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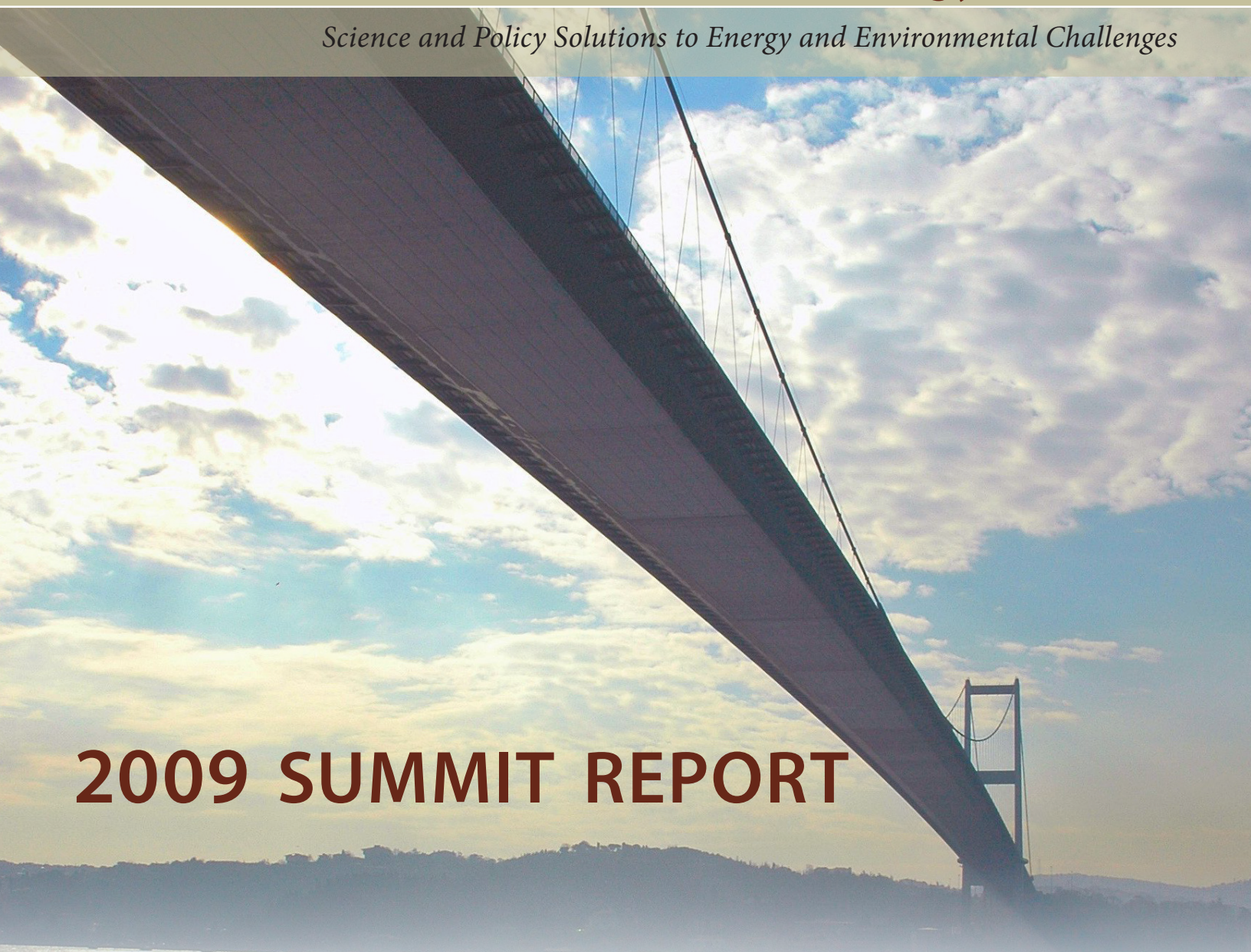
Pacific Energy Summit

Science and Policy Solutions to Energy and Environmental Challenges



2009 SUMMIT REPORT

ENERGY SECURITY AND ECONOMIC GROWTH IN THE ASIA-PACIFIC

Innovations, Markets, and Smart Policies for a Low-Carbon Future

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PACIFIC ENERGY SUMMIT

2009 SUMMIT REPORT

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EXECUTIVE SUMMARY

This report outlines the key themes and findings that emerged over the course of two days of discussions at the Pacific Energy Summit.

Background

The Pacific Energy Summit brought together over 100 leaders in science, policy, and industry in Tokyo to discuss the challenges facing economies in Asia and the Pacific as they pursue energy security and economic growth in a carbon-constrained future.

Main Findings

- Meeting the region's energy challenges requires combining market forces and smart public policies. Neither is sufficient on its own.
- For many developing countries in the region, the need for economic development and improvements in living standards makes providing reliable access to energy the highest priority.
- A flexible, transparent, and socially-equitable carbon pricing mechanism is essential for speeding the deployment of clean energy technologies and energy efficiency in the region.
- Improving energy efficiency is the cleanest, quickest, and most cost-effective method for enhancing energy security, managing demand, and reducing greenhouse gas emissions.
- Carbon financing and government support are essential if carbon capture and storage is to be brought to scale. Fuel switching, from coal to natural gas, is also a practical way for countries to meet growing energy demand while minimizing greenhouse gas emissions.
- Renewable sources of energy such as wind and solar have enormous potential but currently face issues of cost-competiveness and scalability. Nuclear energy will play an important role in the region's low carbon energy future, but this role will be limited to certain countries.
- Smart Grid technologies can provide numerous benefits, but early development will need government support for pilot projects and public-private partnerships to facilitate learning and data collection.
- Concerns about the adequate protection of intellectual property are slowing the transfer and diffusion of green energy technologies in the Asia-Pacific region. Government to government dialogue and agreements are needed to resolve this issue.
- Capacity building, especially in developing countries, is critical to the success of programs aimed at managing energy demand, improving energy efficiency, or designing effective energy policies.
- Bilateral, multilateral, and regional approaches should be encouraged as a way to advance free trade agreements on clean energy technology, foster trans-boundary energy cooperation, and provide forums for addressing issues such as intellectual property rights and "green trade."

INTRODUCTION

> Energy security and climate change are the two biggest challenges in Asia today.
>
> — Ken Koyama, The Institute of Energy Economics, Japan (IEEJ)

One of the most pressing challenges facing Asia and the Pacific is how to maintain energy security and economic growth in a carbon-constrained future. The Asia-Pacific is home to many of the world's most dynamic economies, yet hundreds of millions are still living in poverty. Demand for clean energy is soaring, but so is the region's consumption of fossil fuels. Awareness of the potential consequences of climate change is high, but so is the number of people living without access to modern sources of energy. How can the Asia-Pacific meet rapidly growing energy demand while avoiding large increases in carbon emissions? What policies and technologies are necessary to improve resource security, sustain economic growth, and reduce environmental impact? What challenges are standing in the way of this transition, and, more importantly, how can they be overcome?

These are the questions that leaders in science, policy, and industry from around the Asia-Pacific gathered to discuss at the inaugural Pacific Energy Summit, held November 3–5, 2009, in Tokyo, Japan. Recognizing the need for a sustained, comprehensive dialogue among stakeholders in the region, The National Bureau of Asian Research convened the Summit to discuss the technology, policy, and market solutions needed to create a more sustainable and prosperous future in the region. Participants included government officials from around the Asia-Pacific, private sector executives, and researchers from academia and think-tanks. In spite of the diversity among the participants, there were a number of areas of agreement that emerged regarding key issues and potential solutions. This report aims to identify the key themes and findings that emerged over the course of two days of discussions at the Summit.[1]

Pacific Energy Summit sponsors included the Asian Development Bank (ADB), Asian Development Bank Institute (ADBI), The Japan Foundation Center for Global Partnership (CGP), Chevron, ExxonMobil, GE Energy, and the Japan Bank for International Cooperation (JBIC). Collaborating institutions included the Institute of Energy Economics, Japan (IEEJ), the Kenneth B. and Anne H.H. Pyle Center for Northeast Asian Studies, the Korea Energy Economics Institute (KEEI), and The Energy and Resources Institute (TERI).

Energy Outlook in Asia and the Pacific

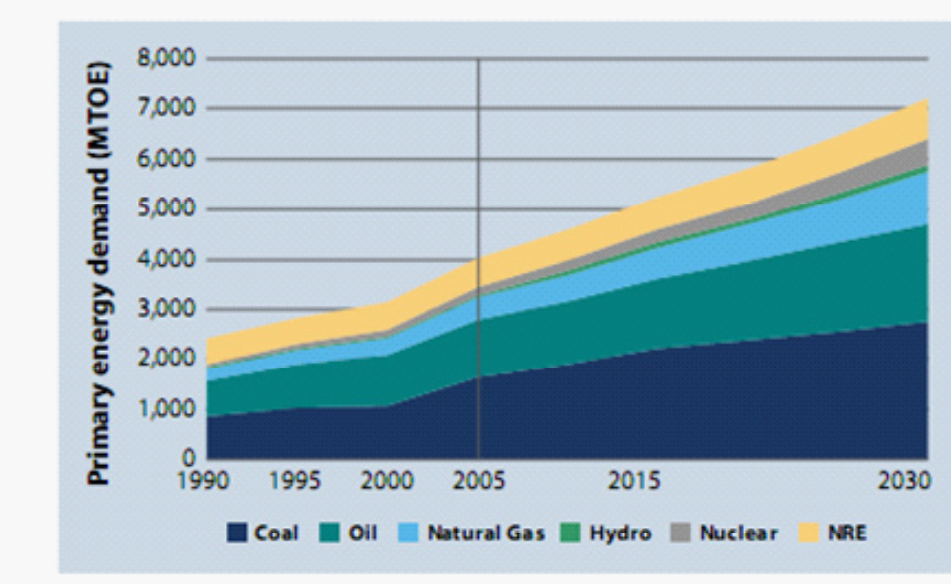
During the Pacific Energy Summit, ADB released the report *Energy Outlook for Asia and the Pacific*,[2] which describes the energy challenges the region will face over the next twenty years as economic growth drives energy demand. According to the report, between 2005 and 2030 the annual growth rate of GDP in Asia and the Pacific will be roughly 3.5%.[3] Annual energy demand will

grow at a rate of 2.4% annually, outpacing the world average of 1.5%, and fossil fuels will supply approximately 80% of the region's energy in 2030. To meet this surge in demand, the region will need to invest between $7 trillion and $9.7 trillion in the energy sector between 2005 and 2030, with more than 60% of total investment dedicated to electricity generation, transmission, and distribution.

The rapid growth in energy demand and continued reliance on fossil fuels will have significant implications for the region's energy security and carbon emissions. Based on current trends, net imports of fossil fuels in Asia and the Pacific will more than double, from 584.9 MTOE in 2005 to 1,385.1 MTOE in 2030, and oil imports will nearly double 2005 levels by 2030. The region's reliance on imported energy will leave it increasingly vulnerable to supply disruptions and price shocks. At the same time, the amount of carbon dioxide emitted by Asia and the Pacific as a whole is projected to grow by 2.3% annually, leading to a total emissions increase of roughly 70% between 2005 and 2030.

> The fundamental problem is that energy use, particularly in this region, is poised to soar in the next twenty years, and we have to find a way to meet soaring energy demand while at the same time reducing emissions.
>
> — Kenneth Cukier, *The Economist*

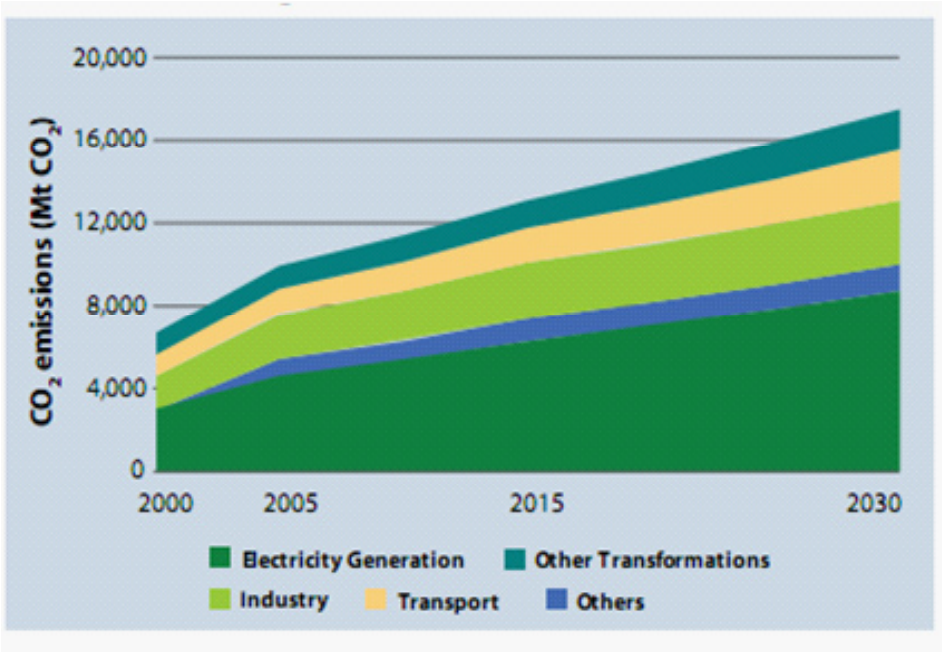
FIGURE 1 Primary energy demand in Asia and the Pacific, 1990–2030



SOURCE: Asia Pacific Energy Research Centre (APERC), 2009.

NOTE: MTOE = million tons of oil equivalent; NRE = new and renewable energy.

FIGURE 2 CO2 emissions, 2000–03



SOURCE: APERC, 2009.

NOTE: CO2 = carbon dioxide; Mt CO2 = million tons CO2.

and the Pacific do not have access to electricity. While developed countries are focused on meeting the challenges of global climate change, many developing countries are struggling to obtain affordable, reliable energy.

The ADB *Energy Outlook* report illustrates the stark contrasts and disparities among economies in the region. Whereas countries such as China, Thailand, Malaysia, and Brunei Darussalam have achieved electrification rates nearing 100%, electrification rates in other countries, such as Cambodia, Bangladesh, Myanmar, and Nepal, are still far below 50%. India, with the world's second largest population,

Access to Energy

"Very important to the Philippines is access to energy for the poor. We can talk about all kinds of investments and developments, but if we do not have meaningful programs in place to help provide energy to the poor, then it is just business as usual."

—Edita S. Bueno, National Electrification Administration, Philippines

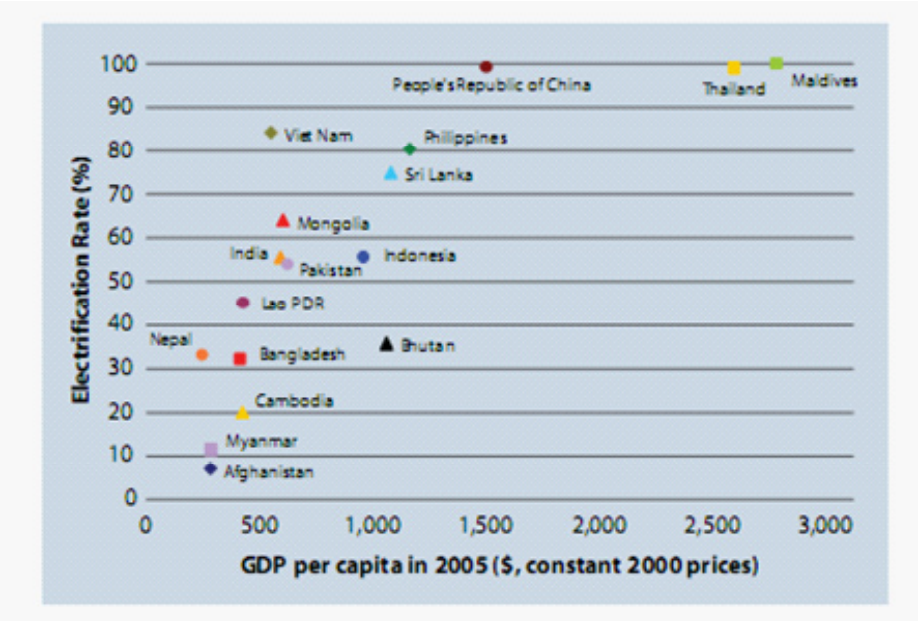
Many Summit participants focused on the need to provide the most basic type of energy security: access to commercial energy sources such as electricity, gas, and petroleum products. Energy access is a prerequisite for economic growth and quality of life improvements, yet almost one billion people in Asia

Left to right: Edita S. Bueno (National Electrification Administration, Philippines) and Tetsuro Fukuyama (State Secretary for Foreign Affairs, Japan) participate in the panel "Balancing Access to Energy, Energy Security, Climate and Development Concerns"

provides electricity to less that 60% of its citizens.

Summit participants from some developing countries in Southeast Asia emphasized that while global climate change is an issue of great concern, the volume of carbon emissions originating from their countries was insignificant relative to those from developed countries such as the United States, both on a cumulative and per capita basis. In this context, carbon reduction and mitigation attempts are important but are a lower priority than ensuring economic growth, raising standards of living, and improving access to energy. According to Nguyen Manh Hung of the ASEAN Centre for Energy, "Energy security and climate change are of course very important issues, but from an ASEAN perspective we are more concerned about the disparities in terms of development and standards of living among ASEAN nations, so for us these inequalities are the biggest challenge." Masahiro Kawai, of the Asian Development Bank Institute, pointed out that "there is a huge gap between developed and developing countries in terms of per capita emissions and per capita energy consumption. Clearly each developed country has a greater responsibility to reduce emissions on a per capita basis as well as for the country as a whole. Developing countries have the right to pursue economic development, poverty reduction, and energy for all, while attempting to reduce energy and carbon intensity (energy consumption per GDP and emissions per GDP)."

FIGURE 3 Electrification rate and GDP per capita in 2005



SOURCE: APERC, 2009.

While not everyone agreed with this perspective, participants recognized that access to modern forms of energy is essential to human and economic development.

As energy consumption in the region grows, per capita CO2 emissions will increase both overall and on a per capita basis, but within the region large disparities will remain. Improving access to energy and meeting future growth in demand through the use of clean energy technologies are critical. Access to energy and sustainable

development should not be an either-or proposition.

Summit participants drew attention to the variety of initiatives underway that are focusing on improving energy access by matching specialized technologies with local needs and conditions. The Energy and Resources Institute (TERI) in India has launched the "Lighting a Billion Lives" initiative that aims to bring access to modern, clean sources of lighting to one billion rural people by replacing traditional kerosene and paraffin lanterns with solar lighting devices. ADB's "Energy for All" initiative aims to provide access to modern energy to an additional 100 million people in the Asia-Pacific region by 2015 by utilizing low-cost, environmentally friendly technologies, such as micro-hydro, solar, and domestic biogas, and by using innovative financing mechanisms. These types of initiatives were applauded at the Summit. In order to improve access to energy in rural or underdeveloped areas, new business models and forward-thinking public policy are needed.

> In many ways the energy access issue in Asia is not as closely related to the climate issue as one would think. In Asia there are hundreds of millions of people living on less than $1.25 per day, but the incremental increase in their energy consumption over the next ten years would be insignificant in relation to the global energy use, but considerably improve their productivity and promote inclusive growth. The larger greenhouse gas emissions will come from the rising living standards of the middle class in emerging economies.
>
> — C. Lawrence Greenwood, Jr., Asian Development Bank

Left to right: Ken Koyama (The Institute of Energy Economics, Japan), Prabir Sengupta (The Energy and Resources Institute, India), and moderator Tomohiko Taniguchi (Keio University) have a conversation with the audience

SOLUTIONS FOR CLEAN, SMART, AND EFFICIENT ENERGY

> The cheapest and most plentiful form of energy we have is conservation.
>
> — Melody Meyer, Chevron Energy Technology Company

Energy Efficiency

At the Summit there was near unanimous agreement that improving energy efficiency is the most cost-effective method available for increasing energy security and reducing greenhouse gas emissions, and that energy efficiency must be deployed on a massive scale. Improving energy efficiency in the transportation, building, electricity generation, and industrial sectors has the potential to dramatically reduce GHG emissions by limiting growth in demand and increasing the productivity of energy consumed. Kateri Callahan from the Alliance to Save Energy said, "We like to look at energy efficiency as a fuel, and it should be the first fuel of choice as we look at meeting the enormous growth in energy demand that we face, and also the first choice as we look at trying to tackle the problem of climate change. It is the cleanest, quickest, and cheapest way to do both." Japan was cited repeatedly as a model of energy efficiency, with many participants pointing out that if the rest of the world used energy as efficiently as Japan, the world would not be facing so many energy challenges.

The Summit's panel of experts agreed that deployment of energy efficiency requires the right combination of public policy and regulation, economic incentives, financial assistance, and public awareness. Public policy arguably plays the most important role by creating an economic and regulatory framework that uses market forces to incentivize energy efficiency. By establishing and strictly enforcing standards for buildings, fuel efficiency, generation performance, and industrial equipment, governments can spur investment in energy efficiency and create an environment where energy efficiency is economically beneficial. According to Jiang Lin of the Energy Foundation, "Managing energy

Left to right: Kateri Callahan (Alliance to Save Energy), Wang Yanjia (Tsinghua University), and Ellen Carberry (China Greentech Initiative) discuss energy efficiency

There is enormous potential for making large improvements in energy efficiency, and there is no shortage of energy efficient technologies available. The real issue is how to bring them together.

— Wang Yanjia, Tsinghua University

demand is essential to economic development. Energy supply is fundamentally a very capital intensive business, and for developing countries, if they don't manage their energy demand well, it can take away huge amounts of financial resources that could be used in other areas…Managing demand growth, particularly through conservation and efficiency, is a profitable, pro-growth strategy."

International financial institutions have an important role to play by providing assistance that encourages initial investments in energy saving technologies, rewarding the use of best practices, and providing technical training where necessary. In many developing countries, energy efficient technologies are passed over in favor of cheaper, less efficient technologies because of upfront cost considerations, even though over the long term the investments in energy efficiency usually pay for themselves in energy savings. By using innovative lending practices aimed at energy efficiency, financial institutions can provide the capital needed to invest in advanced technology and then recover their investment through money saved in energy costs.

Many groups have done extensive research on the returns generated by investment in energy efficiency, and the results are clear: although there is no silver bullet for meeting today's energy and climate challenge, energy efficiency is the first among others in terms of importance.

Carbon Pricing

"Carbon financing is very important to the deployment of clean energy technologies, and the sooner that a long-term agile mechanism can be put in place, the faster the private sector will be able to accelerate action on this front."

— Ede Ijjasz, The World Bank

At the Summit, there was recognition that the factor that could most directly and decisively spur the deployment of clean energy technologies and energy efficiency is the pricing of carbon. There was broad consensus that some form of a transparent carbon pricing mechanism must be developed to encourage long-term investments in the development of clean energy technologies, to facilitate the deployment of energy efficiency, and to speed the replacement of traditional energy technologies with less carbon-intensive ones. Presently, renewable sources of energy such as solar, wind, wave, and geothermal cannot compete against traditional fossil fuels like coal on an economic basis alone. Likewise, carbon capture and storage (CCS) is not economically viable without a carbon price (except in instances where enhanced oil recovery can be used to offset costs) because of high technology and operating costs. And although improvements in energy efficiency

Jiang Lin of The Energy Foundation asks a question of one of the discussants

often pay for themselves over the time, there is often too little incentive to make the larger upfront investments needed to employ best technologies and maximize efficiency. Transparent pricing of carbon will help provide the economic incentives and price signals necessary to overcome these obstacles and thus will catalyze the deployment of clean energy technologies and energy efficiency.

Summit participants from the private energy sector pointed out that current uncertainties about future carbon prices and pricing mechanisms hinder their ability to make accurate predictions about the direction of investment, returns on investment, and investment risk. In the words of one private sector participant, "We can't go to our board and ask to spend millions of dollars on a new energy technology when we can't provide them with accurate numbers regarding projected returns on investment." It was clear during Summit discussions that the private sector recognizes that a carbon price is on the horizon and is ready to embrace the market opportunities it will create in the region's large and growing energy market. The current lack of clarity, however, is forcing many energy companies to take a wait-and-see approach.

But if there was some sense of agreement at the Summit that carbon pricing is of critical importance, there was near-equal recognition of how complicated and lengthy the process will be in developing an equitable and economically palatable carbon pricing regime. Participants from both the public and private sectors raised the question of how to create a carbon pricing mechanism flexible enough that it does not penalize the poor or impede quality of life improvements in developing countries. Participants from both sectors also raised the issue of how trade might be affected by carbon pricing, with one participant pointing out that "one of the challenges to implementing a climate framework is the potentially harmful impact on trade-exposed industries. A key question is how to make potentially affected industries whole and climate policies politically palatable, while resisting the temptation of protectionism."

Nonetheless, there was consensus that individual countries and the international community must begin taking steps now to provide at least a small measure of predictability regarding the future direction of carbon pricing, and that when price

signals become visible, private companies will be able to make increasingly large investments in the low-carbon energy infrastructure of the future.

Carbon Capture and Storage

"CCS currently appears to be a very expensive technology, but if the world is going to continue to use coal at scale, then we need to find a way to make the technology cost effective, and to make it applicable in countries like China where coal use is likely going to be at its greatest."

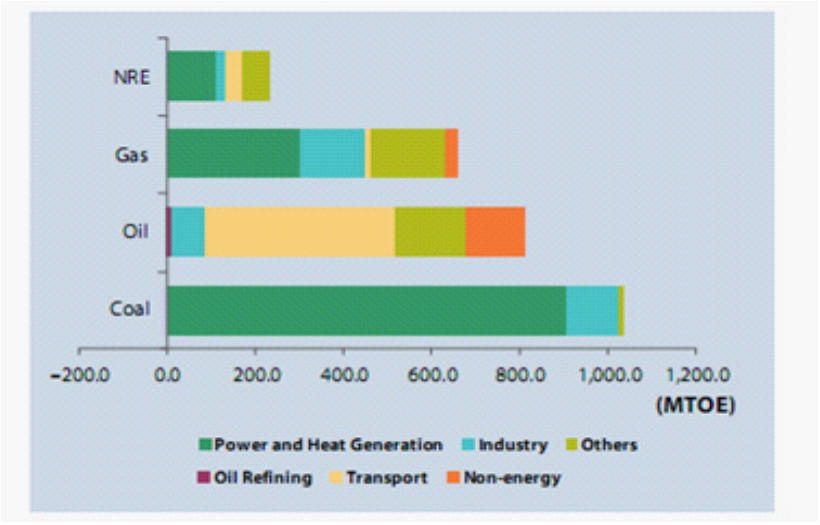
— David Bailey, ExxonMobil

If Asia and the Pacific are to develop in an environmentally sustainable fashion in the coming decades, the region, much like the rest of the world, will have to address the greenhouse gas implications of its dependence on coal for power and heat generation. Coal is an abundant, inexpensive, and reliable source of energy, and in the next two decades it will experience the largest incremental growth in demand among all forms of energy.

In China and other countries in the region, significant efficiency improvements are being made in how coal is consumed, and technology improvements are reducing the harmful nitrous oxide, sulfur dioxide, and mercury emissions traditionally associated with coal combustion. But improvements in efficiency aside, the reality remains that the only way to use coal for heat and power generation without producing greenhouse gas emissions is by capturing and storing the CO2. CCS must be a part of the solution if the world is to avoid the worst consequences of climate change while continuing to burn coal.

Advances are being made in CCS technology, and there are currently more than two dozen demonstration or pilot projects in operation, under construction, or in planning phases worldwide. Experts at the Summit agreed that the obstacles are mainly on the price and geological storage side, as the technology needed to capture and transport large volumes of CO2 is relatively mature and has long been used for enhanced oil recovery. As Ronald Mitchell of Mitsubishi Heavy Industries put it, "On the upstream side of the carbon

FIGURE 4 Incremental demand growth by sector, 2005–30



SOURCE: APERC, 2009.

NOTE: NRE = new and renewable energy.

value chain—the capture, compression and gas cleanup scope—from a technical perspective there aren't any major issues, or at least issues that can't be overcome."

The most obvious obstacle is price. In addition to the cost of installing the CCS technology, there is also an energy penalty associated with capture and storage, estimated at between 15% and 30%, meaning more coal would need to be consumed to operate the technology, adding to cost and supply chain pressures. Making CCS economically viable will require a price on carbon high enough that it creates price signals that drive CCS deployment, but carbon prices this high would create a different set of economic challenges, particularly for developing countries. Creative carbon financing mechanisms will be needed to overcome this problem.

A second obstacle is the lack of a clear legal and regulatory framework regarding the storage of CO2, which is hindering the ability of private companies to make accurate forecasts regarding the long-term cost of carbon stewardship. As one private sector participant noted, "The fact is that to do this you need to be able to provide liability coverage for far beyond what is commercially available right now. Costs are fairly well known on the front-end capture and compression side, but after that the costs start getting murky because you don't know what the liability regime is going to be. Are you going to have to pay a fee to store the CO2 underground? Who owns the space? Does the same mineral regime used in the United States apply to putting products into the earth as opposed to just taking them out?"

In many ways the challenges facing CCS are analogous to the financial, legal, and regulatory challenges that faced the nuclear and liquefied natural gas industry when they were at early stages of development. According to Mark Thurber of Stanford University, "Early on, for radical new technologies that are very capital intensive and have risks that are difficult to quantify, getting those industries off the ground usually involves the government stepping in on some of the initial projects. In the case of the nuclear industry it meant insuring against catastrophic liability issues, and for liquefied natural gas it meant the government underwrote huge financial risks. It will probably take something similar with CCS."

As in the nuclear industry, a key variable affecting CCS commercialization is public acceptance. People around the world will

Left to right: Ronald Mitchell (Mitsubishi Heavy Industries) and Jack Wen (GE Energy China) discuss clean coal and carbon capture and storage

need reassurance before they accept the storage of millions of tons of CO2 underground near the areas where they live. This type of reassurance can only come from large-scale demonstrations and from the experience and knowledge gained in the process. Questions about cost, scalability, and reliability will need to be answered soon if CCS is to be deployed on a scale necessary to significantly reduce carbon emissions. As one private sector participant pointed out, "the challenges CCS faces are great, but they are probably no greater than those faced by any other low or zero carbon fuel in terms of getting to the scale we're talking about."

Left to right: Nicholas Parker (Cleantech Group) and Koji Omi (Science and Technology in Society Forum) discuss clean energy solutions

Renewable Energy

Summit participants recognized the enormous potential in the field of new and renewable energy (NRE) but also were cognizant of the obstacles facing NRE development in the near term.

On the one hand, renewable energy derived from solar, wind, the tides, geothermal heat, biomass, and hydropower has already begun helping countries meet energy demand, reduce greenhouse gas emissions, and improve energy security. Most forms of NRE are by definition localized, have a relatively small environmental footprint, and can be used in different combinations to suit a variety of geographic conditions. NRE technologies are also improving at a rapid pace, and large-scale investments in NRE by countries like China and India continue to drive down costs.

But Summit participants were acutely aware of the obstacles facing the NRE industry, the first of which is the issue of cost. On a per kilowatt hour basis, many forms of NRE are currently more expensive when compared with burning coal, either because of energy subsidies that distort markets in favor of traditional sources of energy or because of the expense of the NRE technology itself, as in the case of electricity from photovoltaic cells. Participants pointed out a variety of ways this issue might be overcome. Suggestions, which were sometimes conflicting, included the use of carbon pricing mechanisms, removing energy subsidies and allowing for the market pricing of energy, government mandates for NRE generation targets, legislating feed-in tariffs that make NRE more cost competitive,

or some combination of the above. All of these public policy options can facilitate the deployment of NRE technology, but they also touch on important social issues, and incentives promoting NREs can create market distortions as well.

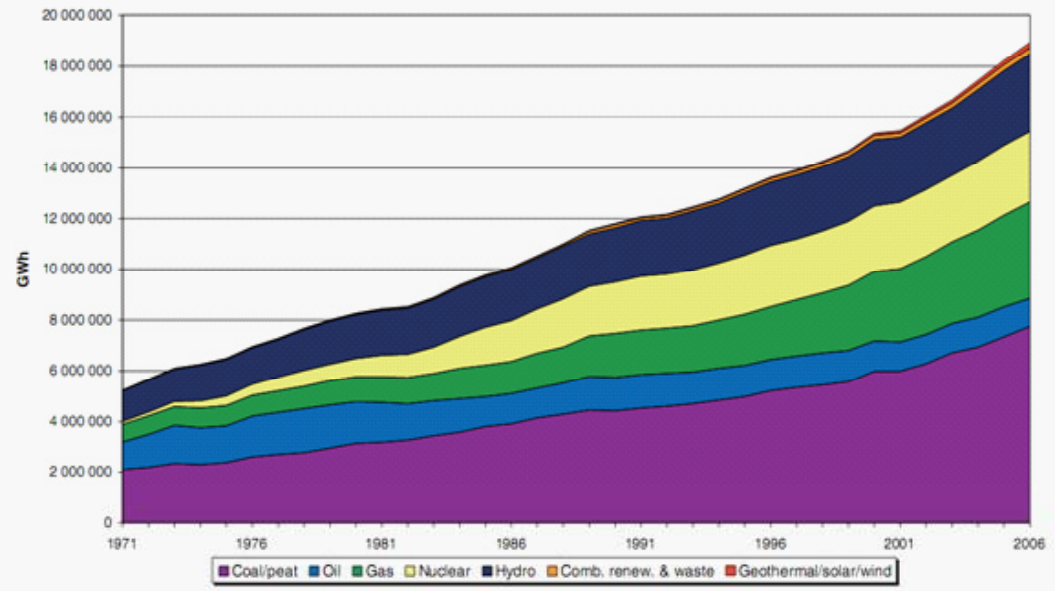
Energy subsidies are often used to address social inequalities and development issues by ensuring that affordable energy is available. One of the most common is using subsidies to lower the price of electricity. But lowering energy prices through economy-wide subsidies not only distorts markets in favor of traditional forms of energy generation; it also undermines price incentives for conservation or energy efficiency improvements and often provides subsidized electricity to those who need it least. Raising the price of electricity, much like raising the price of water, carries considerable political risk.

One way to address this issue is to compensate for higher energy prices through targeted social welfare programs that allow for higher energy prices across the board but still provide subsidies to those unable to afford higher energy prices. As one private sector participant pointed out, "The challenge is that new technologies require higher energy prices, either by getting rid of the subsidies or by having a carbon price, but that clearly is a barrier to access by the poorest people. It seems this dilemma is best addressed through targeted measures to help the poor obtain the energy they need, rather than reducing the cost of energy across the economy so that rich people too enjoy the benefits of lower energy prices." Ultimately, the goal is to facilitate energy access for the poor without creating subsidies that encourage inefficient or excessive usage of fossil fuels. Overcoming the current economic barriers to greater NRE deployment will likely require the right combination of public policy, international support, and innovative financing mechanisms, such as the Kyoto Protocol's Clean Development Mechanism, clean technology funds, and targeted lending strategies.

A second obstacle, and arguably the most challenging one, is that the amount of electricity generated by renewables is currently so small that even at high growth rates renewables are unlikely to make up a significant portion of the energy infrastructure any time soon. As shown in **Figure 5**, renewable forms of energy,

Jesus Tamang of the Department of Energy, Philippines, takes notes during one of the Summit sessions

FIGURE 5 World electricity generation by fuel



SOURCE: OECD/International Energy Agency (IEA), 2008.

NOTE: For more detailed data, please consult the online data service at http://data.iea.org.

excluding hydropower, make up a small fraction of the world's electricity generation. Even bringing NRE to a scale comparable to hydro or nuclear would be a significant accomplishment.

There are, however, policies in place today that are helping to drive down costs and increase the scalability of renewable technologies such as wind and solar. For example, China's Medium- and Long-Term Development Plan for Renewable Energy looks as though it will put China on track to reach 100 GW of installed wind power capacity and 10 GW of installed solar power capacity by 2020. With adequate financial support and smart public policies that create favorable investment conditions, other countries in Asia and the Pacific might be able to realize similar gains. The cross-border integration of energy infrastructures is another avenue that may help lower the cost of NRE technologies by creating economies of scale.

Additionally, several Southeast Asian participants pointed out the potential of NRE for improving energy security and increasing energy access in rural areas. For island archipelago nations like the Philippines and Indonesia, where there are geographical obstacles to creating a centralized, grid-based energy distribution network, NRE can improve energy access by increasing decentralized electricity generation capacity in remote areas. There are also important energy security benefits to be gained by countries heavily reliant on energy imports. One official explained, "In the Philippines, where we only contribute one-third of 1% of global GHG emissions, mitigation measures would not be contributing much in terms of reducing global GHG emissions. Nonetheless, we are moving toward renewable energy because we import 96% of our oil requirements."

Smart Grid

"Smart Grid can mean many different things, not so much because there are contentious views of what a smart grid is, but because what it means often depends on where you're sitting."

— James Foster, Microsoft

> Smart Grid is the infrastructure we need to reduce CO2 emissions, and it is the infrastructure we need to effectively and efficiently integrate energy consumers and producers in an innovative way.
>
> — Shuhei Abe, SPARX Group Co., Ltd.

Smart Grid was one of the Summit topics that generated the most interest and discussion. One Summit expert defined Smart Grid as "the integration of automation and information technology into the current electrical infrastructure, which results in a grid that is not only responsive but also adaptive." It is still a relatively new concept, and its specific applications and capabilities continue to expand as more companies seek their niches in technology development and deployment. As Jim Suciu of GE Energy explained, "Smart Grid means enabling renewables, enhancing the reliability and efficiency of the system, and empowering consumers. At this level there is wide agreement about what Smart Grid means. But I think if you step one level below that, meaning how do you do these three seemingly simple things, then you end up with almost an infinite number of ideas for doing them."

Smart Grid has so many possible applications that its utility will likely be determined by place-specific geographical and development conditions. According to Hiroshi Watanabe of the Toshiba Corporation, "The definition of Smart Grid technology, and the expectations for Smart Grid technology, is different in every country. In the United States, Smart Grid would help to enhance the reliability of the system, and also help integrate peak shifting and peak shaving into the transmissions network. In Tokyo, the definition of Smart Grid is different. Here it might be used to help power system operators overcome the inconsistencies in renewable energy generation from wind and solar, and to maintain reliability and high quality power supply." The application might be different still in a developing country like Indonesia or Vietnam, where Smart Grid might be able to help increase access to energy in rural areas by complementing the traditional transmission infrastructure with decentralized generation and distribution capacity enabled by Smart Grid technology.

What can government and policymakers do to move Smart Grid forward? The Summit's panel of Smart Grid experts agreed that at this stage the first and most important step is to help companies and utilities acquire the data they need to design smarter grids by supporting pilot projects and public-private partnerships. If local governments can facilitate the deployment of the tools needed for data production, in this case the software, sensors, and smart meters, then, as one participant put it, "Once you get data you'll have a host of

Smart Grid Technologies and Smart Policies for Asia's Megacities

The Summit panel on Smart Grid placed special emphasis on the role that Smart Grid technologies can play in the sustainable development of Asia's megacities. For the keynote address, Jim Suciu of GE Energy explained why Asia's megacities are important, and why Smart Grid should be part of their development model. In 2007, for the first time in modern history, the world's urban population exceeded the rural population, thanks in part to the unparalleled pace of urbanization in Asia. At the same time, between now and 2025, almost half of global population growth will occur in Asia. These two trends will be drivers of economic growth and energy demand in the region and will have profound implications for Asia's cities. These trends will also fuel the rise of Asia's megacities, defined by the UN as metropolitan areas with a total population in excess of 10 million. Asia is currently home to thirteen megacities and will add five more by 2025. While these megacities serve as centers of development and innovation in the region, meeting the energy needs of these massive urban areas in a sustainable fashion poses a daunting challenge.

With population growth in Asia's megacities expected to increase by an average of 28% over the next fifteen years, Smart Grid technologies hold enormous potential for ensuring that electricity generation, transmission, and distribution systems are up to the task. The challenges confronting modern city planners and utilities are similar in many parts of the world—improving grid reliability and efficiency, incorporating renewables into the system, controlling costs—but they are an order of magnitude larger and more complex when it comes to megacities. The infrastructure built in these megacities over the next 10 years will likely still be in use 20, 30, or even 40 years later. If renewable energy, energy efficiency, and demand-side management are to reach their full potential, integration of Smart Grid technologies should begin now.

Like CCS, the extent to which Smart Grid technologies will be able to meet tomorrow's needs depends on what is done today to get smarter grid systems off the ground. Government support is necessary, but regional forums such as APEC can also be leveraged by bringing together policymakers, industry leaders, or the mayors of Asia's megacities to explore the value of Smart Grid at the city-scale level.

technologies you can apply to the most cost-effective solutions, and then market forces can take over." Second, by mandating and incentivizing the incorporation of renewable sources of energy into the supply-side mix, governments can essentially "create the problem" for utilities, which will drive them to rely on Smart Grid technologies in order to integrate decentralized generation capacity into distribution networks. As policymakers continue implementing intelligent supply-side and demand-side policies, market forces will drive the deployment of new technologies like Smart Grid where they are needed.

Yahya Rahmana Hidayat (BAPPENAS, Indonesia) discusses Smart Grid

Nuclear

"We must develop science and technology for saving energy, reducing carbon dioxide emissions, and deploying new forms of energy and nuclear power."

—Akito Arima, ACT Foundation

What role can nuclear energy play in securing a low-carbon future for the region? Around the world, there are currently 53 nuclear reactors under construction, and dozens more are planned. According to the ADB *Energy Outlook*, nuclear energy demand is projected to increase at 5.1% per year through 2030, the fastest annual growth rate by energy type, driving nuclear energy demand to nearly triple in the region. While this rapid growth is mainly attributable to the expansion of China's installed nuclear capacity, Japan, India, and the Republic of Korea will also realize important energy security and sustainable development benefits through their use of nuclear energy.

At the same time, there are currently significant challenges to the deployment of nuclear energy on a larger scale. These include issues of public acceptance, nonproliferation, long construction times, human and financial capital limitations, and "back end cycle" issues such as nuclear waste storage (temporary and permanent) and decommissioning. For these reasons, international financial institutions like ADB and The World Bank are reluctant to lend for nuclear development, which will limit the diffusion of nuclear energy in the region. Overall, nuclear energy will play an important role in Asia and the Pacific's low carbon energy future, but because of the numerous challenges surrounding nuclear power, this role will be limited to certain countries.

Natural Gas

In discussions on how the region might reduce carbon emissions while meeting growing energy demand, some participants pointed to fuel switching, from coal to natural gas, as one of the most promising CO2 abatement strategies. Natural gas is the cleanest of all fossil fuels, and the combustion of natural gas emits almost 30% less carbon dioxide than oil and about 50% less than coal. Countries like China, India, Japan, and South Korea are increasing their reliance on natural gas, and exporters are ramping up production capacity to keep pace with demand. The *Energy Outlook* report predicts that between now and 2030, natural gas will have the fastest annual growth rate (3.6%) of any fossil fuel. Switching from coal to natural gas for power generation could play a role in reducing the region's emissions of CO2 and other atmospheric pollutants and would be an important intermediary step in the transition to a low-carbon growth model.

Natural gas infrastructure is highly capital-intensive. To meet growing demand for natural gas and maintain reliable supplies in the region, large-scale investments are needed in the upstream supply and development infrastructure, mid-stream transformation facilities, and downstream distribution networks such as LNG terminals, pipelines, and domestic distribution systems. Because of the capital-intensive nature of the industry, there are significant advantages to be realized through regional cooperation. Private sector investment is essential, but perhaps more important is the support of regional governments for trans-boundary infrastructure projects and better functioning gas markets. The gas trade often requires long-term bonds and agreements among buyers, sellers, and the parties involved in the distribution networks, making political support among participant countries essential in order to secure financing. A regional pipeline grid is already taking shape in places like China, Central Asia, and parts of Southeast Asia, and the LNG industry is gaining momentum. Building on this momentum and finding avenues for greater cooperation among economies in the region can bring important economic, energy security, and environmental benefits.

Left to right: Hiroshi Komiyama (Mitsubishi Research Institute), Secretary Angelo T. Reyes (Department of Energy, Philippines), and moderator Kenneth Cukier (*The Economist*) discuss the importance of harmonizing national and international strategies for energy and environmental security in Asia

GOING FORWARD

Harmonizing Markets and Public Policy

The one theme that came up repeatedly at the Summit is the importance of combining market forces with smart public policies. Whether the topic is CCS, renewable energy technology, energy efficiency, or the Smart Grid, neither market forces nor public policy alone is enough to increase the speed and scale of deployment—only through the right combination of both is it possible to improve energy security, maintain economic growth, and address global climate change.

Markets forces have proven themselves as the most efficient tool available for bringing new technologies to scale, but when it comes to addressing today's energy and climate challenges, markets forces need public sector support to drive innovation and to deploy new technologies that are still in an early stage of development. As noted by Anil Terway of ADB, "In order to address the climate change issue, there must be public-private partnerships. The private sector alone is not able to take up the challenge of addressing all of the externalities created by carbon emissions. It has to be the responsibility of the public sector to address this issue." The public sector can help drive innovation and spur deployment at an early stage

Smart policies are needed to create incentives and price signals that harness market forces and steer them in the direction of desired outcomes. If CCS is to be proven, made economically viable, and deployed on the massive scale that is needed, there must be a price on carbon, and government must help the industry get off the ground by underwriting risk where needed and creating a clear regulatory framework. Even promising Smart Grid technologies need government support during the early stages of their development. In short, the only way to deploy the technologies the world needs, on a scale sufficient to meet the challenges at hand, is through the use of market forces. And while most agree that government should not be in the business of "picking winners," there is recognition that public policy must play a role by making sure the right price signals are sent to the private sector—after which market forces and innovation can take over.

> No matter how you look at it, even if we leave aside Copenhagen for the time being, we need a very clear global compact for energy improvements all over the world, and for that two things are extremely important - transfer of finance and transfer of technology. At the end of the day, how much we can agree on those, and implement those, will significantly impact the extent to which we can reduce greenhouse gas emissions in the coming years.
>
> —Prabir Sengupta,
> The Energy and Resources Institute, India

Capacity Building

"In Indonesia, we need not only the simple transfer of technology, but also the institutionalized transfer of knowledge."

—Yahya Rahmana Hidayat, Ministry of National Development Planning (BAPPENAS), Indonesia

Capacity building is a key component of any successful energy management strategy.[4] Although capacity building is often less tangible and shows slower returns on investment than a wind farm or biofuels plant, it plays an integral role in determining how effectively an economy manages its energy sector. By investing in human capacity, charitable foundations and international financial institutions help lay the foundation for continued improvements in energy efficiency and smarter energy policies. The demand for high-tech skills and services provided by energy service companies, energy engineers, and energy auditors is increasing, and in many developing countries demand is far outstripping supply. Training the workforce of the future to fill these roles is an essential part of the equation, and this process can be aided by expanding collaboration among research institutions and universities in the region. Investments also need to be made in raising awareness of energy efficiency and conservation in all sectors. Ellen Carberry of the China Greentech Initiative pointed out that "to fully deploy industrial energy efficiency on the industrial side, we need to educate plant operators and technology buyers about the advantages of different technologies. Likewise we need to educate the financial players about how to evaluate energy efficiency projects, and how to provide the right kind of financing where there is some kind of guarantee upfront on a longer term return stream."

Intellectual Property Rights

One of the most vexing issues inhibiting the transfer of solutions to the energy-climate challenge is the protection of intellectual property (IP). As one private sector participant pointed out, in a world of open markets, abundant capital, and fluid labor flows, technology is the main differentiator among companies' products and processes. Without strong IP protection, companies with advanced clean energy technologies cannot risk venturing into new markets. How can this issue be

> The issues that are going to influence the availability of the best energy technology, and its ability to be deployed, are market pricing of energy, rule of law so that people have confidence that their investments are going to be protected, effective intellectual property protection, and free trade policies that remove barriers to the flow of these technologies.
>
> — David Bailey, ExxonMobil

resolved so the energy and environmental benefits of advanced technologies can be more widely realized? Several participants thought the most promising avenue is to address this issue directly through government-to-government agreements, either on a bilateral, multilateral, or regional level. IP protection is one of the foundations of free trade and open markets, and governments have an integral role to play by using laws, regulations, policy, and enforcement to create a legal environment where intellectual property is protected. Facilitating the diffusion of green technologies in Asia and the Pacific will require innovative approaches and governance that both protects IP and takes into account the disparities in economic development and technological sophistication among economies of the region. In today's globalized economy, intellectual property rights (IPR) and the creation of technical standards combine to form one of the most pressing and complicated trade issues. Summit participants recognized the need for more dialogue and progress on this subject in order to prevent concerns over IPR from impeding international cooperation on energy and climate issues.

Regional Approaches

Carbon pricing, innovative financing mechanisms, IPR protection, free-trade, market mechanisms, public policy—each one of these issues is extraordinarily complex in its own right, and none can be completely isolated from the others when discussing solutions to the energy-climate challenge in the region. Economies in Asia and the Pacific will be making enormous investments in the energy sector to meet energy demand and control carbon emissions. How these economies decide to invest their resources and coordinate polices will determine if and how the region overcomes obstacles and leverages market forces to maximize the potential of today's best clean energy technologies. While the Copenhagen climate talks were a move in the right direction, it will take more than a single large, formalized approach to bridge the gaps and accelerate progress. Some Summit participants believe

Left to right: Tadashi Maeda (Japan Bank for International Cooperation) and Anil Terway (Asian Development Bank) during the panel on "Facilitating Implementation"

the answer lies not in one individual mechanism or agreement, but rather an array of decentralized, multi-sectoral approaches at the national, subregional, and regional level. The use of existing frameworks like ASEAN (the Association of South East Asian Nations), ASEAN +3, the Asia-Pacific Economic Cooperation forum (APEC), the East Asian Summit, and other initiatives or mechanisms could accelerate the pace of progress, harmonize approaches, facilitate the sharing of best practices, and overcome some of the thornier issues through dialogue.

Regional forums might also be used to advance free trade agreements on clean energy technology, foster trans-boundary energy cooperation (as is being done with the ASEAN Power Grid Projects), and provide platforms at annual meetings (such as the APEC Japan 2010 Energy Ministerial Meeting) to address issues such as IPR and "green trade." Newer frameworks, such as the Asia-Pacific Partnership on Clean Development and Climate, can complement existing ones to build momentum on important regional issues. There is a growing sense that because of differing levels of economic development, energy endowments, and technology development among economies in the region, greater cooperation on energy issues is a win-win situation that can improve energy security for all. Regional mechanisms also can provide a forum for exchanging knowledge on best practices, developing human and institutional capacity, and increasing communication and exchanges among universities and research centers.

CONCLUSION

The differing levels of resource endowment and economic development among economies in Asia and the Pacific mean that no two are alike in terms of the energy challenges they are facing. In some countries, expanding access to energy is the first priority. In others, meeting energy demand, improving efficiency, or reducing greenhouse gas emissions are front and center. But shared concerns about global climate change and energy security are making the transition toward low-carbon growth models a priority of increasing importance. The lack of a binding global compact coming out of the Copenhagen Climate Change Conference underscores the need for continued stakeholder engagement and collaboration in different forums and settings. Summit participants repeatedly stressed the urgent need for action and solutions, but with recognition that global frameworks alone are not enough. As Dr. Hiroshi Komiyama of the Mitsubishi Research Institute pointed out, "Climate change is a global issue, but the countermeasures should be local and diverse."

New and renewable sources of energy, nuclear energy and clean coal, energy efficiency technologies, fuel switching, carbon capture and storage, and Smart Grid technologies, if used in concert with one another, can help meet growing energy demand while facilitating the transition to a low-carbon economy. The question today is how to speed the deployment of these technologies and bring them to scale. The determining factor will be how effectively

market forces are combined with public policies to achieve this goal.

Discussions at the Pacific Energy Summit highlighted several areas where regional collaborations and public-private partnerships can be successful in moving solutions forward. Many of the energy technologies that will have the greatest impact need support or assistance from policymakers and the government, at some point in their development, to enter the marketplace. This can come in the form of support for demonstration and pilot projects, efforts to resolve IPR concerns, definition of legal and regulatory frameworks, or legislation of polices to support the deployment of new technologies. Key to the success of these policies is the extent to which they can take advantage of market forces by not picking winners and allowing the private sector to take the lead in technology deployment, commercialization, and innovation. Bilateral and multilateral forums, regional frameworks, and independent initiatives can play a complimentary role by helping to overcome trade issues, creating free trade or green trade areas, establishing green technology investment funds, and facilitating capacity building.

Together, these initiatives can help spur Asia and the Pacific down the path of sustainable, low-carbon economic development, and toward a more prosperous future. As Nicholas Parker of the Cleantech Group pointed out, "How do we create sustainable prosperity for all? Energy security is really just a way of addressing that issue in Asia and around the world."

Endnotes

[1] The Pacific Energy Summit Team would like to acknowledge NBR Bridge Award Fellow Joe Narus for his work in drafting this report. The views expressed in this report do not necessarily reflect those of Pacific Energy Summit sponsors, collaborating institutions, or individual participants. Comments can be sent to <nbrpes@nbr.org>.

[2] Asian Development Bank, "Energy Outlook for Asia and the Pacific," October 2009, http://www.adb.org/Documents/Books/Energy-Outlook/Energy-Outlook.pdf. Figures in this and other sections are based on this report.

[3] The regional members analyzed in this report are classified by geographical groupings, including Central and West Asia, East Asia, the Pacific, South Asia, and Southeast Asia. The Developed Group includes Australia, Japan, and New Zealand. Detailed information about regional members is available at http://www.adb.org/.

[4] According to the United Nations, "capacity-building encompasses the country's human, scientific, technological, organizational, institutional and resource capabilities. A fundamental goal of capacity-building is to enhance the ability to evaluate and address the crucial questions related to policy choices and modes of implementation among development options, based on an understanding of environment potentials and limits and of needs perceived by the people of the country concerned." *Capacity Building—Agenda 21's definition (Chapter 37, UNCED, 1992).*

ENERGY SECURITY AND ECONOMIC GROWTH IN THE ASIA-PACIFIC: INNOVATION, MARKETS AND SMART POLICIES FOR A LOW-CARBON FUTURE

Tuesday, November 3, 2009

16:00 Registration Opens

17:30 – 21:00 Reception and Opening Dinner Conversation – Fuji Room

Welcome & Opening: Robert PRICE, Senior Director, Pacific Energy Summit

"A Conversation with the Audience"

Moderator: Tomohiko TANIGUCHI, Professor, Keio University

Discussants: Ken KOYAMA, Director, Strategy and Industry Research, The Institute of Energy Economics, Japan

NGUYEN Manh Hung, Executive Director, ASEAN Centre for Energy

Prabir SENGUPTA, Distinguished Fellow, The Energy and Resources Institute, India

Closing Remarks: Meredith MILLER, Vice President, Economic & Trade and Outreach, The National Bureau of Asian Research

Wednesday, November 4, 2009

7:00 – 8:00 **Continental Breakfast – Peacock East Foyer**

8:00 – 9:00 **Leaders Roundtable – Peacock East Room**

"Harmonizing National and International Strategies for Energy and Environmental Security in Asia"

Opening Address: Hiroshi KOMIYAMA, President, Mitsubishi Research Institute

Discussants: Angelo T. REYES, Secretary, Department of Energy, Philippines

Prabir SENGUPTA, Distinguished Fellow, The Energy and Resources Institute, India
Former Secretary, Petroleum & Natural Gas, India

Moderator: Kenneth CUKIER, Japan Correspondent, *The Economist*

9:00 – 9:30 Break

9:30 – 11:00 **Plenary Panel One: *Balancing Access to Energy, Energy Security, Climate and Development Concerns***

Panel Overview: This panel will take stock of and examine the key challenges, needs, and potential innovations and solutions that will shape the

Summit's discussions.

Moderator: Mure DICKIE, Tokyo Bureau Chief, *The Financial Times*

Speaker: Tetsuro FUKUYAMA, Deputy Minister of Foreign Affairs, Japan

Panelists: David P. BAILEY, Manager, Climate Policy, ExxonMobil

Edita S. BUENO, Administrator, National Electrification Administration, Philippines

Masahiro KAWAI, Dean and CEO, Asian Development Bank Institute

11:00 – 11:30 Break

11:30 – 13:00 **Plenary Panel Two: Solutions for Clean, Smart and Efficient Energy**

Panel Overview: How does the current global economic slowdown and growing energy price volatility affect energy and environmental security? Can the current crisis help forge new relationships between energy producers and consumers? This panel will assess solutions such as cleaner coal, natural gas, as well as high-tech and eco-friendly alternatives.

Moderator: Nicholas PARKER, Executive Chairman, Cleantech Group

Speaker: Angelo T. REYES, Secretary, Department of Energy, Philippines

Panelists: C. Lawrence GREENWOOD, Vice President, Asian Development Bank

Melody MEYER, President, Chevron Energy Technology

Koji OMI, Chairman and Founder, Science and Technology in Society Forum

13:00 – 14:30 **Working Lunch – Peacock East Room**

Smart Grid Technologies and Smart Policies for Asia's Megacities

Keynote Speaker: James N. SUCIU, President, Global Sales and Marketing, GE Energy

Moderator: James FOSTER, Director, Corporate Affairs, Microsoft Japan

Discussants: Yahya Rahmana HIDAYAT, Director, Energy, Telecommunications and Information, BAPPENAS, Indonesia

Masayuki TSUKAWAKI**,** Managing Director, Japan Wind Development Co. Ltd.

Hiroshi WATANABE, Senior Manager, Smart Grid Business Department, Toshiba Corporation

14:30 – 15:00 Break

15:00 – 16:15 **Roundtable / Brainstorming Sessions: *Conventional and Alternative Energy Supply and Access Solutions***

Coal – Mai Room

Moderator/Discussant: Mark C. THURBER, Director, Energy & Sustainable Development, Stanford University

Discussant: Yasushi FUKUIZUMI, Deputy General Manager,
Sustainable Energy and Environment Strategic Planning Department,
Mitsubishi Heavy Industries

Ronald MITCHELL, Manager, Business Development, Project,
Management Department, Environmental & Chemical Plant Division,
Mitsubishi Heavy Industries

New and Renewable Energy Sources – Tsuru Room

Moderator: Anil TERWAY, Senior Advisor & Practice Leader (Energy),
Asian Development Bank

Discussants: Toshikazu MASUYAMA, Ministry of Economics, Trade and Industry, Japan

Havidh NAZIF, Officer, Directorate of Geothermal Enterprise Supervision and
Groundwater Management, Ministry of Energy & Mineral Resources, Indonesia

Nuclear – Ohgi Room

Moderator: Ronald CHERRY, Energy Attaché, U.S. Embassy, Tokyo

Discussants: Akira OZAKI**,** Senior Fellow, Nuclear Energy Systems, Toshiba

Le Tuan PHONG, Deputy Director General, Energy Department,
Ministry of Industry and Trade, Vietnam

Oil and Gas – Miyabi Room

Moderator: Hirohide HIRAI, Director, Petroleum and National Gas Division, METI, Japan

Discussants: Tadashi MAEDA, Head, Corporate Planning Department,
Japan Bank for International Cooperation

16:15—16:45 Break

16:45—18:00 **Roundtable / Brainstorming Discussions: *Cross-cutting Issues***

Green Trade and Investment: Policies to Advance Cooperative Solutions – Tsuru Room

Moderator: Peter EVANS, General Manager, Global Strategy & Planning, GE Energy

Discussants: Nicholas PARKER, Executive Chairman, Cleantech Group

Optimizing Access: Urban/Rural Challenges – Ohgi Room

Moderator: Jiwan ACHARYA, Climate Change Specialist, Asian Development Bank

Discussants: Ellen CARBERRY, Founding and Managing Director, China Greentech Initiative

Yahya Rahmana HIDAYAT, Director, Energy, Telecommunications
and Information, BAPPENAS, Indonesia

Regional Collaboration: How to Fill the Gaps – Mai Room

Moderator: Kenji KOBAYASHI, President, Asia Pacific Energy Research Center

Discussants: Biswa BHATTACHARYAY, Special Adviser to Dean, Asian Development Bank Institute

NGUYEN Manh Hung, Executive Director, ASEAN Centre for Energy

The Energy-Water Nexus – Miyabi Room

Moderator: Mark STAPLES, Country Manager, Maritime Sensors & System, Lockheed Martin Global Inc.

Discussants: Kateri CALLAHAN, President, Alliance to Save Energy

18:00 – 18:30 Break

18:30 – 20:00 **Cocktail Reception – Peacock West Room**

Thursday, November 5, 2009

7:00 – 8:00 **Continental Breakfast – Peacock West Room**

8:00 – 9:30 **Plenary Panel Three: Managing Energy Demand**

Panel Overview: When looking for methods to meet future growth in energy demand there are a range of technical solutions that aim to reduce consumption, as well as a number of business and government models for energy efficiency. This panel seeks to better understand the demand-side challenges that exist in the Asia Pacific and models for demand-side management.

Moderator: Kateri CALLAHAN, President Alliance to Save Energy

Speaker: Akito ARIMA, Chairman, ACT Foundation

Panelists: Ellen CARBERRY, Founding and Managing Director, China Greentech Initiative

DO Huu Hao, Vice Minister of Industry and Trade, Vietnam

Jiang LIN, Senior Vice President and Director, The Energy Foundation

WANG Yanjia, Professor, Tsinghua University

9:30 – 10:00 Break

10:00 – 11:30 **Plenary Panel Four**: **Facilitating Implementation**

Panel Overview: This panel will explore the most practical approaches, including public-private partnerships, international and regional financing systems, and policies that will encourage the development,

deployment, and adoption of cost-effective approaches to increase energy supply security along a low-carbon path.

Moderator: Tadashi MAEDA, Head, Corporate Planning Department, Japan Bank for International Cooperation

Panelists: Shuhei ABE, President and CEO, SPARX Group

Ede IJJASZ, Sector Manager, Sustainable Development, The World Bank

Anil TERWAY, Senior Advisor & Practice Leader (Energy), Asian Development Bank

11:30-12:30 **Concluding Plenary Session: A CALL TO ACTION**

Panel Overview: An interactive conversation during which audience members are called upon to highlight key conclusions and propose ideas for ongoing research, policy workshops, collaborative efforts, and other activities to sustain the momentum and lay the groundwork for the 2010 Summit.

Moderator: Tomohiko TANIGUCHI, Professor, Keio University

Closing Remarks: Robert PRICE, Senior Director**,** Pacific Energy Summit

The 2009 Pacific Energy Summit would not have been possible without the leadership and support of the following individuals and institutions:

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