notice that the crystalline panels are not dramatically better than the good amorphous panels. Now, when we wrote this first paper, it was actually published by ESMAP as a technical paper at the World Bank; we had to use A, B, C, and D for these companies, because of concerns that this would bias the market and, in fact, the day after we released the paper with A, B, C, and D panel identification, I received a lawsuit from [X Company]. But at the same time, interesting markets move quickly. Free Energy Europe—that makes the Free Energy Europe panel—came out with a bumper sticker, literally weeks after we released the papers, saying, "Best tested at Bank." So, they utilized those testing results immediately in the market. And here is a picture of a father with one of these XI batteries. Note the Free Energy Europe panel, and notice, of course, there's the panel on the roof, and there may be a light bulb there

This is the voltage current curves. We're going to forget that, because I'll run out of time, for sure. And we've done a lot of work with the age of the panels. It's a remarkable story. I'll leave it all. Going to skip that kind of stuff.

I do want to highlight one point that we'll hear more about later on, and that is that the cost of power from these systems is non-trivial. Many people in developing countries use a battery as a form of electrification, which they take to market, get recharged, and come back. The life cycle cost of power from a battery is like \$2.20/kwhr; 12-watt amorphous system, about a dollar; 20-watt crystalline, around 80 cents. If you go to a little bit larger amorphous systems, you start to get down to the bargain of 66 cents. Now, I say bargain, relative to these higher prices; not a bargain on the absolute scale. And, one of my big worries, and something which I hope we'll debate a bit later on, is that I have seen multiple reports that say one of the neat discoveries of the last ten years is the rural willingness to pay for power. Translation: the market is there, we should take advantage of it. And, I agree, we should provide power to rural communities, but it's a real worry when you can buy electricity in Dar es Salaam for 6 cents/kwhr, and ten miles out of town, the price is ten times that.

And that's one of the biggest impediments to real market evolution, in my opinion, in many of these situations. Okay.

To get these results back into people's hands, what we did next was to hold a series of conferences. That's Dick Rasby, who did a lot of this effort, Arne Jacobson here, who now publishes a monthly article, which I'll pass around when I get to sitting down again—he publishes "A.J.'s"—"Arnie Jacobson's Technical Tips." It's in this local trade magazine, the one you're going to see when I pass it around, and it is on how to size the battery to match the system. And this is a meeting of solar vendors in Kenya, where we got the word out about these panels, and I'm pleased to say—although that one company is not pleased to see—that their market share has dropped from around thirty-five percent three years ago to basically zero today. So, I would argue this is a great success in helping to support a market with what I would call a very, very soft subsidy. We did on the order of \$80,000 worth of research funded by U.S.-based groups that I would argue has had a fairly dramatic effect on the Kenyan market, and, in fact, the Kenyan market is the driver for the Ethiopian, the Somali, the Tanzanian and Ugandan markets. So, it's a very dramatic, interesting situation.

This is the solar newsletter where Arne publishes his technical tips. I'm going to zip along so I can finish up—I've got how much time left? Ten minutes. Oh, even better than I thought. I'm not going to zip. Okay.

This is the feature I mentioned before—these solar systems are not being sold by solar specialists. Here is a store selling shirts, suits, solar panels, watches, all manner of things. How do you support a market that has this sort of non-specialist level involved? Well, one of the sets of recommendations we've made and are working on with our partners in East Africa is training sessions that are integrated into the technical high schools, short courses, into entrepreneurial training that you get, in what's called *jua kali* in East Africa. *Jua kali* means hot sun. That means people who basically work in the informal sector. So, finding ways to make the training available and how to think about market evolution, how to support your customers, because many people who buy solar systems return a year later and want the system increased in size, or they want to buy more light points, or radios. And, in fact, what you see right here—this is the Chinese Great Wall TV, clearly the most popular import in Kenya, it's a very small television that can be run off of these panels, and, interestingly enough, a well-

maintained 18-watt amorphous solar system with a Great Wall TV, with the radio off, can give you around three-and-a-half hours of TV watching, which is critical because that's the length of a World Cup game and the biggest burst in sales came before the World Cups, and then the Africas Cup. So, interesting driver of the market.

Now, in terms of energy and equity questions, and many people interested in photovoltaics are interested in them because of more lighting at night so kids can study, and all these kind of socially beneficial reasons. Well, the number one use of PV systems in East Africa is television. The number one most popular show in Kenya is wrestling. The number two most popular show in Kenya is wrestling. The number three most popular show in Kenya is "The Bold and the Beautiful." I'm not going to make a comment on whether I think we're really driving social values here. I think actually building the market will build those applications in, but it is interesting to know that in some sense, Kenya's photovoltaic revolution will be televised.

Another interesting feature in the solar market in Kenya, and I'll go through very quickly, is the standard picture would be this. This is the international solar module price, dropping over time dramatically. This is the solar sales in Kenya going up. But, the other critical feature here, the black dots, are TV licenses being sold in Kenya. When you buy a TV in Kenya, you have to get it registered like a car. And, we see this interesting ramping up of the two. I'm not going to argue about correlation versus causation, but it's fairly clear that we are seeing TVs and solar systems being bought in interesting conjunction. Okay. A variety of conclusions from this case, the main one that the biggest market inflection that I saw in the market wasn't what I initially went in, thinking there wasn't enough capital for the sellers of PV systems, but in fact that we had this dramatic disparity in the quality of panels, with no ability to tell the panels. But, when you look at the good versus amorphous ones, you can't tell which is which. And so, this sort of advertising, this sort of soft subsidy, I would argue, is a very critical part of the process of building some sustainability into this market that you would hate to see grow and grow and grow and then crash, because some people had these terrible quality modules that they made into Frisbees or planting boxes or whatever.

Again, I'll highlight this point about rural energy and urban energy. One of my concerns about thinking about rural energy is that it has always been marginalized compared to urban energy

because the numbers look so uninteresting. You say a big power plant is 1000 megawatts and big energy in a developed—or a developing—country, you measure in gigawatts. Well, in fact, many of these emerging markets, you're thinking about energy at watts at a time. Now, I would hate to be parading around my whole life trying to argue one watt at a time and, in fact, when I made this case at one time for a young colleague who was up for promotion, the dean of his school told me, "We don't tenure Mother Theresa." So, I would hope to think that this kind of small cell energy gets a little more respectability, but I would argue that these kinds of emerging markets, given how stagnant energy markets are in developed countries is, in fact, an important, interesting place to go.

Let me spend a little bit more of my remaining 4.4 minutes on some of the evolving features in these markets.

What I've plotted here is the growth, the global growth, in the PV industry. The blue line shows that growth. Just to highlight at the endpoint, last year global shipments of photovoltaic modules were about 400 megawatts. Sounds trivial compared to fossil fuel systems, but is very significant for renewable energy systems, for solar systems. Last year, San Francisco passed the Solar Revenue Bond. It's a \$100 million revenue bond that supports the installation of 40 megawatts of solar. That won't happen over one year, but that means that San Francisco, as one city, is basically putting a ten percent boost into the market. San Francisco is about to be followed by Tucson, and by San Diego, and by Marin County, and Hawaii has just passed the first stage of having a state revenue bond for solar. My argument is that those are some dramatic features to both utilize and to build a market for what is generally thought of as the most expensive of the renewable technologies. And again, here is some film of PV being rolled out on the rooftop. Here is a solar subdivision, actually down in Watsonville, and you can see the solar panels from the rooftops. California has a remarkably generous subsidy. For those of you who have thought about the evolution of these markets, some of you have probably seen the so-called learning curves.

The typical learning curve, and this is plotted in unusual units—this is first a case for compact fluorescent lights, this is cost for the ballast, the key component. This is the decrease in the cost of the ballast as a function of how many ballasts are produced. The slope of that line is an engineer's dream—in log space, you get a straight line, you're just in heaven. And, what you see here is that

for every doubling of the number of widgets shipped, you get about a twenty percent decrease in price. Held for compact fluorescents. Holds, so, for photovoltaics. The neat feature of these curves, then, is that what San Francisco and Hawaii are doing will have a dramatic effect on these markets, and, in fact, the World Bank has followed suit. There is a program that I've been very critical of, for reasons we can get into later on, but it's called Photovoltaic Market Transformation Initiative—PVMTI. In Kenya, it's done something very unfortunate, but in the other countries where it's active, in Morocco and India, PVMTI is utilizing this process to buy down this learning curve to both install the systems, to build the market and to make the price cheaper for everyone else. Now, overall, I'm very much in favor of PVMTI. In the Kenya market in particular, for reasons we can talk about in the question time, there have been some issues. These learning curves hold for lots of technologies, but one technology for which learning curves don't hold, interestingly enough, is for nuclear power, where there's been a forgetting curve, where the price has gone up, for reasons we can also put aside to later.

What's the best way to support this sort of marketing evolution in developing countries? One, in my view, is certainly to find ways to support evolving markets around the world in ways that will differ market by market, but trying not to subsidize hardware, but to subsidize kilowatts produced, actual power generated, or to build market capacity. Everyone probably knows the dreadful story of California, in the late fifties to early eighties—you could buy a windmill, rent the land to put it on, install it, never hook it up to the grid, and make money. That would be a bad subsidy on hardware. Today, we have a situation which I am very optimistic about, and I would argue this is, in fact, the true energy revolution, and that is an RPS, a Renewable Portfolio Standard, where on a state-by-state basis, so far that's the way it's been working to this point, states put in a standard for a minimum renewable energy content and then allow the market to meet it. Now, despite all the things you have heard about how free markets operate, most of the time, energy markets are not that free, but one of the ways to actually utilize market power, in my view, has been to build a master structure, where you mandate a certain level that you determine to be either energy, or resource, or socially valuable and then allow the market to meet it. California has a fairly aggressive twenty percent standard by 2017. Nevada has a fifteen percent

standard by 2013, with a set aside for solar, because solar is more expensive. There are thirteen states that have these.

Now, I've gone through a fairly lengthy debate with the Senate Energy Committee on the arguments for a Federal RPS. Recently, Senator Bingaman had actually come out in favor of that, but for the past two years he was not, for reasons which I hope we had a role in changing his mind on. But, this is, in fact, one of the ways I believe we can most dramatically help our own energy security and developing countries. Because by building these more diverse markets, we will get away from what Richard Hirsh, the historian at Virginia Tech, calls utility consensus, where, yes, utilities, when they are monopolies, innovate, but they don't innovate in ways that dramatically change the patterns of power use in production. They innovate to stay in a position of privilege. Building these sorts of diverse energy markets is the best way.

Connecticut, for example, is going to push to be the fuel cell state. California is likely to largely push for wind. Many of you probably have seen that this is the dramatic wind belt of the United States. North Dakota has more wind potential than Germany, and Germany right now has four times as much installed wind capacity as the United States does, 12,000 megawatts to our 4,600 megawatts, and, interestingly enough, despite what people have been saying for years, that these so-called non-dispatchable renewables could only provide a little bit of power because too much non-dispatchable power in the grid would destabilize. Last year, two German states met fifty percent of the electricity demand for two individual months with wind power alone, and they're averaging in the twenties. Now, that completely changes how we thought about these renewables in the past, and it wasn't some academician sitting down to figure out what is that theoretic level, because they've been wrong consistently. It was Germany installing large amounts of wind and seeing what worked. Much to the U.S.'s chagrin, I would hope, is that last month I got a press release from the President of Spain; Spain has now surpassed the United States. So we are number three in wind production.

Well, who did most of the early R&D (research and development) on wind? And on fuel cells? And on PV? It was the United States. This strikes me as a very poor technology giveaway to not be in that leadership role any more. So, that strikes me as an area in which we have a lot of room to improve.

I believe I'm at time. I think I'm going to skip the car credits and stop right there.

3. TECHNOLOGICAL OPPORTUNITIES FOR GLOBAL MARKETS

NANCY FLOYD*

Well, good morning. It's really a pleasure to be here, and particularly to be here in the Law School, because my very first investor in my firm, Nth Power, actually graduated from the Law School in 1971, and that's my husband, who's hiding in the back there. And, if Dean Fitts were here, I'd tell him it's wonderful to see that not only does his school train good lawyers, but astute business people.

I also want to thank Professor Kammen, and not just for the outstanding work that he has done, but also I believe two of my firm's rising stars have been students of his.

This morning, I'm going to speak from a very different vantage point than the other speakers. For the past twelve years, I've been in the role of a venture capital investor, specializing in investing in emerging energy technologies. And, of course, these are the technologies that form the core of sustainable energy. In my presentation, I'm going to discuss what energy technologies are garnering investor interest. I'm going to talk about what's driving the opportunity. What's the role of venture capital versus project finance, or R&D? And, some of the key market and technology trends.

But, first, let me set the stage with a couple of personal observations. Many of the key technologies behind sustainable energy—wind, photovoltaics, fuel cells, fly wheels—were conceived of decades ago. And, let me add to that that I know that there are a lot of people in this room, and a lot of presenters, who have spent decades working on, call it alternative energy, renewable energy, or sustainable energy. But, in spite of those facts, I would allege that we are still in the very early years of this opportunity. You know, up until five or six years ago, the availability of investment capital to fund these companies, these technologies have been not only limited, almost non-existent, that there have been substantial market barriers, some driven by regulation, some erected by incumbent industry players, and these

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have all impacted the pace of innovation and widespread market acceptance. But this is changing.

The other point that I would like to make is that sustainable energy is becoming serious business. For years, policy makers and idealists, like I guess myself, have been touting the societal benefits of these new technologies. But, in the past few years, a fundamental shift has occurred. We have seen sustainable energy go from a policy-driven debate to a business-driven agenda. You know, the societal benefits, of course, are still there, but major corporations, incumbent energy players and investors are moving to the sector because they can make money and they can create shareholder value. Let me move on.

So, just as background, Alex mentioned that I co-founded Nth Power in 1992. It's a San Francisco-based venture capital firm, and really the first venture capital firm to specialize in opportunities arising from restructuring of the global energy industry. We're backed by world class strategic and financial investors, which I will show in the next slide. And, we've been investing since 1977. Now, founded in '92, investing since '97, did we not find any good deals for the first four-and-a-half years? Well, the fact is—and it tells you the state of investing in energy technologies—it actually took us four-and-a-half years to raise our first fund, which was \$65 million. And, on one dark and dreary plane ride home, my co-founder and I calculated that we had visited 197 prospective investors. In the end, nine of them bought. Our second fund only took us six months to raise, and today we have \$250 million under management.

I list our investors for a couple of reasons. First, two-thirds of our investors are strategic, one-third are purely financial, and that was really by design. Our original business strategy envisioned a very active partnership with our investors, which most venture capital funds don't have. We realized that our strategic investors were sort of a self-selecting group. They were the most progressive of the energy players. And our strategic investors fall into a couple of categories. You've got, you know, ChevronTexaco, and EnCana, and North Pedro, which are in the exploration and production business. You've got players like ABB and Emerson Electric. And then, you've got a pretty diverse group of utilities. Geographic diversity was a goal of ours, not a result. We found that in our first fund, we had several European investors, and they had the effect of pulling our portfolio companies into those markets much sooner than they otherwise would have gotten

there. And, because of our active partnership with our investors, they have been early adopters of technology, they've been channels to the market, they've been customers, and, in many cases, they've been direct investors.

Now, what's driving this opportunity? The first is industry restructuring and this is really where we started in 1992, focusing on the opportunity that would arise out of deregulation in the United States ("US"). When customers finally have choices, then the energy suppliers are going to want to deploy market differentiating products and services. But, of course, restructuring is much larger than the United States. It's been happening worldwide.

The second is environmental concern, of course. We have a developing emissions market which is obviously concerned over CO₂. Interestingly, in all the studies that have been done, a significant demand from consumers who say they would be willing to pay higher prices for green energy.

The third is remote infrastructure and populations, and this addresses, of course, the two billion people in the world who don't have access to modern energy. Over \$2 trillion is to be deployed to bring power to rural populations over the next thirty years. But where we're seeing immediate demand today is in powering remote infrastructure, powering pipelines, offshore oil platforms and communications. Just the growth in global communications is driving very heavy demand for distributed energy.

Power reliability—you know, our system and the system in developed countries, our electric system, was designed for 99.9% reliability. That was fine in the industrial age, but it's not good enough in the digital age, because that still translates into more than twenty hours a year of outages.

And finally, what we call gridlock, and there has been a serious, serious under-investment in our transmission and distribution infrastructure and, of course, that leads to reliability problems. In addition, there are capacity issues. We have, in this country and other developed countries, regional bottlenecks where we may have the power to supply demand, but we don't have the capacity to transport that power to the users.

Very briefly, our investment profile—of course, distributed generation and storage. And again, this represents all the key technologies that form the core of sustainable energy. First of all, our investment profile, by the way, is on the left-hand side. The right-hand side is a listing of our portfolio companies. So, under

distributed generation and storage, the technologies include what we've already heard about this morning—PV, wind, fuel cells, advance batteries, fly wheels, hydrogen generation—this is an area that has garnered the most investment dollars over the years. It's certainly captured everybody's imagination, and, in a short history of there being venture capital dollars flowing to energy technologies, the most IPOs (initial public offerings) have been in distributed generation companies.

Power reliability—again, I talked about this briefly in the market drivers, but distributed energy is a wonderful way to provide highly reliable backup power.

Utility IT solutions is another category. It includes customer care software. It includes risk management software. Not really applicable to this symposium today.

Customer energy management includes a lot of energy efficiency technologies, a lot of tools to be able to manage your energy usage in real time. And also, very importantly, it includes the communication technology, the networks that are starting to come into place to link dispersed energy assets. And when distributed energy systems are networked, they become highly valuable because you can remotely monitor them, dispatch them.

Grid optimization—again, we talked about gridlock. These are technologies to upgrade the existing infrastructure. A lot of sensing technology.

And then, outsourcing and business services.

I wanted to take two slides to explain the role of venture capital, and I apologize that this is, you know, VC 101, but since there are going to be a number of speakers talking about both R&D and project finance, I thought I'd try to clarify the role. First, on the top of this graph, the company time line from inception to maturity, and it says maturity is years 3-6. That's being a bit optimistic.

Company activity—this is what the company's management team is really focused on. In the early years, years 0-2, it's technology development. In years 1-3, moving into product development. And then, finally, into market development. And, as you can see, there is overlap here because, as a company matures, of course, they'll be focused on market development, but presumably there'd still be R&D and new product development.

Along this time line, funding needs in the early years are small—\$500,000 to \$2 million. As the company emerges onto the marketplace with products, \$2-8 million. And then, as the

company is more successful and going to major market expansion, \$50-100 million. So, where does that money come from? In the early years it's seed and R&D funding. It's a government, angels, universities. Venture capital comes into play when a company is about to emerge onto the marketplace. And, of course, as a company expands in the market, it's either an IPO, or an M&A (mergers and acquisitions) transaction.

So, the role of venture capitalism is that it is a very proven model for bringing innovative ideas to the market. We invest in businesses, not technologies, nor do we invest in projects. Project finance is a very different animal. Deals are structured very differently. There's a different risk/reward profile. There are different criteria to evaluate. We provide expansion capital, not R&D funding. You know, we say the best R&D funding is paid for by somebody else. And usually, the use of funds includes, as I said earlier, product development, building out sales and marketing, because early on most of these companies don't have that, expanding the management team, and acquisitions. Venture capital doesn't invest in the status quo and venture capital doesn't invest in regulated markets, which is some of the reason behind why there has been little venture capital flowing into energy technology up until recently.

When we wrote the first business plan in 1992, we decided to chart the venture capital dollars flowing into private energy technology companies, and so this chart goes from 1990-2002. And, as you can see, in the early years of this chart, there is virtually no venture capital investment. In 1994, the California Public Utilities Commission initiated inquiry into restructuring of the California market. In 1996, retail competition was authorized in California. As you can see, obviously, the amount of investment in this area has grown significantly, quite rapidly, and deregulation really was the triggering event. It is only, of course, one market driver, but it started the flow of venture capital to energy technology companies. Now, we peaked at \$1.2 billion in the year 2000. It's dropped somewhat since then, but you will see in the next slide that as a percentage of overall venture capital investing—in fact, the energy sector has grown from less than half percent to two and a half percent. Now, that's still very, very small—okay, *very* small—but it's now big enough to, first of all, be its own category, and to garner the attention of firms like Venture Economics that keep statistics on venture capital.

So, what's the outlook? Over the next twenty-four months, and I'm going to cover each of these points in some detail, we predict sustained market growth. We see success, continued success in early adopter markets. We see favorable public policy globally. We see greater participation by traditional companies. And, increased venture and capital investment in this sector.

So, the market, as I think Professor Kammen has pointed out, for some of these new technologies has been growing substantially. And, I'm going to start first with PV. Actually, in the PV market, over the last decade, or decade-and-a-half, PV has been growing consistently at twenty-five to thirty percent a year, sales of modules or systems. Now you know, fifteen years ago those were small dollars; now we're starting to see some pretty big dollars.

Clean Edge, which is a consulting firm in the Bay Area, and I think these numbers also have been published by some of the other consulting firms like Navigant, predicts that PV will go from \$3.5 billion in sales in last year to \$27 billion in 2012. Pretty significant growth. What's driving that? Well, as we heard in the previous panel, the first cost of some of these technologies can be a real barrier, but the costs are coming down. Through investment by venture capital—and innovation, as well as volume—the price of modules have come down, at least in the last decade, from \$6/watt to \$3/watt, and many of the firms that we are working with have a goal of \$1/watt. Some of the players are big firms. BP, Sharp, Kyocera, RWE is a German utility, and then there are some venture-backed companies; both of these happen to be public—Astra Power and Evergreen.

In wind, we see even substantially greater growth, from \$5.5 billion last year to \$49 billion in ten years. What's driving this? First of all, larger turbines are lowering the cost of projects. In the early eighties when wind really came about in this country in a substantial way, turbine sizes were in the range of 10 kilowatts to 100 kilowatts. Today, what we're talking about are megawatt-sized turbines. The players, again, are a combination of big companies, as well as start-ups, and I think the comment was made today the United States did a lot of the R&D on wind turbine technology, but we've really lost the lead, the lead has gone to Denmark and to Germany.

Fuel cells—as you can see, last year, sales were half a billion dollars. I think that that is an indication of the really early state of the technology development, though there have been significant R&D and investment dollars that have gone into fuel cell

companies. We see the early markets. The costs are coming down. We see the early markets in really stationary applications. And again, a mix of both traditional players, as well as venture-backed companies. In terms of fuel cells, fuel cell-powered cars and hydrogen refueling stations for those cars, we do still think that that's about a decade off.

Success in early-adopter markets—our distributed generation companies, which include fuel cell companies, PV, wind and systems integrators, are showing compelling paybacks today in the following markets. First, powering off-grid requirements, and I mentioned earlier that remote infrastructure is really fueling—not to use a pun—really significant demand for distributed energy, and that is remote offshore—the remote oil pipelines, offshore oil platforms, and telecommunications sites. We're seeing a number of post-9/11 security projects, where they're using distributed energy to power those projects. Those include remote disaster centers. That includes wireless communications networks.

In the grid-connected markets, distributed energy makes economic sense today as backup power for critical operations, and also for projects that involve the sale of pollution-reduction credits.

I talked about favorable public policy trends, and I think it's fair to say global public policy is certainly favoring sustainable energy. And, Japan and the European Union ("EU") are really leading the way. It was mentioned again in the previous panel that it's been a combination of rebates, tax credits, and buying back power at high prices that has fueled a lot of the development of wind and PV in the EU.

We talked about Renewable Portfolio Standards, where it's a mandate that a certain percentage of electricity is generated from renewables. Japan is targeting a three percent renewable energy standard by 2010, and the EU is in aggressively at twenty percent. Interesting, the rationale is economic vitality and job creation first. The other issues, important issues, energy production security, environmental issues come in a close second.

In the United States, stable public policy is really at the greatest at the state level, and maybe even at the city level. Support at the national level has been really tepid at best, and very uneven. The renewable portfolio standard can't underestimate how important that is going to be as a driver for these markets. California has adopted a twenty percent renewable portfolio standard. New York just passed a twenty-five percent renewable portfolio standard.

And, I think Professor Kammen showed that more than a dozen states have these standards, and they work.

There are a number of state renewable energy funds. California, Connecticut, a total of \$4 billion available for both investment in companies, as well as investment in renewable projects. And then, in thirty states, there is the ability to, "net meter" small distributed generation assets.

The incumbents are playing. Before this symposium started this morning, I was talking to the gentleman from Consolidated Edison Development, and making the observation that a lot of the utilities have gotten out of distributed energy investments in international investments, but nonetheless, there still are a lot of traditional companies that are continuing to invest. GE acquired Enron Wind, now the largest U.S. turbine manufacturer. Bechtel and Fluor Daniel are spec'ing in hybrid power systems for remote projects. These are combination PV, wind and diesel. BP Solar is rolling out a program called Home Solutions in the United States and Europe, very interestingly applying commercial mass marketing techniques—advertising and direct mail—to sell solar at the consumer level. Utilities investing broadly in sustainable energy projects, though that has come down somewhat in the last two years, since utilities have not fared well. And then, other players—ABB, Volvo, ChevronTexaco, Shell, etc.

We predict that there will be increased venture capital flowing to the energy sector. The first wave of venture-backed companies now are maturing and beginning to impact the market. These are the success stories. These are the companies that made it out of technology development into market development, and those success stories will further fuel the growth in venture capital investment in energy tech.

And, behind that first wave, there are many, many more venture-backed companies. There are a lot of new entries coming into energy venture capital. It's a mix of some of the big traditional funds, like Kleiner Perkins, Venrock, Sevin Rosen, as well as, at this point, more new funds under formation to specialize investing in energy technology. Also, there are several project finance funds under formation. And specifically, these funds are focused on financing small projects, using distributed energy, new technologies in developing countries.

So, in conclusion, we all know that sustainable energy produces a great societal benefit, but the decisions today to invest in this area are being made for business reasons, not just for policy

reasons, a very fundamental shift over the past five years. There is momentum. You can see markets are growing, even in this environment. Of course, the market is global and we're still in the very early years of this opportunity.

Thank you.

4. U.S. FEDERAL ENERGY POLICY

STEVEN RICHARDS*

I want to thank the staff for all their hard work and preparation. I'm actually appearing in here in lieu of Larisa Dobriensky, who is the Deputy Assistant Secretary for National Energy Policy, and Larisa asked me to substitute for her; she is in Australia at the moment.

We are a new office in National Energy Policy, and she is the Deputy Assistant Secretary. She has been there a few years. I am new to the agency, three weeks on the job. I'm her second employee on that job, and I am the director of a new office called International Energy Market Development, and we are in the stages of formulating some programs and policies that we think address the needs of market development. And, I've been very curious, listening to the presentations, and particularly the last comment about the California regulators contradicting themselves. Just expand that on a global scale, and you have the challenges that governments and the private sector face in addressing sustainable development and melding policies together that formulate a business case. And so that's the focus, essentially, of the Office of Market Development. How can we assist in a way to formulate a business case, to allow the private sector to succeed on a long-term basis? And, we welcome the United Nations. And we welcome World Bank. And we welcome our own agencies in other developed countries, aid agencies in doing that. But ultimately, we're talking about the success of the private sector and the odds of that happening, or the calculus of that happening, are very, very complicated.

Energy security is certainly a phrase that I embrace, and I think it's something that has been well spoken of, not only in terms of

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U.S. policy, but I think international policy. Security is critical, and diversification of energy is fundamental to all success, and we are a world economy, for all intents and purposes, and we need to have strong relationships with our allies and with the developing world in diversifying our energy.

Energy security, in the terms of sustainable development, means environmental-friendly technologies and how we are going to evolve towards that. I had some guests from Germany in the office recently, and we were visiting and they were asking about mandated standards, and that's certainly a good debate about standards. But fundamentally, I think energy security evokes economic security. And, our economy is not as good as it could be, but it's better than the German economy, and it's better than the Japanese economy. And so, those dynamics are critical. In addition to energy policy, we have other objectives, or there are other considerations relative to policy concerns—national security, et cetera. And so there are a lot of dynamics to those issues, and there are a lot of other issues going on that we could talk about.

International cooperation, though, is central to this dynamic. In the National Energy Policy, which came up with about 105 specific recommendations, only a third of those involve international cooperation. In terms of emerging markets and sustainable development, that is international cooperation.

Technology—a question I asked Nancy is one that fascinates me. MIT's Media Lab, Johns Hopkins' labs, all these very highly renowned labs—AT&T's lab—invest a lot of money, and they have a certain model that they incorporate, in terms of their goals and objectives, and some of their goals are just fair, pure science. They don't intend to commercialize, they just want to push the envelope on science, the basic research. But ultimately, that dynamic of how we invest our dollars in technology and how that then gets translated and implemented into a product or service that actually makes a difference in someone's life is an interesting dynamic, a model that we want to be part of, and helpful to, in a way. And so, that's certainly a focus of our policy.

And finally, is that market development? There are a lot of rules and regulations everywhere we go, in everything we do, and we need to try and do all we can to create the right dynamic for companies, or for products to actually be sustained in the market. And for it to grow, and I'll talk about an example or two as we go.

My office—we are in the formative stages of defining who we are. We have some momentum that has propelled us to where we

intend to go, but fundamentally, we want to be strong in private outreach. I've been in the private sector, and to say, "I'm from the government and I'm here to help you," isn't always welcome, I think, or we don't always get what we think we're getting from the government. But fundamentally, we want to be engaged in the debate and in the development of good policies and of good opportunities for the private sector.

Part of that involves advocacy. There are a lot of agencies within the U.S. government, and you don't necessarily think of Energy as advocating commercial interests, but we certainly want to be part of that process. The Department of Energy has a lot of assets to bring to bear, a lot of labs that have technology, and, to the degree that we can advocate certain opportunities we're interested in that.

There is an initiative that has been on the books a couple of years, called The Clean Energy Technology Export Initiative. It doesn't have much behind it. It's not well-defined, but this is a directive that was passed by the Congress and that the administration has embraced, and we will be leading that initiative, in cooperation with other agencies, to try and develop some strategies that will help. The important part here is that it gives us authorization to do some things that haven't been there that our agency hasn't done in the past.

The world summit on sustainable development, which took place at the end of last summer, was a critical point of junction relative to our interest in terms of defining the role of sustainable development and energy. And, fundamental to that is a focus on reducing intensity on a worldwide basis. It's easy to maybe do it in your own backyard, or do it in your own way, but you would hate to do it where you are and then have that intensity simply be transferred to another location. And so, that dynamic of how you effectively help develop reduction in intensity is going to be a focus along that line.

And then, the fourth area is, again, advancing technologies in emerging markets, which I'll hit upon in a moment.

Our outreach will be in helping to develop business strategies. I kind of like this because I don't know that anybody needs help in developing business strategies. There are a lot of smart people out there. Finance is fundamental to that approach, but we want to be, in some way, a catalyst towards helping develop some of those opportunities. And, talk about market drivers, one issue is when you have a product in the market, or you're introducing a product

to the market, there are a lot of considerations relative to capacity-building and regulation and rules and law. I'd be curious as to some of the studies and analysis where some of the photovoltaic or other renewables have been deployed, and the rules and laws in those economies—what is the business model and what is really happening there? Has it taken place? Because they're all interrelated, fundamentally, and that's the key for sustainable development.

In building private, public partnerships—on the public partnership side, really fundamental is the leadership aspect. And, this gets to the infrastructure—the rules, the regulations, the legal and financial regimes. If you're going to build anything, you have to be able to finance it, and financing is fundamental, and so we will be focusing and trying to be, in essence, transactional-centric to a degree, in terms of our models or partnerships that we develop, because financing is fundamental.

Coming out of WSSD⁸ was an initiative on the part of the Bush Administration called "Powering Sustainable Development from Village to Metropolis." Three agencies are involved in this—USAID, EPA, and the Department of Energy ("DOE")—each having their own program that they are developing and will be reaching out and working. There will be coordination among the agencies to try and take advantage of economies of scale, but these are programs that are just now developing, and will be forming into specific initiatives and partnerships. All three have similar goals. One is energy access, energy efficiency and air pollution. That essentially mimics USAID's, DOE's, and EPA's roles, and they all have the objectives of public leadership, private partnership and sustainable finance, again trying to interrelate them in a way that makes for a meaningful and long-term impact.

In addition, we have formed a partnership as a result of WSSD with the APEC Energy Working Group. Australia has retained the leadership of that group, and so, in terms of a strong emphasis from our perspective, we will be focusing on the Asia-Pacific region, which includes all the Pacific Rim on both sides. Mexico and Australia have similar programs, and in fact that's why Ms. Dobriansky isn't here. She's in the process of working on that development. But, if any of you have an interest in the APEC region, certainly there's an opportunity to follow up in this area

⁸ The World Summit on Sustainable Development.

that we will be focusing on, and we will be looking for ideas and partnerships.

Energy market development—I mean, these are some of the goals and objectives of where we want to go. I think it's going to be interesting in the end where we are able to succeed, and how we're able to drive some of those successes—and, in terms of technology and sustainability, and by sustainability, not only how we define energy sustainability, but a perpetuation of opportunity and development. I thought the photovoltaic example, the case that Professor Kammen gave, where it took ten to fifteen years to develop that market, in a sense, is interesting. Hopefully, we can do things in a shorter time, but it takes a lot of time to achieve success in some of these markets.

In conclusion, let me just give you my contact information. Any of you are free to contact me, send an e-mail and I'll be happy to forward to you materials that we're developing, and provide an opportunity for you to get involved in our activities and help in defining kind of our success metrics and in partnerships. I'll welcome any questions you might have. I've only been on the job three weeks, so go easy. Everybody's ready for lunch.

5. THE WORLD BANK'S ENERGY ASSISTANCE PROGRAM

DOMINIQUE LALLEMENT*

Thank you very much for inviting me and being with you today. I truly enjoyed the morning, and it's a great pleasure to be here. I haven't been in Philadelphia I think in about thirty years, really, and the very first time that I came was a short time after I arrived in the United States, and I had bought a car that I didn't quite know how to drive. And, I think it's the only time in my life when I actually went through a whole beltway, because I could never find the exit! Now, as I think of this experience, I feel a little bit guilty, because I was not very energy-efficient.

With this, what I would like to do with you this afternoon is to cover—first, I will cover a few global facts, and then I will try to recite briefly on energy and development objectives, share with you what I see as some of the achievements seen in the field of

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energy development; also some challenges, there is never any achieving where there is not a challenge. I'll brush a quick picture on what the World Bank Group is doing and say a few words on the Global Village Energy Partnership.

At the bottom of the slides I have printed two web page addresses. ESMAP.org—ESMAP is a technical assistance program which is jointly sponsored by the United Nations Development Program, UNDP, and the World Bank—it's managed in the World Bank, but in fact it is co-financed by about fifteen donors, mostly public, mostly Europeans and Canada, and also some private funders. We have three main lines of products in the program. We provide technical assistance to developing countries. We do a few kinds of projects. And, we have a major knowledge dissemination and training responsibility. We publish about forty documents a year, amongst other things, and most of them are available on our web page. So, if you want to consult the web page, or are interested in some of the documents, next week, it should be more user-friendly than it has been in the past. We're trying to improve all the time, but do write us with comments, questions, and ask for the documents if you want a printed copy. The second web page address is the one of the Global Village Energy Partnership and again I invite you to consult it.

This is a picture of the world at night. Maybe some of you have already seen it in previous presentations. I think one of the stronger messages which is on this picture, although it's more focused on electricity, since it's what you can see at night, it also shows that there are enormous disparities in the world between the energy-rich and the energy-poor, and I think one of the major questions that we have to ask ourselves is, are these inequities sustainable?

We have also heard this morning that there are about two to three billion people who do not have access to modern energy, and yet there is a limited correlation between access to modern energy services and natural endowment of primary energy resources. While the majority of the people of the countries who do not have access to modern energy, many of those countries also are well-endowed with primary energy resources. So, one of the questions is, how come those which are well-endowed currently are not making use of these resources for their own development?

Amongst the global questions, I think we have also touched upon this morning the issue of global warming. But, as we reflect on the issue of global warming, and what could be the role of

renewable energy in meeting the challenge of controlling or reducing emissions and global warming, we have also to be concerned with local issues. In fact, you know, for politicians I think it's a very interesting question, because what we have found in our dialogues is that, while there is a concern about global issues, in fact, the politicians are confronted more with local issues. So, you need to find a way of balancing or addressing those.

Amongst the local issues, again, thanks to the presentations this morning, we touched upon the issue of indoor air pollution, and here we said that half of the world relies on traditional biomass, largely fuel and dung for heating and cooking meals. This is extremely important, not only from the human health perspective, as we discussed, but also from a biomass management, as well as biodiversity perspective.

We've also touched upon the gender questions, and I will repeat, as I promised this morning, that indoor air pollution kills more women and children than malaria and tuberculosis combined every year.

In terms of the local issues, I think it's interesting to also think about urban pollution issues, and the poor are more susceptible to air pollution. WHO has done some very interesting work in that area, which also documents the impact of air pollution—urban air pollution on the poor, including the loss in IQ of children. But, what I'm bringing here is the lessons from a project that we developed in Bangladesh, with the drivers of two-stroke engine vehicles, where in fact through this project we gave the drivers some medical tests—for most of them for the very first time in their lives, and what was both very interesting and very poignant is that it was the first time that they actually realized the impact on their own health of the use of their own polluting vehicle. And that was possibly the first time that this sort of correlation was established. And, in terms of the property paradigm, I said that's very important, because we found out that those people were really living at the very extreme level of poverty because of increased illness due to pollution, and they are losing about one-third of their work capacity every month, which puts them further and further into poverty. An interesting aspect of this is that once we shared those results with the Government of Bangladesh, they also revisited their legislation on fuels, on lubricants in particular, to prevent the adulteration of some fuels on the market.

Some work which we've also been associated with is some work initiated in Latin America, but which we have now carried

out in Asia, Central Asia, and also in Africa, to eliminate lead from gasoline. I could not find the slide that I wanted to show you, that's why it is blank. I have a nice bank of slides with me, and I couldn't find it, but I wanted to show you a picture of the world illustrating the amount of market restructuring initiatives going on around the world. And again, it was highlighted in the presentation by Ms. Floyd this morning, and we did the study in about 116 countries to see what was happening with the various energy sector policies and energy market restructuring. It was really quite interesting. We did that about three years ago, and at the time, there was still the sense that there was a major, major movement around the world for market restructuring, and at the time, out of the 116 countries surveyed, there were no more than twelve where you could have said that there was an evolving market structure in place, including having the appropriate legal and regulatory framework, having competent institutions, having substantial participation from the private sector. And this is only in developing countries. What was also interesting was that Latin America, and, to some extent, Asia, shared the twelve countries, but Africa had virtually no movement towards market restructuring at the time. Only a few had some of the criteria met. And again, the report on this is available on the ESMAP database. However, today, we're in the process of updating this because what we are going to probably see is that there is a quasi-regression in some parts of the world, in Eastern Europe and Central Asia, market restructuring is progressing very, very slowly. At times, some of the utilities which had been privatized are being returned to the public sector, because the private owners cannot operate. However, in Africa, there is quite a bit of evolution in the development of energy markets and a very substantial build-up of institutions. And, that's important when we think about both the needs for investments, but also the opportunities for investors.

In terms of the development issues, I think it's very critical to keep in mind the correlation between the development of energy services and human development, as well as the correlation between energy and growth. And certainly, in the World Bank Group, we are convinced that we cannot have economic growth, if we don't have efficient and sustainable energy services available, we cannot have poverty reduction, if we do not have economic growth. So, it's important to keep these correlations in mind.

Many of you have heard about the Millennium Development Goals, which were established by the international community and developing countries, and which were reiterated during the World Summit on Sustainable Development. An interesting feature of the Millennium Development Goals ("MDG") is that energy is not registered, *per se*, as an MDG, but the question that we can pose is, *does it matter?* And, in a way, we have come to the conclusion that it does not necessarily matter, as long as it is understood that energy is the hidden multiplier to achieve the other development goals. Which leads me to make the point that it is important to focus on the interrelationships between energy and the productive sectors, be they agriculture or industrial, or industry enterprises, but also between energy and health, energy and education, and so on.

In terms of the opportunities, I think that one of the greatest opportunities to develop and where there is a very, very strong demand, and it is estimated that the bulk of this demand over the next twenty years is going to be in developing countries; however, the investment needs to meet the demand are enormous, and certainly, if we wanted to see a substantial difference in the availability of the services, we would have to find a way for these services to become available at a much higher rate than they currently are. Just to take the example of electricity today. It is estimated by the World Energy Council that there are about forty million people a year who benefit from new connections, while about a hundred million people should be connected a year, if you wanted to make the difference. Otherwise, at the current rate, we will have another 450 million of energy-poor which will be added. As I mentioned this morning, there was also the issue of where are the energy-poor between the rural and the urban areas, and the increasing trends on urbanization where sixty percent of the population in the urban areas will be below the poverty level.

Understanding demand for energy services is critical, and it's important to understand demand, so that we understand whether we are talking about household needs, or demand for household services, or for community needs, such as health, education, but also street lighting, for example, or whether we are talking of the demand to meet the economically productive needs or uses.

Opportunities – as we've already heard this morning, there are many technological options, including all sorts of technologies – fossil fuels, renewables, minigrids, hybrid systems. It is important to keep scale in mind, because I think at present there is almost a

line on developing, where there are the crowds of the “small is beautiful,” but when we look at numbers, I think we really need to challenge ourselves, to see whether the small solutions will be sufficient to really meet the scale of the needs at the speed at which they are needed. So, I personally am convinced that we need again to let the market allow for a very wide range of options, small and big, to emerge.

I think the whole debate about hydropower is coming again to the fore. I think it's a very substantial renewable energy, and most of you will be familiar with the outcomes of the World Commission, and, in terms of outcome, I think it has made a number of investors very concerned that these would be extremely risky and costly investments. I mean, for example, there is a project under development in East Asia, in Laos, called the Nam Theun Project, which has already been under development for eight years, and it's not yet concluded. On the other hand, Africa, for example, which has enormous hydro resources, and enormous unsatisfied demand, only has about five percent of these hydro resources developed. So, there are tremendous opportunities of various possibilities.

I think the important thing is that when these possible investments are considered, that they be looked at in an environmentally and socially responsible fashion.

I would also like to mention the opportunity for regional interconnections and not only for grid electricity, but also for gas development in particular, and all the gas-to-power potential.

Opportunities in terms of the cost reductions—and I think unfortunately, this slide—I have not had the time to update it into 2002—but I think it's really remarkable to see how the cost of photovoltaic and wind, in particular, has gone down over the past twenty years, and I am convinced that it will keep going down, as the market expands.

In terms of the energy poverty reduction paradigm, let us not forget the role for hydrocarbon products. And, I say this because, for the poor, you know, diesel remains one very important source of power, and decentralized power, in many rural areas. But also, a large potential for LPG. Diesel is also very important for transport. Of course, there are biofuels also which are emerging in the market, but the economics are not yet, I would say, systematically documented and they tend also to have a local component that makes international comparisons more difficult.

In terms of institutional opportunities, I think what's important to highlight is that we generally moved in the energy sector from having monolithic providers of public services to decentralized customer-oriented service businesses, and I think that also is interesting because it gives room for many more actors in the market to play the role. So, we are seeing all sorts of new business models emerging with the lesser number of integrated monopolies and more independent power producers. We're seeing a large number of entities developing from large to small. We're also seeing more competition amongst providers, other solutions, as concessions.

And lastly, I want to stress the point on manufacturing for appliances, because I think we tend to forget that, when in fact you can't have uses of various power systems, if you don't have affordable appliances on the other hand. New opportunities, in terms of partnerships, that was also mentioned this morning, in particular public-private partnerships, and the importance of building up these partnerships between central governments, local governments, non-governmental organizations, financial intermediaries of all kind, local or international, but also local communities, and let's not forget the customers, the energy users.

These are mixed opportunities in the sense that, again as it was mentioned but I want to stress this, we have found that the poor do pay a very high price for energy services. We often argue that there is an unwillingness to pay, and this is not correct at all. Unfortunately, the poor often pay up to one-third of their disposable cash income to purchase energy services of rather poor quality. And, there are huge margins, as well, to begin, you know, when you pay the equivalent of 35-45 cents/kilowatthour or more, you know, through poor energy, batteries and the night candles, kerosene and the like, there are technologies today that can lower this cost.

New financing options—we touched upon the question of subsidies but there is a very big debate around subsidies, and I think today there is a sense that there are certainly a lot of subsidies. I think in the United States you often say that you would not have been able to have the rate of rural electrification that you have had, had there been less subsidy provided by the government for rural electrification. I would say one of the major differences between the experience of today's industrialized countries at the time of those rural electrification programs and what's happening in developing countries is that the fiscal base of

developing countries is much lower today than it was in today's industrialized countries at the time that you were providing subsidies for these programs. However, as we want to encourage the private sector to move in, there are elements of subsidization that are necessary. And, in particular, there are subsidies necessary for institutional development, for capacity-building, for knowledge transfer, but eventually, in the delivery of the services to kick-start the market, one can look at various subsidy schemes.

Subsidies are not only for lighting or power services, but they can also be for liquid petroleum gas ("LPG"), and that has a very interesting dimension, when we make a relationship with the environmental issues, as LPG is at times, you know, a cheaper fuel than wood or charcoal in the poorer urban areas, but also increasingly in the rural areas. And, in some parts of Africa, I have been struck how the penetration of LPG has enabled the development of small enterprises—you know, LPG-based refrigerators give rise to small product transformation industries, like cheese—see my French background, right—like cheese processing and cold water and things like that.

I think it is also interesting to think that today we are seeing a larger number of rural electrification firms being set up in which governments contribute, but also local entrepreneurs, or at times foundations; the bilateral or international financing community is trying to support these efforts. One of the critical things for these is that they be managed in a transparent way with good governance. There are also models of concessions which bid on minimum subsidies, and we are also working on the development of new guarantee instruments, which will enable more private investors and financial intermediaries to come out.

There are always challenges, and I think we currently are in a period of power market troubles, for one, and I think that's no news to everyone here, but certainly, starting with the East Asia crisis, compounded with the crisis in some Eastern European countries and Latin America, and reiterated again with what has happened in Argentina, the markets are currently pretty cold as far as investing in developing countries. And that's an enormous challenge, because the investment and financing needs are still there and very present; however, we are finding fewer and fewer investors who are willing to move in. So that one of the things that we need to really think about is how to finance high-risk/high-reward projects, but also how to assess risks and how the risk can be distributed amongst a large number of stakeholders.

We also have to look into instruments to modernize the domestic financial resources, which we have found out are often available, but are not directed towards the energy sector; they are directed more easily towards the agricultural sector, or towards commerce, basically. So, we see that even for the near future, it is going to continue to be a difficult road to attract private capital for emerging economies, and particularly for the least developed developing countries.

Part of the question that investors often ask, and you are lawyers and I am not, is what is the legal and regulatory framework in the countries? And, I think that is where there is still a lot of work to do. I know that several of you will graduate soon, so it may be that's a field that will attract you.

What does the World Bank Group propose to do? I think the challenge that all of us have, and it's not only for the World Bank, but also for all the stakeholders, is to be able to increase the delivery of energy services, enabling the market to build alliances amongst various institutions, to develop the proper financing mechanisms, to have efficient markets, and to let all sorts of technological options come out.

The World Bank has a business strategy which is anchored in four areas: those activities which will have a direct impact on poverty reduction, those which will help the macro and fiscal stabilization of economies, those which assist with the development of government and private sector participation, and those which have a direct impact on environmental and social sustainability.

The World Bank is a group of various institutions, in addition to what we call the World Bank, which has also a sub-branch called IDA, which provides concession loans. We have an International Finance Corporation and our guarantee branch. I will not go into—I'm going to try to pass rather quickly on the next slides, except that they are set up in a fairly slow way, so that we can show you some slides about the volume of our activities.

This gives you a sense of the volume of activities that we have, in terms of the numbers of projects. To the right hand side of the screen, we have the current portfolio, which is close to \$4 billion, and that represents a significant decline, if you compare the early part of the eighties—of the nineties, and what has happened in more recent years, since 1997. Again, I think this is the result of what has happened in East Asia, in particular, but also the difficulties that we have experienced with the development of

energy markets. Now, today, we are seeing an increase in the number of projects, in particular as we want to do more activities focused on those which will have a direct impact on poverty reduction. These give you an idea of the volume of projects, which include a reform component. Again, I think we are at the stage that more recently it has been more difficult to continue lending for these kinds of activities. In the mid-nineties many of our works had major privatization components, and, because of the difficulty of attracting private sectors, we've moved away from that.

One of the challenges for us when we provide policy advice is to provide advice on integrated energy policies, so that we move away from working in silos in electricity, gas, biomass, and the like, and then we can have multiple technologies, multiple sector applications, multiple stakeholders involved and institutional mechanisms.

There is quite a bit of work done on what is the new role that the private sector should play, in view of the fact that the private sector is not very active. There continue to be issues of human resource development, in particular in the areas of legal framework, policy formulation and the like, and a special sub-need of that is to attract more women in the energy professions. That's critical for developing countries.

I think it's important as well that we see in developing countries the mobilization of politicians, but it's not something that the World Bank can do directly; however, we do try to help governments who want, for example, to work through our World Bank Institute in the training of parliamentarians, which is a very important element. I won't go over the various instruments of the World Bank. You can see that on our Web site.

We have an increasing number of activities which integrate environmental considerations. Our renewable energy portfolio is also growing, and I would say growing quite fast. What we have found, in terms of renewable energy, is that these are difficult operations, with a very high transaction cost very often, and also a very high upfront cost. But these are also high-risk/high-reward activities, when you take into account the social and environmental benefits. What's interesting is that in the field of regulatory frameworks, I think there is not enough of the body of work and experience on what sort of regulatory frameworks do you need for renewable energy, or for distributed energy as well?

We are also active in the oil and gas sectors. We launched an initiative with Norway on reducing gas, but we are also doing a lot of work on revenue management and governance.

I mentioned hydropower. Our hydropower portfolio has gone down considerably, again following the whole controversy with large dams, but it will be interesting to see, five years from now, whether it has picked up.

A few words now – and I probably have a minute and twenty seconds – on the Global Village Energy Partnership, which is an initiative which was launched officially at the WSSD. It was the outcome of discussions that we had during Village Power Conference 2000, at which people were very frustrated that a lot of the efforts did not seem to have the sort of big bang that one would want to have. And, we came to the conclusion that perhaps one of the problems was that there were lots of scattered experiences, but people were not putting their efforts together, the knowledge was not passing from one set of experiences to another, and, therefore, what could we do so that, you know, ten years from now we would have a large number of countries with national scale energy poverty reduction programs, so that we could double, essentially, the number of people who today benefit every year from the incremental delivery of modern energy services, so that we would have at least 50,000 new communities which are equipped with modern energy services, so that we could have a large body of competent entrepreneurs.

The partnership involves public, private, non-governmental organizations, financial intermediaries, UN organizations, and so on, and the partners are bringing not only their demand, or their country action plans for developing country partners, but also their knowledge, their portfolio of investments and activities, and their financial resources. The partnership will provide five types of services, because, again, you know, if we want investors, the investors need to know the legal regulatory framework, they need to know the rules of the game, they need to know what are the objectives. We also provide some knowledge services, some enterprise development services, fronting facilitation in order to train the financial intermediaries to the energy business and help tap some of the local financial resources, but also results and impact monitoring. And, this is very critical. At WSSD, I think there was a major call to the international community that all of us have to be publicly accountable for everything that we do, large or

small and, therefore, we need to have ways of measuring those results, and we have to be willing to share those results.

So, in conclusion, I would say that the challenge of meeting energy services is enormous and is not just about solar home systems. I think—just to try to make the loop with the first presentation this morning—it's a tremendous opportunity, and it's an opportunity for the poor. And, I think that the poor themselves can be part of the solution. This is the experience that we have had in Bangladesh, with very, very poor women, who have been trained in making maps, assembling some electronic components and so on, although most of them don't have more than three years of primary education. But today, they are getting ready to bid for a major procurement under a World Bank financed project. So, I think that when you give people the opportunity to know and learn, they also contribute to the solutions. Thank you.

6. SUPPORTING ENERGY FOR SUSTAINABLE DEVELOPMENT IN CHINA

ROGER RAUFER*

Thank you very much. I started off this morning by saying I was very happy to be back at Penn. It always is wonderful to come back. I always enjoy it very much.

As I mentioned, I work with the UNDESA—DESA is part of the Secretariat. And, I started most of my work in the UN, I've worked in a number of countries in South America and elsewhere, but most of my work has been in China over the last couple of years. And so, when we're talking about trying to get energy for sustainable development, that's obviously a major thing in China. China, as you know, is a very, very large coal user, seventy-five percent of its primary energy is coal-based. They're already importing oil because of the growth of the transportation sector. So, the question about energy in China—they also have very high levels of pollution. I mentioned earlier about the five percent sulfur in Guiyang. I have to be a little bit careful, someone caught me at the break here and asked me about that. It's now illegal to burn five percent sulfur coal in China; three percent is now the

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level that they're allowed. But unfortunately, that's, as I mentioned, a very poor province, and they have shut down the high sulfur coal mines, most of them very small, but many of them still operating illegally. And one of the points I'm going to make later on is about the whole institutional infrastructure, being able to carry out the laws, for example, that you do make. So that's always an important issue.

In terms of supporting energy, what I'd like to do is talk about three different mechanisms and then talk about specifically how we might pull this all together in China. And the first thing is, as you were saying, a Clean Development Mechanism. The Clean Development Mechanism, as you know, is part of the Kyoto Protocol—it's the part of the Kyoto Protocol that's aimed at developing countries—again, not the ones that are going to take a carbon hit, but basically countries that can do projects. The second question is about the renewable mandates, and you heard about that earlier today, RPS, the Renewable Portfolio Standard, and as a renewable mandate are price supports. And then, we also have a concession idea which we've been studying. So, those are the three topics I want to work through and then we'll try and pull them together at the end.

I'm an old environmental engineer who worked on air pollution issues here in the United States for many, many years, before I did anything in terms of working abroad, and I like to think about the world in a couple of different ways and then see how this has evolved. And, the first one is to think about the world like an engineer thinks about the world. And, if you think about the world like an engineer, you think in terms of little black boxes—you've got inputs and you've got outputs—and it can be a process, or a boiler, or a refinery, or a motor in your car, or whatever. You think about the world like that. And so, if you want to control pollution, you either worry about the output, or the input, or the black box itself, or sometimes we link them to what we call performance standards. We do that for power plants. We had a new source performance standard that said you could put out 1.2 pounds of sulfur dioxide per million BTU of heat input. So, this is the engineering view of the world, and it's a really, really hardcore engineer view. You say, look, you use all the best available technology and then whatever happens to the environment, that's what happens. As long as you use good technology, whatever happens, happens.

We didn't quite buy into that in the 1960s, although some people in the past, like in Britain, have done that. They had something called best practicable means, and if you did that, then whatever happened to the environment, that's what happened. Well, in the sixties, we didn't buy into that, and so we set up a different idea, in which we said we would set goals based on what's going on in the environment; we want to breathe healthy air, pure air, that doesn't have much pollution in it. So, we would set ambient standards about what's going on out there in the environment, and then we would use this engineering technology to help us achieve those particular goals. And so, the linkage is physical modeling. We do that through doing air ambient dispersion modeling. You know, we have computer programs into which you put all these stack heights, and the emissions, and the temperatures, and the biometric flow rates, and they link what's going on in the power plant with what's happening outside in the ambient air. And this is the way I grew up; this is what we learned when we did all of our air pollution engineering in the sixties and the seventies.

Now, that's an engineer's view of the world. What does an economist think about the world? Well, here's an economic view of the world. Economists say, "Well, it's pretty obvious that you want the point of your marginal costs, so you can reap your marginal benefits. And, all that stuff you were talking about, about healthy clean air, and making sure that there is no acid rain damage and crop damage and forests and things like that, and people who are doing all those kinds of environmental things, well, we can stick those in those two curves." Okay. Well, actually it's the marginal benefit curve. The marginal cost curve is what it's going to cost us to control the pollution; the benefits are what we get from doing that. So, we want to be at marginal cost equals marginal benefits. But we have a bit of a problem here, because there's no invisible hand that is going to take us to marginal cost equals marginal benefits. In fact, it takes a government to get us there.

Now, the economists have come up with two different ways of getting us there. One of them is to come in on the price side and set a tax on the pollution. This goes back to Arthur Pigou, a professor at Cambridge University in 1920 in the UK; he said, "Tax the pollution." What happens if you tax the pollution? Well, if you set it at the point where marginal cost equals marginal benefits, then all the people who have low marginal costs will put

on pollution controls because they don't want to pay a tax, and all the people who are above that point pay the tax because it's cheaper to pay the tax than it is to control the pollution, and you end up right at the point where marginal cost equals marginal benefits. Very simple, very elegant, very rational idea. So, you would think in 1921, everybody around the world would implement Pigouvian taxation. Correct? Well, it didn't quite happen that way.

But in the 1960s, we had a new idea, which said that we ought to be able to limit the quantity of pollution and, if we divide that up into little segments and sold it in a marketplace, then people could buy and sell, they could sell to each other. There's a quantity limit on the pollution and, if you want to emit pollution, go ahead and emit the pollution, but you've got to have a license, or a little sticker, or something that says you're allowed to do that. And, you can buy those in the market. The problem is that when the market starts off, because everybody's polluting, maybe there's a 100 units of pollution, but maybe there's only forty stickers. So, what happens to the price? Well, it goes up and up and up and up. And, as the price goes up and up and up, because there's only forty stickers out there and there's 100 people wanting them. Then the people with the low marginal costs start to control and the people who end up buying the stickers (the licenses) have the high cost of control. So, it's a very different world view now. This is a totally different world view than the engineer, who says we can do everything by setting goals based on economics—marginal cost, marginal benefits—but we've got a price mechanism and a quantity mechanism.

We like these ideas that the economists tell us because they have certain characteristics that are kind of interesting. And, one of them is that it gets the governments telling you to stick something on the back end of that power plant or go in and put a scrubber or something on it. The government is in there tweaking every valve—governments don't know how to turn valves. We don't know that kind of stuff. What you want government to worry about is the total quantity or something like that. You want them setting one of those kinds of goals, as opposed to getting in there and changing the stack-by-stack needs.

The efficiency means we can do the same thing for less. It's cheaper to do it. It's efficient. It's economically efficient to do it that way. That efficiency can actually help us set goals. Ideally, in a situation like that the economists want us to set marginal cost

equals marginal benefits, but let me tell you, we don't know that. So, what happens is we set them by political finagling and political wrangling and fighting; and, if we're doing things efficiently, this lets us be a lot more aggressive in what we're trying to do.

And then finally, one of the most important ones is that, if you're dealing with taxes or market systems, every single bit of pollution you cause is going to cost you money. Under that engineering approach, you do the black box, and you do what the government says, and what does the government do? The government walks away. You've done what you had to do. But, that doesn't mean you try to reduce your pollution. You already did what they wanted. But now, under this economic kind of thinking, every little bit of pollution costs you money.

Now, let's step back a second here. And, a very interesting thing has evolved in this kind of thinking and that is that, not surprisingly, we have a very big European-versus-American shift here, and the Europeans historically have gone towards price-based kind of thinking, and the Americans have gone towards quantity-based kind of thinking. These kinds of ideas of pollution markets and things are very much an American—I mean, they came from Canada, Professor Dales,⁹ at the University of Toronto—but basically this is American kind of thinking. You have markets, you have emissions brokers, things like that. On the price side, this is where the government collects the taxes and then, hopefully, does some good things with it. But it's very much a price-based kind of thing. So—very, very different.

Now, China tends to be much more like Europe, much more price-comfortable than that. But what's happened is a couple of interesting things. One of them is that in the United States, we started thinking about the way economists thought about the world, but we did it by keeping everything about our engineering thinking. We said, "Hey, here's the engineering world view. We're going to keep our goals. We're going to keep our black boxes. We're going to keep everything, but if you can figure out a better way to do it, then we're going to let you figure out your own way of doing it, and you can do that. It has to meet all the requirements basically of the black boxes, but if you can figure out a way to do it cheaper, we'll let you do it, and you can do that by trading these things called emission reduction credits." So, back in

⁹ Professor John H. Dales; *see, e.g.*, John Dales, *POLLUTION, PROPERTY AND PRICES* (1968).

the early 1970s—excuse me, mid-1970s—we introduced these ideas of emissions trading. And, these emission reduction credits were the very first kinds of things that could be traded. They had to meet the same kind of requirements of all the engineering stuff, but they could be surplus as well.

Now, I got my start—I was actually, in 1980, an emissions broker. I set up one of the very first emissions brokerages in the United States. I got EPA funding to set up a brokerage in Chicago, Illinois, and I lasted in business about six months. I burned through all my money. I had essentially no clients. Everybody—and for the same reason—would look at me and they would say, “What the hell are you talking about? Buying and selling pollution? That’s most bizarre idea I ever heard in my entire life. Absolutely crazy.”

Well, interestingly, that—the failure of my brokerage—is what brought me to Penn. I came to Penn because I wanted to figure out why aren’t these markets working? I’ve got to figure out what the hell is going on with these markets? So, I decided if I’m going to go to a school and I want to learn about using economics, I’ve got to come to Penn. So, that’s how I ended up here. And I got the EPA to fund all my dissertation work which is in this area.

In 1990, we had the Acid Rain Control Program. This was the first time that we actually introduced those quantity-based limits. We were worried about sulfur dioxide. So we had localized SO₂, we kept all of our engineering stuff, we kept our emissions trading provisions, but now we added a new one for total loading of SO₂. And, this was the first time we introduced a new economic instrument, emission allowances. So now, we not only could trade emission credits, but now these were emission allowances. This was a nationwide market only for electric utilities, because we were worried about the total loading of SO₂.

A couple of years later, our acid rain market was working so well that we decided to do it with ozone, too. But now, we had different markets. Instead of having a total nationwide market, we had city markets. And so, we introduced city markets, like in the northeast, and also regional markets. We had a northeast budget for nitrogen oxides. We had Los Angeles Reclean Program, which is the regional air incentive market. We had Illinois—the Chicago area had a market. So, we were introducing different kinds of pollutant allowances. We went from this engineering view, to a sort of tweak in the engineering view, to introducing the quantity-based thing in acid rain, to now introducing it for ozone. And

these, by the way, are only summertime markets. We don't operate them all year. Ozone is a problem in the summer, so we only operate the markets in the summertime. We also expanded it beyond power plants to include some major refineries and major industrial sources.

Well, why are we talking about all of this? The reason is, of course, that we are now worried about global warming, and the United States, before the Kyoto Protocol, said, "Well, the only way we're going to play the game is if you introduce market-based thinking." And, it's interesting that we now have these price-versus-quantity debates not in obscure technical journals about environmental economics, but in *Foreign Affairs*. That's where you had the price-versus-quantity debate. That's occurring in the major international journals. So, this is where we had that kind of a debate, and we ended up with the Kyoto Protocol which has three quantity-based flexibility mechanisms, as we call them. Joint Implementation ("JI"), which has emission reduction units, is only between the countries basically that are taking the hit so this is really particularly good. JI is good for countries like those in Eastern Europe, Hungary, Bulgaria, that want to sell credits by improving their infrastructure to countries perhaps like Japan or Germany, Holland. We have the Clean Development Mechanism ("CDM"), which I'm going to spend more time talking about today. And then, International Emissions Trading, which is more of a budget scheme. Again, the assigned amount units are only for the countries that are taking the carbon hit, not a country like China. China is only affected by the CDM.

If I laid out the Kyoto Protocol in the same kind of framework I just did before, we have all the regular technology and we're going to make various kinds of improvements, like JI. (I'm with UN, we love alphabet soup kind of things—JI, CDM, and these wonderful ones, like LULUCF, you know, Land Use, Land Use Changes and Forestry. We have all these acronyms about everything.) But the bottom line is that we have these different kinds of instruments that can be sold, bought and sold. So, if you're a country like China, and you do a CDM, you make an improvement somehow off of the baseline, and the arguments about baseline in CDM are critical, then we end up having a CER (certified emissions reduction) that we can sell in an international market. And that means that we can pay for projects in China. So, that's obviously potentially a major important point.

Now the CDM—what is the role of CDM? The developing world desperately, desperately, desperately needs funds for environmental infrastructure. And, if you look at the energy assessment, all these numbers are kind of flaky, but basically, the one number that they have is \$130 billion per year for sustainable development only in developing countries—that's just developing countries.

The CDM market is about—well, I put the number of up there, \$10 billion per year. That's a meaningless number as well, because it's a pre-Bonn number. And what had happened in Bonn? That was basically where the United States walked. Okay. The United States *would* be a major driver in this market. We *would* be buying credits. If we're not in there buying credits, then what happens to the price of credits? Down! So, that number is dramatically lower now than \$10 billion per year. Some of those estimates—another interesting point, though, is that they said—or some of the technical analyses said that, at that point when they were analyzing the CDM/potential CDM market, China could walk away with sixty percent of that market. Sixty percent of that whole market could be one country. What's particularly interesting, some people were so annoyed at that they said, "Well CDM doesn't mean *clean* development mechanism, it stands for the *China* development mechanism."

But CDM introduces the right kind of projects and we need it basically as a project-oriented kind of thing; so it's voluntary, completely voluntary, and voluntary in the context of China. China can do CDM or not do CDM. It doesn't have to on a project-specific basis. If China doesn't like a specific CDM project proposed, it will just not allow it to occur. Or, they can build the project, but not sell credits for it. It accomplishes greenhouse gas reductions and meets sustainable development criteria, and that's a very important "and" because if you look at JI, if you look at International Emissions Trading, if you look at all those kinds of things, they have nothing whatsoever to do with sustainable development. But CDM does. To do it, to do a CDM transaction, you have to not only get that carbon reduction, but you also have to make sure that you meet sustainable development criteria. And, who sets those criteria? The countries do. It's China's definition of what's sustainable development. That's how they do it. So, its country—the host country—gets to set those criteria.

And, from my point of view, one of the most powerful, powerful things is that this is a project-oriented kind of program

that introduces increased standards of accounting. What we're doing here is we're introducing market mechanisms on a project-specific basis into countries that often don't have it in institutional infrastructure—things like environmental regulations, or enforcement of environmental regulations. But now, who's enforcing this? Who's looking at the carbon count? These are instruments that are being sold on international markets. And so, there are accountability and transparency requirements that would be radically different for China's energy projects, radically different. We could spend a whole afternoon here talking about what's called—again, another acronym—DOE, Designated Operational Entities, which is UN-speak for the auditors, the guys who are going to go in and make sure these things work or make sure that if you claim carbon credits, you have carbon credits. Make sure this project is built right. Make sure this project does what it says it's going to, because those projects could be offsetting, in effect, carbon from Holland or Japan or somewhere else. So, they have to meet international standards.

There's a whole bunch of CDM projects currently being funded by the international community. World Bank is in there with power, energy efficiency, and renewable energy projects by Asian Development Bank, transportation and carbon sequestering by Canada conservation, UN.

The group within China that handles this, SDPC, the State Development Planning Commission—that's one of the big power groups, or one of the big major institutional infrastructures in China—is going to set up a coordinating council that works within SDPC but has access to all the other agencies. They're going to review all the overall policies. Then they have a Project Approval Council and there's a whole series of things that have to happen. This is only being developed right now in China, but when they review it, and how it gets reviewed and all those kinds of things—and then, all the way down at the very bottom, we start on the international processes—this is just to get the thing through China. Okay? So, it's a very complicated, complex process. And, let me go back to it.

So, this question about CDM is only one of the three mechanisms—I was saying that we might be able to support this. I personally don't think right now the price of carbon—we talked about the Carbon Prototype Fund and things like that—the Prototype Carbon Fund, I mean—those numbers are very, very high. They're talking about approximately \$5.00/ton of CO₂.

Right now, so far to the Executive Board, there have been thirty-four projects I believe that have been submitted already as CDM projects around the world. Thirty-one of those basically are selling their carbon to one of two sources, the Carbon Fund, the World Bank's Prototype Carbon Fund, and the Dutch government. Those are the two buyers. Those two buyers are paying about \$5.00/ton. There's some project-specific things, but basically, you're talking \$5.00/ton. If you go to the international market, this stuff's anywhere between sixty cents and \$3.00/ton, more towards the 60 cents end than the three dollars.

These numbers are not going to generate much. I mean, let's be very frank. This is not a big income stream going into these kinds of projects. I think what's happening though (and I think this is very, very important) is we're laying means. Think about it—the first CDM can start right now, but the first commitment period for the Protocol is 2008-2012. We are now essentially laying the institutional groundwork for the first commitment, but in these countries, to be able to get them thinking in this way. This is a major step for China even to allow this because they have been very worried that anything that quantifies carbon would, somewhere down the line, lead to them having to perhaps take a hit. I mean, it's been a long haul to get them to this point, to even accept it.

Ultimately, we've got to get the U.S. in. The U.S. is the main driver. It has to be. And so, right now, we're laying the groundwork for those kinds of transactions. I don't expect to see a lot of CDM money tomorrow. I don't expect to see a lot of CDM money, quite frankly, in the first commitment period. But eventually, the United States will be a player, and, eventually, those prices are going to go up. We're playing a long-term game here. We're talking decades. We're talking about changing the energy infrastructure of countries. So, this is the long haul. We're not going to get something tomorrow.

The second component: should governments even support this? And there are a lot of reasons. You can see about the externalities, essentially, of conventional technology. All the cities are much polluted because they don't have good environmental laws. We don't take that into account, and there is a whole series of reasons why we're willing to do this kind of stuff—good technology, job creation, power system resiliency and other kinds of things like that. And here again, it's very interesting because, in the renewable energy, we're seeing the same debate that we saw

on the pollution control side—price-versus-quantity once more. Only this is an interest, and you can understand why, we're trying to use economic instruments in an area that's regulated where the market doesn't really work. People pollute because it's free to pollute, so they pollute. When we start putting constraints on them, when we introduce these sorts of foreign economic ideas, if you will, we're doing the same kind of thing with renewable energy—people don't buy renewable energy because it's too expensive. Okay. So, what we're saying with an RPS is, instead of having like a pollution constraint, where we would say, "Here's the amount of pollution. We're going to bring it down," and then we'll let people trade to reach that level. In RPS, we're building it up. We're saying we don't have enough renewables, we want more for these reasons—or for the previous slide's reasons—and now, if you say you want 10% energy that's renewable, some people will do eleven, some people will do nine, and they can trade to get to the point where you get the exact amount.

What's happened is that the Spanish, the Danish and the Germans—the one, two, three power guys, basically, on wind turbines—all went with price supports. The U.S. went with RPS and quantity supports. You can have a quantity support without trading. You can make everybody meet their quantity limit, but it's very inefficient to do that when you can accomplish the same thing with renewable energy credit trading, just like ERC trading. We have these instruments we can use and buy and sell. Texas was extremely successful. They put in an RPS with trading, they got 915 megawatts in 2001 which is more than the entire United States in any previous year. So, we know from the experience. You heard this morning about Germany and Spain; we know that price supports work. We also now have shown that quantity supports can work. So, we have this same price-versus-quantity debate. We can do it voluntarily, as I said, with green power. In Europe, they have green labels and various kinds of trading schemes that were all based on voluntary—but, the numbers are very low. Out of green power, you can see, we're getting about one percent market share. People are talking ten percent and twenty percent market share, so you're going to have to mandate that.

In Europe, they have targets (which is a quantity-based approach) and originally they tried to make them mandatory, but now they're targets. They're looking for twenty-two percent by 2010, and they have different certifications to make sure these are

real. What's interesting in Europe is that they had success, or I guess we could call it success, when they went from price to quantity. I mentioned there was a distinction between Europe—I used to go lecture in Europe in the eighties and I would talk about emission brokers and buying and selling pollution, and they didn't like it any more than my original audience did, when I was in the United States as a broker. They said, "Well, that's such a horrible thing to do, selling pollution, and we are never going to do that in Europe." And of course, now, they are. I mean, they're doing it as part of the Kyoto Protocol, and they're the ones who are now setting up trading schemes in all these various European countries. So, Denmark has them, and the UK has them.

Basically, they've made a very successful transition from price to quantity in the pollution control side. On the energy side, they are nowhere near as successful. They have a lot of good price supports in Germany, and now they have very powerful wind turbine industries in those countries. When Denmark tried to turn the switch off of the supports and go to a market quantity-based scheme, boy, there was so much screaming, you wouldn't believe! And, it's happened in other countries as well. So, they're having a much more difficult time making that transition to a quantity-based scheme.

And they have both. You can see that there is a feed-in, there's the price-based, and the obligation plus transferable green credits is the quantity. So, we have this kind of debate happening. Most people think that because of the EU's liberalization on the energy market, they will move towards RPS plus trading, the obligation plus trading schemes, probably as a European market, instead of country-by-country. And they'll probably do that sometime after 2010, particularly as some of these other markets, like carbon markets, get more involved.

A couple of interesting points, obviously, about these schemes is that we can separate the electricity from its environmental characteristics and we can sell them in two different markets. So, we can sell the electricity locally, and now we can sell the environmental aspects potentially in international markets, if we want to.

And, one of the fascinating things, I think, is you can bundle or unbundle the carbon. Now, when you're putting in a renewable energy credit, why are you doing that credit? Well, you want renewable. Well, why do you want renewable? Well, you can argue, if you're China, that "I want renewable to get rid of coal,"

that "I want to improve the air quality of my city," or that "I want a more diverse power system." Well, do I worry about global warming, if I'm China? Probably not. So, what they could do is unbundle the carbon, sell that in international markets, and then they now have an extra income stream, over and above the portfolio standard income from the trading credits. So, this is a possible thing that they—I would suspect that China, for example—would unbundle the carbon. In the United States, we don't allow that in most schemes. Texas, for example, is bundled and it's always kept apart, and most European systems will be bundled soon. But for developing countries that might be different.

Here are a bunch of the characteristics, and I think the one point I want to make about this is that it takes good, strong institutions to make, in particular, quantity-based systems work. You need good, strong institutions to make taxes work on the price side, to collect taxes (but there is always a government incentive to collect taxes, they always want to do that). So, even though you have to make sure that the taxes get done, there's at least a little bit of government, whereas institutional structuring of these markets are much more difficult, they're not easy to do. And so, Texas had a particularly good one because it had all these other kinds of components.

The third component (and I'm sure I'm totally out of time here, already running past) is talking about a wind resource concession. And the idea behind this a couple of years ago was that we could sell wind packages just like we did oil and gas. They are very similar cases. They're both geographically constrained resources. There are exclusive access rights. You can give them to things. And so, originally, the idea was that you could package these things in very large tracts, just like we do, potentially hundreds of square kilometers. So, you want to build wind offshore? You want to build in one section of the country? Buy a tract, just like the oil and gas company does. Come in, exploit our resource, and build windmills on it. Okay? That's the idea.

Well, there are some differences, though, and some very important ones here, as you can see. Note: one of them is intermittent; one of them is very storable, refundable products, and you can sell in international markets; the other one is generating something that has to be bought locally. So, we have very, very different differences as well.

We did a couple of studies. I won't go into those. One of them was done by Professor Brennand,¹⁰ University of East Anglia, and another by Professor Ni,¹¹ of Tsinghua. Brennand is interesting just from the point of view of saying that today, even if we went with extremely large wind units, like 500 megawatts up there, it's not going to generate bidding on those kinds of tracts. This is, by the way, on-grid concessions, not off-grid. One of the comments this morning was about Argentina and Morocco having done some off-gridding. But, Brennand was still optimistic, because he expects the power costs to drop and, when China starts getting in the wind turbine game, they should be able to manufacture a lot cheaper than other people.

The Ni report focused mostly on the institutional kind of issues that were problematic in the wind industry in China. And now China, just last month, issued its first wind resource concession guidelines. We had a draft last November. For 100 megawatt units and bigger, you have to use 600 kilowatt turbines, twenty-five year concessions, power price and local content. We're getting ready to give out two local projects, power projects, in Guangdong and Jiangsu – two areas, relatively wealthy areas, both on the coast, a lot of wind resources.

Basically, what I'm suggesting from all of this is we have those three things: the CDM market, the price-versus-quantity debate internally within the country, and concessions. If we bring all these things together, what we suggest—what our report is suggesting—is you have three phases: a take-off phase; the first phase, in the initial year, where your focus is mostly on helping China get its wind industry up and running so you have a lot of diverse small projects with very narrowly defined concessions with heavy national support on the price base and you just do the CDM; and a maturation phase where we now focus much more on providing cost-effective wind power that we move to larger project sizes with broader concessions with the concession people now taking more of the hit in terms of the risk and we shift towards provincial governments, in terms of support, as opposed to national. It's closer to the situation we have today.

And then finally, we go into a post-2015 phase. Regulatory support for full-scale markets. Hopefully by then, it will be very large units, probably greater than 100 megawatts, the bigger tracts,

¹⁰ Professor Timothy Brennand, University of East Anglia.

¹¹ Professor Ni Weidou, Tsinghua University.

not much government support, in terms of prices, but now we're much more into this RPS market-oriented world, with concessions basically tying into that as well. So, we put that all together and basically that's our proposed support program to try to move wind power, in particular, but RPS affects all renewables into China. You've got to develop those institutional kinds of frameworks before you can start running the more sophisticated quantity-oriented systems. Prices are easier to build, and we know from the countries in Europe, that we can develop an industry, which is also one of the important things, job creation and things like that. We know that that can happen in China. So, we start with price, we move to quantity, over time, just like the Europeans have been doing in both of these markets, and we have a little bit of shifting later. Thank you very much.

7. AMERICAN INVESTMENT IN OVERSEAS ASSETS

STEVE TESSEM*

The dreaded last presentation of the conference. Let's see what we can do with this. I'll try to keep it short. I know everybody has plans for the weekend. I know I do.

I work for Consolidated Edison Development. It's the utility that serves the city of New York, recognized as one of the more conservative businesses in the country, and it's a reputation that's well-deserved. I work for an unregulated subsidiary of Con Edison.

We've had some pretty interesting presentations today, and they've come from a lot of different parts of the investment business, or the energy business, around the world and I think I'm fortunate in that I get to, I guess you could say, close the circle. We've had—I thought—an incredibly interesting discussion by Professor Kammen on life improvement on a local level in a highly undeveloped economy, and the things that are done on a family unit basis, and on a village basis, and the sort of things that need to be measured on that level to see what really does constitute an improvement in a person and a family's life.

Ms. Floyd I thought had a very interesting presentation, in that she's out there funding new technologies, and trying to bring these

* Director of Project Development, Con Edison Development.

new technologies to market, and they are technologies that apply to sustainable development.

And, Ms. Lallement—and pardon me if I mispronounce the name, but I'm not French—I thought brought up a good point about institutional structure reform. If you're going to be a person like me, who is going to make a direct investment in a country, the biggest issue that I deal with is risk management. And, if I know that structurally in a nation, or in a market, that my interest is going to be protected over a long-term because you've got to remember, when I make an investment, I'm probably going to be investing at least \$100 million, and maybe as much a \$1 billion or \$1.5 billion, I'm going to have to know that risk is being managed on a long-term basis, so that I'm going to be able to operate a business at a profit over that time period.

Having said all of that, what I'd like to talk about is what an American company investing overseas is looking for, and what are the drivers that help me make a decision, or help my company make a decision in making an investment. I'm going to talk about six things: What are the requirements for a country that is a candidate for investment that I'm going to look for? What are the things that I have to have before I even, you know, get on an airplane to go over there?

The second thing I'm going to talk about are things that are not needs, but they're wants; they're desirable things about a country, or a market, or a culture that help me make a decision to go write checks in that country.

The third thing I want to talk about is, given that I don't have everything that I want, how I am going to mitigate the things that don't get there for me, and the costs that are involved with that.

The fourth thing I'd like to talk about is the role of the U.S. government and how the people who work for the government, overseas and in the United States, help me and how they hurt me. You get some of each when you go overseas.

Then, I'd like to talk about what happens when somebody like me, or somebody that works for me, gets on the ground and makes an investment, and gets engaged in that country; what to look for, how to behave, and what we should expect once we're there.

And then, I'd like to wrap it up with, given I'm at the University of Pennsylvania Law School, is what I think the role of the legal profession is in helping a person like me make these decisions, and helping me protect the investment that I have once I'm there.

So, without further ado—okay. First topic, the fundamental country requirements that we have. Rule of law. We got into this in the discussion on China. Some people got into a rather large energy investment. The competition came in after a contract was signed; they had a better deal, or so the Chinese government saw—thought. The next day, it is like the little duck, “Quack, quack, it’s a new day, it’s a new deal.” And, when that happens? All of a sudden, there’s \$300 million worth of iron on the ground and nothing to do with it. And, people lose jobs, both here and in China and, you know, everybody looks bad all around.

The thing that I look for, and that I think all of my peers look for is a system that features rule of law. We want to have a codified system of behavior for counterparties in contracts, for people that are going to be customers, for people that are going to be suppliers, for people that are going to be dealing with us in a regulatory fashion. I want to have it written down. I want to understand the rules of the game before I go into that country. I still don’t know how people like Coca-Cola and other people that function in China and succeed in China do it, but for me to build a multi-hundred-million-dollar asset in that country, I’ve got to know what the rules are before I go.

The second thing I look for is, again, the sanctity of written contracts. That comes from the rule of law. When I put my name on a piece of paper, I plan to live by it; the contract has the actions that each party is going to take, what happens when one party or another defaults. And I want to know that what I have written down and what that other person has signed are the rules that we’re going to use when we relate to one another.

The third that we go with is recognition of property rights. I don’t want to keep going back to China, but it’s the biggest example out there. Let’s face it, it’s a communist country, and communists, by and large, don’t formally recognize private property. If I’m going to invest several hundred million dollars in an asset, and I don’t know today or tomorrow or the next day, if the nation, the government, on behalf of the people, is going to come in and seize my asset, and tell me I no longer have rights to it, I’m not going to go make a thirty-year plan to put a lot of money in that country and spend a lot of effort getting it done. This applies not only there, we can talk about back in the fifties when the OPEC nations were busy nationalizing oil assets. We can talk about lots of places—the State of New York comes immediately to mind with the contracts and the abrogation that utilities went

through when they signed contracts to buy power and how they got state sponsorship to render those assets useless.

We're also going to look for courts with authority to make independent rulings of law. I want to know that if I have a dispute with a counterparty that I can go in front of an independent judge or jury, and that person hasn't been bought before I go before that person to get a ruling on my dispute, and that I'm going to get a fair shake when I go to court. If you can't guarantee that to me in that place, I won't, and the company that I work for will not go there to make an investment.

And, at the end of the day, you know, if there's not a need for what I have to sell, then I'm probably not going to go there. I'm not going to Italy selling pasta machines. And, I'm not going to go to Iceland and sell a coal-fired power plant. The place sits on a volcano, they've got plenty of geothermal power. Good for them. They don't need me, and I'm probably not going to push the market, as it were.

Now, what we want to get into next is what are desirable characteristics for investment in a country? Don't have to have this, but this is a shopping list of things that we do during the due diligence process that tell us we are or are not going to have to get into some pretty active risk management when we fail to see these things. Number one is a culture that accepts American capitalism—free enterprise concepts, obviously. If we're preparing to make an investment and the people and the government and the other business folks there, and the marketplace don't want an American coming in and saying, "This is the way I do it at home. I need to have contracts, I need to make a profit on what I do," and if that's not acceptable to those people, you know, we've got a problem. We've got a problem getting to the starting line because, at the end of the day, profits create wealth development, and people's lives get better. And, that's the way Americans see things, by and large, and I think it's a good way to think, and you don't have to have it, but it sure is helpful if your counterparty does.

And, two, is a freely convertible currency. That says if I'm going to go into a country and, let's say, build a power plant, because that's the business I'm in, I want to know that the currency that I get paid in is something that I can either trade in the world currency market or is a U.S. dollar. It's got to be one of the two. And, there's got to be a liquid, well-defined market for that currency, such that I can define what the value is of what I'm selling each and every day. In fact, to take it one step further, for

example, I did a geothermal project in Indonesia. The local currency, at that time, I was not allowed to trade on the international market so the idea came up, and it became accepted practice, that for geothermal power projects, the payment by the customer to me, as the owner of that asset, was going to be in a U.S. dollar-based contract, plain and simple, and I was going to be able to get a check for dollars, take that check to the bank, and make a deposit into the United States, or to reinvest that money as dollars in Indonesia. Plain and simple.

I want to see that there is a minimum level of corruption within the government and in the private sector. You see deals all the time in the power sector where generally you're working with a government-owned entity as the utility. During the, I guess you would say, the heyday of development in the late eighties and early nineties overseas, especially in the less developed countries, one dealt with the energy minister, or an appointed political person that ran the utility, and generally, the opening discussion was, "How much is this worth for me before I'm going to grant you the contract to do work here?" Over time, as American companies reminded our friends that the Foreign Corrupt Practices Act ("FCPA") applied to the developer, and that if I were to write a check to that person for getting the contract, I could look forward to a jail sentence upon going home and I wasn't going to play the game, the culture came around. There are many levels of this and, by and large, if you get into a corrupt situation, the only thing that happens is costs go up and the consumer suffers. There is nothing that corruption at a government or a corporate level does to enhance the economic growth of the nation. It's been proven a zillion times, ever since the dawn of man. It still applies.

We also look for at least a neutral attitude towards American culture and business practices. Quite personally, I don't care if they love me or not, I just want them to respect what I have to offer and I want to offer mutual respect to the people in that country about what they need from me, and what we can do together to make things better.

I look for liquid debt and equity markets, number five. That is not essential, but again, we get into the issue of, if I have to go offshore of that country to get financing, that enters into the costs, and that makes for more expensive investment, and it doesn't enhance the price of that product in that market for anybody, and nobody gets ahead.

We also try to find transparency transactions. And, that is, are the accounting books according to GAAP? Are the contracts fully reviewable by attorneys on both sides? Are there any side deals? Are there any rules that nobody told me about before we went in? Are there going to be conflicting regulations and permit requirements? Does somebody have a brother-in-law on the side who is a finder in the deal that we've got to pay? All that stuff needs to be hashed out before we go in. Mitigation of that costs money and it makes for a more expensive transaction, or an uneconomic transaction.

We also look for lack of civil unrest. It's not essential, but it makes an investor's life much more comfortable, and it makes the investment a lot more attractive economically if I don't have to worry about hiring, you know, the army to come look out for what I've built in that country.

Anecdotally, I suppose, I can talk about a trip I made to Sierra Leone in the early nineties during the opening days of their civil war. And, actually, this will apply to two things that I'm mentioning here, so that's even better. One of the budget line items we had in the power plant that we were planning to build—we were also planning to purchase a refinery over there—was a land minefield. And, because of that, I was able to, you know, offer back to my employers a very good budget number for installing land mines, wherever they wanted to go in the world. So, you know, it is a cost, and it's not an expertise I was looking for, but it was a way that we had of managing the security of what we planned to build.

The other story I have about that is when we were there, we were looking for security of the payment stream for the electricity we were going to deliver. At the time, and I think it still applies, Sierra Leone essentially had a foreign currency reserve of zero. There is no money that is transferable in the world markets that is in the Sierra Leonean banking system. The way that our payment stream was going to be securitized was with diamonds. They had diamond mines out in the hinterlands of the country. The government controlled the concession. We were going to have to determine the world market price for diamonds on a monthly basis, and basically ours was going to be a diamond-based contract. It was a little strange. It was interesting. And, I don't care to do that again.

The other thing we look for, laws and regulations around foreign investment. Now, this would seem to be blinding glimpse

of the obvious to most people, but I literally have gone to do a due diligence trip in a country where the local business people wanted to do a deal, wanted to build a power plant, wanted to bring investment over and technology transfer, and the whole thing; went to visit the finance minister, who, in a preface to a three-minute meeting, said, "Well, this is all well and good, but our laws don't allow you to come here and spend your money." So, it was embarrassing for everybody, so it just became an important part of the due diligence that I do when I go somewhere.

Now, how do you mitigate this? American companies can set up offshore investment vehicles and take ownership in the local economy through an offshore investment vehicle and have representatives that are local by showing them as our management team of our company, and they are the shareholders, et cetera, et cetera. And then, we go offshore again to determine how payments are going to be repatriated back to us as owners.

Mitigation measures for the previous set of circumstances. I could buy insurance. If I'm afraid that, you know, the local terrorists are going to come by my plant, I can buy insurance for that. If I'm afraid that, you know, there's some rare and strange disease that's out there that my plant manager is going to get, for that I can get special health insurance, et cetera, et cetera, et cetera. At the end of the day, it's got to cost, and the more insurance you buy, the more your product costs.

As I discussed before, we can seek out offshore funding of debt and equity. That's got all the attendant multiple transaction costs associated with it. Also, we can search for hedging mechanisms for the funds that we generate when we make an investment for income.

Creative collateral and security requirements. I just discussed one when I talked about a diamond-based deal.

Physical security practices. Again, you can do everything from hiring the local militia to be the guard at your house. You can enter into a contract with any number of security services. You can not show up. You can do lots of things to ensure that you're going to be secure.

As we got into before, we always look for FCPA language in our contracts. Step one to any investment by an American company is to make sure that this happens. There are about half a dozen officers of General Electric, who will be glad to remind you of the dangers of not abiding by FCPA when you go overseas investing. It's not pretty, and it's one of the rare instances in

American law, criminal law, where the onus is on the accused to prove himself innocent. It's not pretty, and I don't play.

Again, we talked about establishment of offshore investment vehicles. Engagement of local agents to be owners. And, we can – if we don't like the way the legal system is working, we can seek offshore venues for dispute resolutions. One of the better contracts that I got involved in involved an arbitration clause that said the venue for arbitration was Tierra del Fuego. We all were very incentivized to make sure that we resolved our differences on-site and locally.

The role of the U.S. government. One of the primary ways and one of the more constructive ways I think that the American government participates in investment overseas is through a vehicle called OPIC – Overseas Private Investment Corporation. It is – help me here – I think it's a quasi-governmental agency? Is that right? Semi? Okay.

What they do is they provide insurance where a private insurer might not help you with risk management. And, it's a vehicle that was set up initially to encourage American companies to place goods and services in overseas markets. Among the many things that OPIC will cover would be, say, creeping regulation, where, when you started your investment in year one, the regulation set was this, in year five, the government locally has decided that, "Gee, whiz, you're making a lot of money, and so I need to re-regulate you to increase the tax base of my country, and to make life harder on you, and make it more expensive, and you can leave more of your dollars here." One of the things that OPIC will not cover is the currency exchange rate risk of the investment that you make. When an investor goes overseas to make – to place funds in a country, you'd better recognize that you're on your own to figure out if the currency in play locally is going to work for you.

We got into FCPA already, and, by the way, that is working. As time went on, in the five to ten years that I was working overseas, I would look at contracts and the FCPA language that I would be looking for would already be included in the contract. And, even more refreshing, the people that work for government-owned utilities knew that those were the rules of the road in the United States, and they played by our rules. It is very refreshing, and I think everybody benefited here and abroad from that.

The United States gets into tax treaties. That helps me when I need to figure out my income taxes for the year. I don't like paying taxes two and three times in many venues. It doesn't help.

Trade treaties, also—I want to know that I'm not going to have to pay; say forty percent tariff on a turbine when I want to place that turbine in another country, if it's made in the United States.

The U.S. government also helps in enforcement of these international trade laws. I think that's self-explanatory.

Bully pulpit refers to, on a government-to-government level, I think the State Department and the various agencies that deal with international business for the American government do a good job of reminding other governmental people that capitalism is a good way to go, and that private investment is a good way to go, and the trickle-down effect is pretty significant. In the course of many years of working overseas, I saw a much quicker embracing of the idea of working for a profit being good for everybody involved.

Now, once we get on the ground overseas, we've done our due diligence, what do we do once we get there? Well, the first thing that I ask people who report to me to do is act with deference. Learn the language. Learn the customs. Behave yourself in general. Don't be arrogant. It's no way to get what you want at your house; I don't think it's a good way to get what you want when you're working with somebody overseas. They don't need to be reminded that you're an American that's highly educated and highly motivated and highly paid. They already know that. That's why you've been invited over there. So, you know, tone that down.

Number two is research and homework on local custom and law. I can tell you any number of stories about people that—American people—that have been looking at investments overseas that have broken laws and didn't even know that they were doing it at the time. You know, a representative of an American company winds up in jail and is not even sure why he did what he did, or if what he did was wrong; it makes a pretty lonely phone call home trying to find his way out of a bad situation.

Have a plan for your investment. Do you want to set up an offshore entity? Do you want to go for project financing? Do you want to seek OPIC insurance? Do you want to have the currency of record being local currency, or offshore currency? The shopping list goes on and on. You'd better have your plan put together before you go, because trying to think on your feet while you're there is not something I would recommend.

That goes into don't jump in head first. I've seen many people go out there and invest a million dollars setting up an office in a capital city in Southeast Asia somewhere, and then the executive

sits there, wondering why he doesn't have any business. It happens all the time, and it's ugly, and it's not fun. Send a scouting party into the country first. Talk to people who know what's going on. Invite people over to the United States to explain what's going on. There's plenty of good consulting help out there to show you the rules of the road and how to make investments.

Number five: Expect higher front end costs and longer lead times. Most of that is due to the fact that we just, as Americans, don't understand what other people in other markets are looking for, so it takes time to learn what it takes. Also, I've found the counterparties overseas are very, let me say, nervous about going into a contract with an American. They're afraid of getting outfoxed somehow. So, it just takes time. They're not going to sign anything. You'd better allow for the fact that it's going to take probably twice as much time to conduct a transaction overseas as it does here.

Do not wander from your investment requirements. If you have a defined rate of return on a particular investment, if you have a particular budget in mind, after doing your homework, don't get away from that. That causes sorrow and misery at home and abroad. Negotiate tough. You have your requirements. Your counterparty has theirs. Stick to your guns. It is, by the way, one of the ways that people wind up respecting you more is when you do negotiate tough. Be fair, but be tough. Recognize you're in a long-run engagement. An energy project, like I said, is several hundred million dollars and it's not for the faint at heart, and it's going to be an asset that will probably stay in that country for a long time.

Also, you need to look for exit strategies, in case things do go bad. How do you manage your risk at all times? Every day, you need to look and see what your exposure is and what's going to happen if things go bad.

Last but not least, and this was told to me by a boss of mine when I made a lonely phone call home to Manila one night, he goes, "Look, I didn't hire you to be whiner. Now, stop whining and get out there and go to work." That's what American investors look for, no whiners.

How's the legal profession going to help me? Well, they can help me with research and developing an entry strategy when I want to go into a marketplace. Also, they can help me find out which countries have rules of law, which countries recognize contract rights, which countries have property rights being

recognized, et cetera, et cetera. Attorneys are good at U.S. government relations. Almost every place I've worked, the person who is responsible for government relations usually was an attorney, or one of their top people was an attorney.

Probably the biggest thing that an attorney can do for me, as a person making an investment, is management of local counsel, if that attorney is working in my company. An outside attorney who's working for me is going to help me most in transaction legal work, putting together the contracts that make the deal work. Also, they're going to help me with finance legal work. What do the banks require? What do the regulations say I can do? Et cetera, et cetera, et cetera.

I think I'm just about out of time, so I believe that's the end of the show, and we'll go to the panel now.

8. CLOSING REMARKS

BARTON MARCOIS*

I want to start by thanking the people who have organized this. It's an incredible undertaking and it's something that shows a great dedication to good works. I had intended to speak about, in my closing remarks, about the importance of service, of public service, of volunteering and giving back to the community. Every one of us in this room, by virtue of our being here, our being here is prima facie evidence that we are very rich people, very blessed people by the standards of the world, in particular, even compared to most Americans, the fact that we cannot be working in a money-making endeavor right now, or that our money-making endeavor allows us to be here. I don't know why some of us are blessed more than others materially, but I do believe that because we are, we have a duty to take what we've been given and try to help other people with it. This conference is a great example of that.

We're talking about changing lives, one person at a time. There was a slogan for—I think it might have been General Electric, several years ago, "Bringing light to the world one home at a time," or something like that. That's what we're talking about doing here. We're talking about harnessing energy sources.

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I would like to submit to you that the single biggest source of energy in the widest possible interpretation of the word is finding a way to harness human self-interest. As I started listening to the strategies that worked, from every speaker I saw, I just started categorizing all the points, and I put "SI, SI, SI." Human self-interest is and always has been the main driving force of human progress. If we're to truly change the world, we have to find ways to tap into that perceived self-interest, what people see as their self-interest. What they believe is in their interest to do, they will continue to do, they will continue doing, and they will keep looking for better ways to do it.

That's what we're talking about here. That's especially true when we're making policy in a democratic society. We're not a collectivist society. We're an individualistic society. Our citizens resist anything that looks like statist central planning. So, that means that usually our progress must be incremental. We often look for good solutions, rather than the best solutions, because the best solutions are harder to achieve immediately. That's why—that's the reason for the focus of policy on existing infrastructure, even while we're trying to make plans to change that infrastructure, to develop new technologies, to reach out and prepare for the future.

We are rich people. We live in rich societies. We're very wasteful by the standards of the world. We had a perfect example this morning, talking about diesel trucks idling, terribly wasteful practice. You wouldn't have that in a society that was much poorer. But, one of the greatest luxuries in the world is renewable energy and clean energy supplies. John Haddon pointed out that most renewable energies cost over eighty cents per kilowatt hour—or no—yes, it was Dan Kammen's numbers, exactly—while we pay an average of six to eight cents. It's more than ten times the amount.

Remember, Dominique—forgive me—Ms. Lallement—if I said it right—pointed out—I liked her pyramid. It showed consumers as the base of the pyramid. I look at that as having consumers as the foundation of everything—the foundation of policy. They are the key; the poor should be part of the solution, they should help drive it. People want access to affordable, reliable energy, and they will use whatever they have in hand, whatever they can find. We must find a way to put into their hands good solutions, while we're looking for ways to put into their hands the best solutions, the best possible solutions.

How do we harness this self-interest? Well, we use the forces of the market. Roger Raufer talked about market mechanisms to find the cost benefit balance, about market mechanisms in absolutely every—in the trading, in the credits trading, and so forth.

One thing that I'm not sure got much attention is the entrepreneurial model. You all are familiar with the Bank of Gramin in Bangladesh. I don't know whether you've heard of the so-called Gramin telephones industry. Similar idea. Micro-credit lending, but specifically aimed at a telecommunications network. They lent women, again, tiny—just enough—money to buy an internationally usable cell phone, and the women set up businesses letting people use the phone and charging them for it. Tremendously successful, tremendous market penetration in a very short period of time, because we found a way to give people what they want. They wanted a communication vehicle.

I loved the idea of distributed generation entrepreneurs and clean water entrepreneurs. Somebody who puts a distributed generation machine of some sort, whether it's the Stirling that some of us have been looking into, or solar technology, or any technology that's available, but something that's small and portable and puts out a certain amount of electricity, and runs on locally available fuel—put it in the back of a wagon and take it from place to place, or take it, and along with a clean water facility, put up a 400 square foot enterprise zone where people can come and harness that power for a certain amount of money, so that it's in the interest of everybody involved in the transaction to do this.

I love Dan Kammen's idea of soft subsidies. I love that expression and the implications behind it. Again, distributed generation that—here in the United States that—who was it that was talking about that? I've forgotten—Nancy Floyd, I think was talking about that. The importance of creating a regulatory atmosphere that would encourage people to build their own electrical generating capacity. Another—my favorite example of soft subsidies is what the State of Virginia, and I think many other states have done, with the hybrid electric vehicles. You know, they cost about \$20,000 in the consumer market. The Federal Government has talked about, has proposed—the administration has proposed a \$2,000—there's currently a \$2,000 tax deduction available, which puts about \$500-600 in your pocket for buying one of those. The administration has proposed a \$2,000 tax credit, so you get \$2,000 cash back when you buy it. But, far more important

than that \$2,000 tax credit, to me, the State of Virginia, if I buy a hybrid electric vehicle, it'll allow me to drive it by myself in the carpool lane. That's worth far more than \$2,000 to me. And, for those of you who think in terms of billable hours, that's an easy calculation to make.

Nancy Floyd also talked about how sustainable development was once the idea of romantic policy wonks, idealistic policy wonks, and that it's now the realm of steely-eyed business interests. Why? Because people have found that they could make money doing it. And that they are serving the interests of people who want power, who want energy, and they're serving their own interests, too. That which is in their interests to do, they will keep doing.

I call myself a steely-eyed idealist, but I don't think that people in Washington understand what I mean, generally speaking. When you have people doing good things because it pays them to do it, you don't have the problem of donor fatigue. One of my favorite examples of an inappropriate technology transfer was when I was stationed in Yemen, driving through and seeing a huge tractor—for those of you from agricultural areas, it was a Cat-D6, a Caterpillar D6, a multimillion dollar piece of equipment, it was sitting in a field, and it was rusting, and I was with a guy from AID, and he said, "See that? We gave them that. We gave them that. It was a \$7 million machine, it was about three years ago, when we gave them the machine." I said, "Well, what happened to it?" He said, "They stopped using it because they didn't want to spend the \$25 to buy a new oil filter." They changed the oil once, they never changed the filter, and within eighteen months, the entire machine was ruined. And I said, "Well, can't you, you know, re-do it?" He said, "Well, we could, but they just left it there when it died. They just left it out in the field, and it would now cost a half-million dollars or more just to bring it back into usability, and we don't have that in our budget any more." And so, a \$7 million machine is an eyesore, and worse yet, from a, you know, an exporter's point of view, the Yemenis say, "Oh, don't buy any of that American stuff. That thing is no good. Look, it's just sitting right there, you know, how good can it be? It's just sitting there in the field." The donation was driven by a choice made by the *donor*, but purchasers of those Gramin phones we talked about a couple of minutes ago was driven by *buyers* who wanted to go out and make a living.

Another example from Yemen. The Yemen Hunt Oil Company—the Hunt brothers of Texas are not known for being idealists, they're not known for being soft-hearted people, but they established an oil company, and guess what they do in Yemen, when they go into tribal areas? They go in, they drill water wells. They put in small purification plants. They pay people twice the going rate for wages. And they teach them English. Do they do this because they are idealists and they're trying to make people's lives better? No. They do it because they need reliable employees who will show up for work, with whom they can communicate, who won't be staying home because they have dysentery from drinking bad water. They're doing it in their own self-interest. But, have they made those people's lives better? Far more than the guy who gave them that \$7 million tractor. They're doing it because they're after the oil that sits on the land of these people. They made their deal with the central government. They paid the central government—their deal—this is the deal they have to make with the local people, so that they're happy, and—so that they can continue to go in and pursue their interests.

Jean-Jacques Rousseau had an allegory he called "The Stag Hunt Allegory." Any of you who have studied international affairs are probably familiar with it. He said, "The international system is like a group of strangers that happen upon one another by happenstance in the forest and they're all hungry and they're all lost, and they hear a stag, and they know it's in the thicket somewhere, and they say, "Let's make a big circle and drive together, and we'll drive the stag to the center, and we'll catch it, and then we'll have enough food for all of us for several days." And they say, "Alright." And they go out, but not—no single one can see any of the others, and one of the guys, as he's going in the circle, you know, rattling the bushes, trying to drive the deer forward, sees a hare, sees a rabbit running this way out of the circle, and he says, "How do I know those other guys didn't see a rabbit? Should I chase that rabbit and go after that thing that's going to feed me for one day? Or, should I stick with these guys for something that's going to feed me for two weeks?" And, Rousseau said, not only will he chase the rabbit, but he must. It's his duty because there's no element of trust with those other individuals.

We are faced with a somewhat analogous situation when we're looking at energy development. We have to go after the stag. The U.S. government has decided, in this energy policy, this multi-

tiered energy policy that we've talked about, to try to get the rabbit *and* the stag. That's what we're trying to accomplish, and we're trying to harness people's self-interest in doing it. And to carry Rousseau's allegory forward, we're also planting seeds and establishing a farm to take care of the ultimate long-term interest, so we're feeding ourselves not just for a week, but forever, to have a truly renewable resource.

How do we convince the world, the United States, our cities, our neighborhoods, our families, ourselves to go after our long-term rather than our short-term interest? We do it any way we can. We do it one person at a time, one home at a time, by taking the great gifts that we have been given in our lives, and finding ways to give them to other people, and to share them with other people, and to make their lives better. And, that's what we're here for. That's what government is here for, that's what people are here for, and that's the mission that I leave us all with. Thank you very much.