Strategic Framework for Energy Security in APEC: An Update

(Revised)

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June 2011

Prepared for
National Center for APEC and APEC Business Advisory Council

I. Preface

In 2008, the APEC Business Advisory Council and the National Center for APEC commissioned the East-West Center to do a study[1] (hereafter the 2008 Study) of energy security in APEC that businesses in the region could use to develop a strategic framework for action. The study, entitled, "*Strategic Framework for Energy Security in APEC,*" outlined four themes to regional energy security: expand and diversify supply of energy resources; manage energy demand through conservation and efficiency; promote efficient energy markets and clean energy use and technological innovations. Today, energy security—defined as access to reliable, affordable, and environmentally sustainable supplies of energy—is still a top priority in Asia and the Pacific. Now amid elevated yet volatile energy prices, the threat of inflation in some countries, and deflationary debt traps in others, it is important that some of the key elements illustrated in the 2008 Study be reviewed and updated. Moreover, it is critical for the APEC community to identify priorities and implement policies that address the gap between supply and demand, strengthen regional energy security, and reflect energy's relation to regional economic vitality.

The task is balancing escalating energy demand with the reality of constrained supplies. The purpose of this brief is to revisit and update the 2008 Study by incorporating views from various regional experts and ABAC members[2], and provide a revised strategic framework to advance policy development and implementation throughout APEC and align the Leaders' multiple goals for energy and develop a long-term integrated strategy with measurable objectives for improvements in the areas of energy security, efficiency, and technology renovations.

The focus of the study—energy security—has many intertwined dimensions, particularly for a group of economies as diverse as APEC. For developed economies such as the United States and Japan, energy security has been focused on international oil market stability and mitigation of the risk of interruption to the functioning of the market and the smooth flow of oil. For rapidly developing economies like China and Southeast Asian nations, energy security also includes the need to develop energy resources and infrastructure fast enough to maintain a stable economic growth. The power sector specifically, is a key concern in these developing economies. Furthermore, there is a greater connection between the energy demand in the transportation sector and demand by the wider economy.

As such, energy security should be broadly defined to include economics (adequate supply), market (free flows and minimization/removal of barriers), geopolitics (access to resources),

[1] See K. Wu, F. Fesharaki, T. Hosoe, D. Isaak (2008), *Strategic Framework for Energy Security in APEC*, East-West Center, Honolulu, Hawaii.

[2] We would like to thank Dr. Tilak Doshi of Energy Studies Institute (ESI) in Singapore, Mr. Osamu Fujisawa of FACTS Global Energy Japan, Dr. Ken Koyama of The Institute of Energy Economics Japan (IEEJ), Mr. David Pumphrey of Center for Strategic and International Studies (CSIS), Washington, D.C., and Dr. Shixian Gao of Energy Research Institute (ERI) of China for reviewing the 2008 Study and their valuable comments on the current one. We are also indebted to a number of APEC Business Advisory Council (ABAC) council members and as well as the National Center for APEC (NCAPEC) for their critique on an earlier draft of the report. All errors, if any, remain those of the report authors.

efficiency (demand management and conservation), environmental (clean fuels), and other dimensions. Of course, in a region as complex and diverse as APEC, a strategy for enhancing national and regional energy security could touch on literally hundreds of topics and tactics (such as increased oil stockpiling, bilateral energy cooperation, and free trade agreements). However, these are not touched on either because they have been examined at length over the previous decades, or because they do not seem to be of APEC-wide interest. The four objectives identified in this study are not intended to be exhaustive, but instead to suggest the areas where efforts by APEC could have the largest effect on improving long-term energy security.

As we did in the 2008 Study, the framework presented in this updated report continues to restrict itself to four broad objectives that seem both most urgent and most underdeveloped:

- Objective No.1: Expand and Diversify Supply of Energy Resources
    - Expanding the use of natural gas
    - Increasing access to conventional resources
- Objective No.2: Promote Conservation and Improving Efficiency
- Objective No.3: Promote Open and Efficient Energy Markets
    - Removing barriers to trade and investment
    - Phasing out inefficient fossil fuel consumption subsidies
    - Studying the futures market
- Objective No.4: Clean Energy Use and Technology Innovation
    - Expanding the use of clean coal through technology innovations
    - Reconsidering the use of nuclear power
    - Expanding the use of renewables
    - Smart grid, intellectual property rights, and other issues

Under the discussion of each objective, explicit questions are raised for policymakers to consider in grappling with the topic and in proposing the best means for APEC to address the issues at hand. Policy recommendations for each objective are included throughout the report and are also summarized briefly along with the conclusions for the report.

II. Background

Energy insecurity is a major cause of concern throughout the APEC community. However, security is attainable, but will require a concerted, cooperative effort by everyone. A key element regarding energy security is the requisite for a dual approach to the multidimensional dilemma of oil. First, alternatives to oil need to be expanded and encouraged, and oil use needs to be made more efficient, so as to reduce demand. Second, governments are encouraged to ensure high levels of oil production and efficient, smooth trade to stabilize prices and to avoid supply disruptions. Undoubtedly, in the long run, we all have to be prepared to go beyond oil. But in the short run, a period mandated for this study, the objectives discussed in this report are critical for APEC Leaders, Energy Ministers, and individual economies if the 2007 Darwin and Sidney, and 2010 Fukui Declarations on energy security are to be implemented. Singapore (efficient energy market), Japan (efficient use of energy), the United States (energy demand management), Russia (expansion of energy supply), and Indonesia (diversification of energy sources) as the hosts of the APEC Leaders' meetings of the recent past as well as through 2013 offer unique opportunities to address the policy issues underpinning these four themes. It is believed that the APEC agenda on energy security, sustainable development, and low carbon-economy will move forward substantially if each of the four themes and related issues can be turned into policy actions and implemented over the coming years.

Conceivably, the APEC agenda on energy security and sustainable development will move forward substantially if each of the four objectives and related issues can be turned into policy actions and implemented over the coming years. In the meantime, any framework to enhance energy security in APEC will have to recognize these dual mandates without giving priority to one over the other.

A. History of Energy Policy Discussions within APEC

Since the latter part of the last decade, APEC Leaders and Energy Ministers have addressed the issue of energy security on numerous occasions. The reality facing the APEC community and the world at large in terms of current and future energy demand and supply has also help put energy security on the center stage for future energy development in the region.

As noted in the 2008 Study, the issue of energy security has been consistently highlighted as a concern by APEC Leaders since 2004. In 2007, an additional dimension was added to the energy debate by the Leaders. It included the need to accelerate the development of clean and efficient energy and to devise methods to reduce greenhouse gas emissions, including the facilitation of clean technology use and trade within the region, thus creating, a multifaceted challenge of ensuring energy security in the region amid increasing demand, stagnating supply, and emissions constraints.

This initiative was expanded in June 2010 with the Fukui Declaration. Specifically, the ministers focused on energy-efficient buildings and appliances; fuel-efficient vehicles using lightweight materials, and other advanced technologies; low emission power sources including renewables, nuclear power, and fossil fuels with carbon capture and storage, renewable energy technologies, including solar, wind, geothermal, nuclear power; and bioenergy for electricity and biofuels for transport, to diversify their energy mix and limit carbon emissions. Additionally, the ministers emphasized increased use of cost-effective carbon capture and sequestration (CCS) and smart grid technologies, including advanced battery technologies for highly-efficient and cost-effective energy storage.

Following the publication of the 2008 study, a *Long Range Plan for Enhancing Energy Security in APEC* has been created by National Center for APEC, which intended to develop discourse between the public and private sector. The Plan included several workshops that were intended to generate specific recommendations and tangible policy objectives on each of the topics.

The first workshop was held in Singapore in November 2009 and focused on 'Diversification of Energy'. The purpose was to explore the expansion and diversification of energy resources as a means of security. Given the current situation of water restraints, depleting oil reserves, and emission standards, diversification of energy resources remains critical to regional security. The panel acknowledged that renewables, nuclear power, clean coal and natural gas are not currently or equally viable. Specifically, the panel targeted the need for rapidly expanding natural gas markets, smart grid standards, and government policies to incentivize energy diversification and innovation.

The panel agreed that government policies such as tax incentives, increased infrastructure, greenhouse gas emission standards, and mandatory fixes of renewables and traditional resources, has potential to impact the speed of energy diversification. Furthermore, they concluded that the APEC region requires comprehensive policies that include fair access to trade, investment assurances, and tax policies in order to promote investment of new sources of energy alongside traditional sources. Additional consideration was given to the importance of smart grid technology in managing supply and demand and alleviating system volatility and stress. Essentially, as energy sources diversify, smart grid technology will be critical to balancing the grid and using appropriate amounts of energy from each application.

The second workshop was held in Yokohama in November 2010 and focused on 'Harmonization of Standards for Energy Efficiency'. The panel acknowledged a necessity for cooperative development and mutual recognition of standards. Considered initiatives included third-party product testing, reduced technical and trade barriers, acceptance of a carbon market scheme, and consumer surveillance programs. To achieve this initiative, the panel recommended a synthesis of government regulations and incentives that enforce and encourage efficiency improvements, as well as disseminating knowledge through trade. However, they recognized existing obstacles induced by the differing conditions and circumstances among the APEC countries.

A common method of standards measurements will move the region toward greater harmonization and efficiency, benefitting companies, consumers, and the environment. In fact, access to larger markets has translated into economies of scale and greater profits for companies and lower costs for consumers. Nevertheless, although most consumer electronics have worldwide specifications, home appliances have different specifications based on the standards of each country. And due to the constantly changing regulations and varying levels of standards enforcement, substantial resources are spent on multiple product lines and consumers end up both unaware of what the labels mean and what their implications are for what they buy. Consequently, production is done in small lots which are less cost effective to the manufacturer. Thus, consumer-material certification agencies should ensure cooperative development of standards, meaningful label programs, and quality of product research laboratories and consumer education should be mandated.

The panel emphasized the need for energy savings across the entire supply chain to include power generation, transmission, and conservation. Specifically, they focused on supply side savings because they are more immediate due to available technology, more effective due to higher return on investment, and more achievable than at the consumer level. They also acknowledged demonstration projects and mandatory targets for cogeneration that can provide a strong incentive to deploy combined heat and power (CHP).

Ideally, businesses should take a leading position in these initiatives and comprehensive government policies should mitigate uncertainties and increase the private sector's willingness to invest. Essentially, government regulations should include a range of actions including: tariff-based incentives that support targets for efficiency, phase out fossil fuel subsidies, create emissions performance standards that reinforce the retirement of older plants and upgrade existing plants and allow markets to reflect reality i.e., eliminate artificially low energy prices that discourage environmental goods and services (EGS) investment, market failures such as poorly informed consumers, and multiple and shifting standards that discourage companies from investments. Trade policies should eliminate tariff and non-tariff barriers and instead encourage the dissemination of energy efficient products and services. The true cost of energy should be reflected. In many countries, energy is subsidized; therefore, carbon costs should be built into the price so consumers are more attracted to energy efficient products. Finally, green tech should be accompanied by strong intellectual property rights (IPR) and EGS agreements that make green adoption more affordable.

In 2009 and 2010, APEC summits were held in Singapore and Japan, respectively. For 2011, the summit will be hosted by the United States, for 2012 by Russia, and in 2013 by Indonesia. These economies play key roles in the energy sphere:

- Singapore - the trading hub of the Asia Pacific for petroleum products;
- Japan - the most efficient user of energy of the developed APEC economies;
- United States - the second largest energy consumer in the world and the member economy capable of having the greatest impact on demand; and
- Russia - an important global energy producer.
- Indonesia - a resource rich developing economy that is in need of increasing as well as diversifying sources of energy supply with rising demand and stagnating domestic production.

B. Current Energy Situation and Future Growth

In the APEC region, there is a huge gap growing between energy demand and supply. Despite the presence of resource-rich economies such as Russia, Canada, and others, the APEC region is the largest net energy importer in the world and will remain so for many years to come.

In late 2008 and 2009, the global financial crisis temporarily slowed down the demand for energy resources in the APEC region and the world at large. Since then, the world economy has been in the process of recovering, led by developing Asia, particularly China and India. However, the recovery has not been stable and challenges remain high amid volatile and high energy prices. For instance, in late June 2011, International Energy Agency (IEA) authorized the release of 60 million barrels of oil from strategic petroleum reserves (SPRs) for its 28 member countries over a period of 30 days. The fact that this is only the third time that IEA issued a release of SPRs is a reflection how fragile the energy market is as well as how serious the challenges are to the current recovery of the world economy.

From the depths of the great recession, a new financial order has emerged, marked by growth from the developing world, particularly those within Asia and the Pacific. 2010 marked the second largest energy demand increase in 30 years. And, for the first time in modern history, demand shifted from West to East and North to South.

At the core of this new global paradigm is the Asia and Pacific region. Thus, the APEC community is poised to emerge as the most dynamic economic region of the 21st century. Certainly, the region will experience great triumphs and tragedies in its phenomenal ascent to economic eminence. Yet, the APEC region faces unprecedented challenges ahead; one of which is shared by our common need for energy security.

2011 has been characterized by emerging realizations of our era. The Middle East and North Africa turmoil represents the instability—at least partially since the most important oil producing countries are less impacted—of the largest oil supplying region (upon which APEC is particularly dependent); natural catastrophes in Japan represent the inherent risks and our ultimate reliance on fossil fuels; and, the subsequent European reaction (Germany, Switzerland) that led to nuclear power decommissioning will have lasting pressures on demand and hence fossil fuel prices.

However, as the world economic growth transitions from the developed to developing economies, the proportions of energy supply is transforming as well; albeit at a much slower rate. Nevertheless, the trend until 2030 is evident. In its 2010 annual report,[3] IEA estimates that total energy demand will increase by 40% by 2030 and hydrocarbons (coal, natural gas, and oil) will increase by 80%. In other words, the IEA expects that fossil fuels will remain dominant, despite the implementation of low carbon policies. In its latest release,[4] BP indicates that liquids currently represented 33%, coal is 30%, and natural gas is 24% of primary energy consumption, totaling 87% in 2010. The remaining shares went to nuclear power (5%), hydro (7%), and renewables (1%). In 2030, the forecasted proportions are similar where fossil energy accounts for 81% of the total: liquids at 28%, coal is 27%, natural gas is 26%, nuclear power is 7%, hydro is 7%, and renewables are 5%. In terms of absolute growth, the overall world energy consumption increases by nearly 40% in total, which oil 14%, biofuels 300%, natural gas 53%, coal 26%, nuclear power 79%, hydroelectricity 48%, and renewables 417%.

Therefore, in the next two decades, energy security will be determined by the availability of the fossil fuels supply. Notably, petroleum will be used for an increasing transportation sector as well as power generation and feedstock for the petrochemical and industrial sectors. In order to mitigate risks, in the APEC community must hedge against volatility and supply disruptions in the short and medium term, and ease supply and demand tensions by developing new and diversified sources of energy and decreasing energy intensity in the long term, in order to facilitate a smooth transition to secure energy future.

[3] See IEA, 2010, *World Energy Outlook 2010*, Paris, France.

[4] See BP, January 2011, *BP Energy Outlook, January 2011*.

However, the next two decades will be accompanied by depleting traditional reserves, which will require the discovery of new sources that will likely be smaller and less economical to produce; in essence, the age of easy oil is over. The IEA estimates that investments of US$450 billion are needed in conventional and unconventional exploration and production every year over the next 25 years in order to satisfy our growing energy appetite. Consequently, the price of nonrenewable energy will rise as demand increases due to increased population and standards of living worldwide and as reserves become smaller and more difficult to bring to market. This leaves policymakers with a daunting task of balancing escalating demand versus the reality of limited oil supplies.

Needless to say, we are not necessarily running out of our conventional energy resources; they are merely becoming more expensive to produce. The IEA estimates that 70% of conventional oil production needed by the end of this decade is yet to be developed or discovered. In addition, 75% of the reserves are owned by state-owned companies from which foreign investment is restricted, whereas 60% of production originates from non-nationalized oil companies. Evidently, nationalization usually prompts inefficient extraction and production of these resources. As a result, international companies are moving their operations offshore, to remote and harsh regions where oil production is expensive and difficult. Notably, in the last ten years, more than half of all new oil and gas reserves have been discovered offshore. Energy Information Administration (EIA) of the US estimates that by 2020, nearly 1/3 of oil will come from offshore of which 1/3 will come from deepwater. In addition, the conventional oil sources are complemented by unconventional supplies such as tar sands and oil shales. What offshore and unconventional resources both have in common is a high capital cost and operational difficulty.

Nevertheless, unconventional resources are estimated to be much larger than conventional oil resources; thus, they will play a major role in the future oil supply. The rate at which they are produced will be determined by economic, environmental, and technical variables. Notably, technologies that provide more efficient extraction, carbon capture and storage (coal-to-liquid plants), and the addition of biomass to feedstock will be in high demand.

Technology will play an important role in bringing resources to the market. Innovations will improve the size and recovery rates of existing resources and will attempt to solve the unconventional production problem. This however, requires extensive research and development, intellectual property rights, technological adaptations from other industries and commercial timing. In fact, the first innovators will benefit through reduced energy resource imports and increased energy technology exports. For example, the US was among the pioneers of the solar industry; however, China invested heavily in solar technology and has since surpassed the US in terms of national solar capacity. The need to develop energy efficient technology is emphasized by the IEA's New Policy Scenario,[5] which expects persistently high levels of oil spending and imports. Under this scenario, total spending on oil and gas imports more than doubles from US$1.2 trillion in 2010 to US$2.6 trillion in 2035. Furthermore, China will overtake the United States as the world's bigger importer and spender on oil imports around 2025 and India will overtake Japan as the world's third-largest spender around 2020.

[5] See IEA (2011), ibid.

Energy security is predicated upon a greater diversity of the energy mix. Ultimately, more renewable energy sources will emerge, but will remain in modest proportions compared to fossil fuels. Thus, over the next two decades, we will continue the transition to a more diversified energy supply base consisting of fossil fuels (coal, natural gas, oil), nuclear power, biofuels (trees, shrubs, culture and animal waste, agriculture), and renewables (solar, wind, hydro, geothermal). The potential for renewable energy is extensive and these sources are the answer to a secure and sustainable energy future. However, due to their capital-intensive nature, development is dependent on substantial government financial support and technological innovation, a complementary combination of public and private sector investments and collaboration. For example, hydroelectricity is capital intensive and low operating costs, but most of the potential sites have been used; nuclear power is capital intensive, but entails risks of accidents and adherence to the Nuclear Non-Proliferation Treaty (NPT). In the meantime, we will require increased energy efficiency, sustained access, and a profound development in our transitional energy resource, natural gas.

The objective of efficiency is to consume less energy while maintaining current economic activity. A reduction in energy intensity is conditional upon the removal of subsidies, as to expose the energy market to natural forces of supply and demand, which will logically increase the price and decrease the intensity through less consumption and technological innovation as prices increase. Although there are concerns that less energy consumption will result in less economic growth, this hypothesis is not exactly true; it depends on the level of economic development within a region. Theoretically, as an economy transitions from an industrial base to a service base, energy intensity should decline. Regardless, global electricity demand is expected to grow faster than any other form of energy. Under the IEA's New Policy Scenario, energy use is expected to increase 2.2% annually between 2008 and 2035 (76% total). For example, Chinese electricity demand will triple and the amount of capacity they are expected to add is equivalent to the total installed capacity in the United States.

Energy security is also conditional upon the availability of necessary resources. It is estimated that there are 1.2 trillion barrels that can be extracted, refined and delivered *with current technology*. Among current reserves, 75% are held by Organization of Petroleum Exporting Countries (OPEC), which are inherently unstable societies. This political dimension creates additional supply instability as experienced by the recent turmoil in North Africa and the Middle East. Although the events had a relatively small effect on physical supply, the psychological effect was substantial and was reflected in crude prices. Similar events are troublesome for the Asia and Pacific region, which is heavily dependent on the Middle East, a region that will continue to be characterized by instability and uncertainty. Thus, expensive production accompanied with Middle East instability will continue to raise oil prices. This will ultimately stimulate the necessary amount of exploration and production as well as increase financial interest in alternative energy sources such as natural gas, renewables, nuclear power, and biofuels.

The natural gas market is growing much faster than oil, because it is currently the best option for energy security and environmental concerns. Also, it is a component in a variety of uses ranging from heating, power generation and agricultural fertilizer to many more uses in the future. The economics of the natural gas market are governed by the geography and proximity to market. In Asia and the Pacific region, prices have been determined by long-term contracts as a function of the price of oil. As a result of their link to oil prices, natural gas prices tend to be volatile by nature. This occurs because of the lack of an established regional natural gas commodity exchange. Thus, without a secured sale price through long-term contracts (typically 20-25 years), producers cannot ensure product sales or obtain the project financing necessary in developing their resources. Essentially more growth, investment, and interconnection are needed, which can be partially accomplished through a regional futures market.

This transition to natural gas is evidenced by the perception of a relatively secure and environmentally sustainable source of energy. However, prior to the 1990s, gas production would have been considered unconventional and a nuisance to most producers. Nevertheless, considerable achievements in technology have enabled a renaissance in the US natural gas exportation and production (horizontal wells and hydraulic fracturing for gas shales), as well as established financial markets, intellectual property laws, and consumer demand.

EIA projects that shale gas production could account for 46% of all US gas production by 2035.[6] However, technology will need to develop significantly in order to extract the full value from currently wasteful shale gas production. In addition, EIA sponsored a study[7] that estimates a presence of about 5,700 tcf of technically recoverable shale gas resources from 14 regions containing 32 provinces. Put into perspective, this estimate is nearly as much as the world's current proven gas reserves.

III. Objective 1: Expand and Diversify Energy Supply

As we noted in the 2008 Study, it is very important for APEC economies to work together to expand and diversify the supply of energy resources. The diversification efforts focus largely on the reduction of the dependence on oil by expanding the supply and viability of substitutes. As APEC economies look to options of natural gas (including unconventional gas), clean coal, renewables, and nuclear power, it is important to note that these alternatives are not equally viable at the present time. Some may take longer and require technological progress to become possibilities. We believe these challenges can be overcome through regional cooperation.

A. Expanding the Use of Natural Gas

Natural gas provides a clean and efficient alternative to oil in a wide variety of uses, from fueling centralized power generation to meeting home cooking needs. Since gas must be kept under pressure, however, it presents special transport and storage requirements, and has tended to be used first near centers of production. While oil-import facilities are relatively

[6] See EIA, April 2011, *American Energy Outlook 2011, with Projections to 2035*, Washington, D.C.

[7] See EIA, April 2011, *World Shale Gas Resources: An Initial Assessment of 14 Regions Outside the United States*, Washington, D.C.

cheap and can be scaled from tiny to large, the infrastructure required for long-distance movement of gas, whether via pipeline or LNG (liquefied natural gas)—except for mini-LNG plants and distribution facilities which serve smaller markets—usually requires large investments and has a minimum economic scale. For this reason, gas projects designed for international export tend to require long-term contracts to proceed. The scale and the possible political risks are both substantial.

Asia Pacific Gas/LNG Demand Prospects

In 2010, natural gas' share of primary energy consumption in the Asia-Pacific region was only about 10%, which is much lower than the estimated global share of over 23%. This shows that while Asia dominates with 60% of the world's LNG market trade, gas is still a smart part of the fuel consumption pie which is dominated by coal (46%) and oil (24%). While this is predominantly due to the distance between demand centers and supply sources, it once again highlights the growth potential of natural gas as Asia continues to develop its appetite for the fuel.

The "Big 4" gas consumers in Asia in 2010 were China, Japan, India, and South Korea. China saw gas demand hit 10 bscf/d, nearly doubling the combined gas consumption in South Korea and Taiwan. Japan comes in second with around 9 bscf/d. By 2030, Chinese gas demand will represent more than one-third of Asia Pacific's gas demand, up from about one-fifth in 2010. India will come in a distant second, despite consuming roughly the same amount of gas as China in 2000, after overtaking Japan post-2020.

The mismatch between gas use and supply by the "Big 4" Asian gas consumers is expected to widen as gas demand in outpaces growth in gas production. Japan and South Korea scarcely have indigenous gas supplies and will become more heavily dependent solely on imported gas sources, while India and China still have domestic gas sources to turn to. As Japan and South Korea are not expected to assume pipeline gas imports, these two countries will depend on LNG to meet their rising requirements. Combined LNG deliveries are expected to exceed 120 mmt by 2020 and almost 130 mmt by 2030. Imports are also expected to make up an even larger share of China (45%) and India's (34%) natural gas supply by 2030. India is only expected to import gas via pipeline post-2020; therefore only China currently imports gas via LNG and pipeline gas.

LNG imports accounted for some 36% of the Asia-Pacific region's total domestic natural gas supplies in 2010 and this share is expected to continue to rise in the coming years as growth in LNG demand outpaces growth in domestic gas supplies. Imports in 2011 are expected to increase by over 15% on the year thanks to increased demand across the board, especially from Japan. Due to the triple disaster (earthquake, tsunami, and nuclear power issues) in Japan, it is estimated that Japan's LNG requirements could grow by up to 9 mmt on the year. Although South Korea and Taiwan will show impressive growth, Chinese and Indian LNG imports are tipped to increase by 38.4% and 40.9% respectively on the year largely due to the start-up of new LNG import contracts and ramp-up of existing ones. Combined, these countries could constitute over 25% of total Pacific Rim LNG trade by 2020, up from 13.5% in 2010.

By 2030, Asia Pacific LNG demand could exceed 290 mmt, approximately half of the region's total marketed production. Growth will be driven by countries like China, India, and new markets where regasification facilities are already under construction such as Thailand, Singapore, Indonesia and Malaysia.

Unconventional Gas

In terms of supply prospects, global unconventional gas prospects—namely, shale and coal bed methane (CBM) gas—is tipped to play an increasingly important role in the future gas supply mix of many countries, thereby transforming the total supply picture. The breakthrough in unconventional gas across America have since led to many discoveries and developments are now taking place in Asia, Europe, the Middle East, and selected African countries, whether it is shale gas, CBM, tight gas, or gas hydrates. Higher natural gas prices and advances in technological know-hows in recent years have made unconventional gas production more economically viable. In the APEC region, while unconventional gas in Australia's gas supply scene is not a recent phenomenon (it has been present in the country's domestic gas supply for decades), Australia's unconventional CBM projects now account for over 40% of the country's future LNG export capacity. China who is one of the biggest importers of conventional gas is now realizing the huge potentials of its CBM and shale gas resources.

US Shale Gas Developments

The US has been at the forefront of the unconventional gas revolution. In the context of overall domestic gas supply, unconventional gas accounted for about 31% of total US gas supply in 2010, with shale gas alone accounting for about 23% of total supply. While it is still relatively marginal in the total supply portfolio, its share will increase significantly in the coming decades according to the early release version of the Annual Energy Outlook 2011, published by the US Energy Information Administration (EIA). According to the EIA, unconventional gas (shale and CBM) is forecast to grow by 3% annually to 2035. Shale gas alone is forecast to grow by over 3.5% per annum through 2035 and will account for nearly 50% of total US domestic supply under the same growth projections.

The growth in US gas supply as a result of increased shale gas production has had a dramatic effect on LNG imports. As recently as a few years ago, everyone from independent consulting companies to the US government to the oil companies themselves were forecasting a significant increase in the US LNG imports in the near term. Companies invested billions of dollars in liquefaction trains targeting the US market. Now, given the surge in domestic supply, the LNG is not needed in the US, at least in the near term and certainly not on the scale that was envisioned a few years ago. However, the investments have been made and LNG is beginning to flow, particularly from larger producers such as Qatar. The implication is that large volumes of LNG, that were targeting the US market, are likely to go to higher value markets around the world, as long as the US gas prices remain relatively soft given the domestic supply position.

In the US, LNG is a price taker as it is based off of Henry Hub. Thus, if producers can achieve higher netbacks in alternative markets, they will redirect the cargoes. We expect LNG to still come into the US, but on a much smaller scale than envisioned a few years ago. According to the EIA's early release version of the Annual Energy Outlook 2011, LNG imports are forecast to peak around 2021 at roughly 11 mmt, compared with 2010 imports of around 9.4 mmt. This is a far cry from EIA's forecast a year ago of approximately 31.0 mmt and over 60 mmt by 2020.

Optimistic production outlook has in retrospect, helped the US LNG export projects garner momentum. Already, the US export proposals have obtained some traction with prospective tenants. Cheniere Energy's Sabine Pass LNG has signed non-binding memorandum of understanding (MOU) with five companies for up to 7.7 mmtpa of bi-directional capacity rights. Cheniere also has an MOU for 0.6 mmtpa of LNG supply with two Caribbean electricity utilities. Meanwhile, Cove Point's biggest tenant, Statoil, could monetize some of its Marcellus assets through the 1.8 bcf/d terminal if it is reconfigured as a bi-directional facility. In short, the shale gas revolution has had a profound effect on the US gas supply and lessened the need for LNG. This bodes well for other LNG importing nations as investments made by producers for the additional bi-directional facilities will mean that gas exports would be directed outside of the US.

Other Developments on Unconventional Gas

Unconventional gas projects are in their infancy in Asia, but the outlook seems promising. China is leading Asia's prospective unconventional gas development. For example, the recent EIA study puts China as having the largest total recoverable resources (1,275 tcf) in the world. Though still in early stages, China, as well as Asia as a whole, could reap significant rewards from unconventional gas developments going forward. If Asia can replicate what has happened in the US, there will be major implications for the global LNG market—although we believe this is unlikely. It is too early to determine how large an impact shale gas will have on Asia's gas balance, given that a surge in unconventional output could potentially back out LNG from the largest regional market in the world; the situation bears close monitoring.

For China, under our base-case scenario, total unconventional gas (CMB and shale gas combined) is forecast to account for 15% of China's domestic gas production by 2020 and 21% by 2030 as a result of promising foreign investments and government-backed policies for CBM. As for India, we remain skeptical regarding the shorter-term progress of CBM production. Most of India's CBM blocks are either along the North Eastern belt or scattered in states like Madhya Pradesh and Tamil Nadu that do not have good pipeline connectivity and exploration have yet to make significant progress. However, New Delhi hopes to see CBM production reaching 130 million standard cubic feet per day (mmscf/d) by 2012, but energy companies in India need to develop the slated gas grid that will improve connectivity amongst producing states to end-users by 2013 before there can be significant growth for CBM output.

From a supply point of view, unconventional gas to LNG supply projects is deemed to have more significant impact on the international level of gas supply from 2015/2016 onwards. The three likely supply projects from Australia for unconventional gas–based LNG—Queensland Curtis LNG (QCLNG), Gladstone LNG (GLNG), and Australia Pacific LNG (APLNG)—will add 28.8 mmtpa of LNG to the market. The additional supply may be dwarfed by the total announced projects in Australia, but still represents a significant volume—almost 10 mmtpa more than China and India's combined LNG imports in 2010. This is a huge step for the LNG industry, as the success of these projects will set the benchmark for future unconventional LNG supply projects around the world.

Key Issues on Gas Trade in the Region

As mentioned, developing gas use generally requires much larger investments than do oil or coal projects because gas is more difficult to transport. This has deterred lower-income countries seeking rapid economic growth, which have preferred easier, smaller-investment projects using oil. The international corporations exploring for oil and gas in Asia have preferred developing oil there for the same reason it brings quicker returns on investment and is easier to market. This helps explain why gas markets in the region are generally less developed than the oil markets.

The lack of infrastructural (LNG importing terminal facilities, storage, trunk and distribution lines) is one of the key impediments to consumption growth and trade. A good pipeline network system in place would facilitate the growth in use of natural gas domestically. China, for example saw a 7-fold increase in gas consumption over the last 15 years, strongly attributed to the addition of more than 30,000 km of pipeline networks. In addition, the additions of LNG receiving terminals in the last couple of years have enhanced the use of natural gas in the coastal regions. The development of the transport and distributional infrastructure necessary for dramatic gas expansion will require support from both the private sector and, most importantly, Asian governments. The establishment of international gas transport infrastructure, be it pipelines or LNG terminals, invariably requires the involvement of government. In the least interventionist of cases, this might mean involvement in the permitting and routing process. However, establishing international gas trade often includes governments as parties in the negotiations themselves. Since the lack of infrastructure is one of the principle barriers to increased gas trade, APEC governments who wish to expand the role of natural gas need to study and confer on how infrastructure can best be expanded.

Domestic gas prices in several countries in Asia are regulated to benefit specific sectors. However, excessive government intervention in natural gas pricing discourages exploration, development, and production of natural gas in many Asian countries, leading to less natural gas consumption. This also affects the affordability by the various sectors to pay international prices, creating obstacles in gas/LNG trade. Where gas/LNG imports costs are higher than the gas retail price, this may yield negative returns to gas suppliers as the differentials may initially be borne by suppliers, ultimately discouraging gas imports. On the flip side of the coin, the opposite may hold true for exports where producer/suppliers find greater incentive to export to higher paying international markets (like in the case of Malaysia and Indonesia). With global oil and gas prices (especially for contracts indexed to oil) forecast to continue climbing in coming years, the situation is expected to be under greater scrutiny if adjustments are not made to address price disparities in wake of rising gas demand.

The immaturity of the international gas market, relative to the oil market is another key impediment. At the risk of perpetrating a pun, one of the biggest problems with the gas market is a lack of liquidity, particularly in Asia. For gas projects—especially LNG projects—to find financing, it is typically necessary for all or most of the gas to be presold in long-term contracts. Cargoes and contracts are traded on a small spot market, but today's market is thin for prospective new buyers or producers to feel certain that they can obtain or dispose of a percentage of their requirements outside of long-term contracts as the main expansion in the spot market has come not from suppliers who have built extra capacity, but from capacity left when long-term contracts have expired.

We continue to believe that a futures exchange in a commodity requires that someone provides liquidity, ensuring that buyers can be matched with sellers, and that contracts not liquidated before the market closes can be physically delivered. Market mechanisms in gas have yet to become as sophisticated as in oil, but reliable forms of trade in pipeline gas have developed in North America and in Europe. In Asia, where LNG dominates the international trade in gas, the market remains quite underdeveloped; thus establishing an Asian futures market in gas remains a possibility. This would make it easier for projects to go ahead without needing to establish contracts for their full volumes, and also easier for buyers to enter the market, committing to greater volumes than they might need. However, we also agree that an establishment of a functional futures market for gas—or oil for that matter—is not an easy task in Asia as it requires the participation of important parties, particularly energy suppliers. Traditionally, Asia's LNG business model has based on producer-consumer relationships. Some of the existing Asian markets of energy trading are struggling to gain acceptance and more studies on demand, supply, market structures, and government policies are needed before any futures market for gas is ever considered in the Asian region of APEC (see *Studying the Futures Market* under Session VI).

Finally, a crucial factor which could make or break gas trade is the involvement and policies of governments. The establishment of international gas infrastructure (be it pipelines or LNG terminals), and the feasibility of trade between certain countries invariably requires the involvement of the government. In the least interventionist of cases, this might mean involvement in the permitting and routing process. In some cases, it may also mean direct investment or financing by the government, especially for mega projects. Very frequently, the establishment of international gas trade includes governments as parties in the negotiations themselves. Some examples of principle barriers to increased gas trade stemming mainly from the direct involvement or policy implementation by governments include—gas allocation policies such as the domestic market obligation (DMO) in Indonesia which essentially restricts exports of natural gas to a certain extent; lack of free trade agreement (FTA) between the US and many countries in the region that could prevent the movement of more LNG from the West to East; regulated price regimes which have made gas imports unattractive; etc. Governments who wish to expand the role of natural gas need to be prudent with their trade, legal, fiscal, and policy frameworks to ensure a competitive and conducive environment is structured.

B. Increasing Access to Conventional Resources

No one today would dispute the notion that nations have sovereignty over their natural resources; this principle has been well-established since the 1960s. While there is no question that a nation has the right to exploit domestic energy resources through whatever mechanisms they see fit—including national monopolies on exploration and production (E&P)—restricting resource access to specially selected groups can have adverse consequences for the producing nation.

The oil crises of the 1970s and early 1980s were the heyday of the national oil companies (NOCs) as a model for resource development. In fact, "access to resources" or "sovereign control over natural resources" has been at the center of NOC-IOC (international oil companies) discussions. Considering that NOCs owned 89% of the global oil and natural gas resources in 2007, according to Energy Intelligence, energy security, future supplies, and policy issues can be understood analytically only if we understand the behavior of NOCs. Opening exploration areas to foreign participation can draw in capital and also pull in the most sophisticated E&P technology—including highly proprietary techniques that are available from only a few companies. While there are service companies that offer to perform advanced E&P on a work-for-hire basis, not all companies are equal in expertise, and it is worth noting that a company has less incentive to perform at its most innovative if it gets paid regardless of its success in finding oil or not.

Today, NOCs come in different forms and with different national objectives—both commercial and non-commercial. Some are major hydrocarbon exporters, while others are major importers. Some have an operating environment similar to that of a private firm, with Malaysia's PETRONAS being a good example. PETRONAS is wholly owned by the government but operates like a commercial entity, as lack of protection has kept PETRONAS as professional and business-like as any international company. They compete with foreign companies, even within Malaysia. (The US spawned many of the world's most successful multinational oil companies, and all of them were created in the most competitive environment possible.) Competition can make NOCs grow stronger and can help them reach out into the international arena, which can increase a nation's energy security. In other words, lack of competition can lead to overstaffing, undue levels of political influence in business decisions, and can encourage various kinds of corruption. PETRONAS—in addition to their crudes/condensates and natural gas production in Malaysia—have participated in upstream oil and gas developments in over 20 other countries, and owns substantial shares in the production of recent oil fields in Chad, Indonesia, Sudan, Vietnam, and Mauritania. They own joint ventures overseas in refining and petrochemicals as well. Although the other key reason to expand its international upstream activities was Malaysia's oil/condensate and natural gas reserves have not been increasing significantly during recent years, PETRONAS' expansion overseas has greatly enhanced that nation's power over energy resources and energy trade.

Although estimates of prospective resources vary, many analysts believe that today, the majority of unexploited oil (and to a lesser extent, gas) lies in areas that are not open to competitive E&P. This not only lowers the supply of oil on the overall market, but also risks that the oil in such areas will be underexploited, either through lack of efficient discovery, or through suboptimum production techniques. Both the international market and the owner of the resource benefit from competitive bidding on resources. (Of course, in the wake of Gulf oil spill in 2010, any discussion of expanding the access to conventional oil resources in the US is sensitive.) There are technologically-driven NOCs who emphasize on technology development and long-term R&D; for example, Norway's Statoil and Brazil's Petrobras. Although the companies rank well in certain technologies, which were developed through their own exploration operations, the future may be different as technical challenges will continue to increase as exploration areas become increasingly harsh—including deep water, further north (the Arctic), and remote locations. Through technology cooperation, there will be more alliances or partnerships between NOCs, IOCs, and service companies.

In encouraging NOCs to maximize the value-added of the national resource, governments have in effect turned the NOCs themselves into national resources, and the oil taps can no longer be turned off without hurting the nation's resource base. Strange as it might seem at first, the expansion of NOCs onto the world market is likely to act as a stabilizing force and damp down the role of politics in oil trade. It is an extremely positive and valuable development for the global energy markets, upon which many economies depend on and will help the global energy markets function with more logic and more attention to market forces.

Key questions to be addressed:

- *What are the options for sharing gas transport infrastructure between importing countries? How can pipeline security be enhanced?*

- *What kinds of technology transfer may have to take place in order for undeveloped, unconventional gas resources in APEC economies to be developed?*

- *How can APEC governments help foster a successful international commodity exchange in natural gas? Are there risks to changing LNG from a bilateral contract product into a generally-traded commodity?*

IV. Objective 2: Promote Energy Conservation and Improve Efficiency

As we noted in the 2008 Study, promoting energy conservation and improving energy efficiency have long been the priority in many APEC economies, partly because high energy prices or price spikes have driven conservation and efficiency efforts forward. Furthermore, most of these gains remained in place when energy prices fell again.

The importance of energy conservation and efficiency has also been emphasized by the APEC Energy Ministers. In their May 2007 Darwin Declaration, the APEC Energy Ministers regarded improving energy efficiency and conservation central to the region's sustainable development of energy in the long term. In the energy workshop focusing on 'Low Carbon Paths to Energy Security' held in Fukui, Japan in June 2010, efficient use of energy and cleaner energy supply were discussed in the context of enhancing energy security and boosting growth and lower emissions.

Improvement of energy efficiency leads to less use of energy while the same amount of products and services provided. It also means greater products and services are supplied with the same or even lower levels of energy consumption. The benefits include emission reductions, lower energy intensity, and more availability of energy available. Energy efficiency is critical to APEC energy security since the region includes the world's three largest energy consuming economies—China, the US, and Russia. Adding Japan, Canada, and South Korea, six APEC economies are among world's top ten largest energy-consuming countries. Yet, energy efficiency achievements in APEC vary widely from economy to economy. Based on conventional exchange rates, for instance, China's energy intensity (amount of energy used per unit of GDP) was five times as high as Japan's and three times that of the US in 2009. Still, the energy intensity in Russia is slightly bigger than China's. Many developing economies like China and some developed economies such as the US and Canada have huge room to improve energy efficiency. The benefits are enormous though costs for certain energy efficiency improvement measures may be high as well. Striking a balance for improving energy efficiency and maintaining healthy economic growth is thus important.

There is still ample opportunity for increasing conservation around the region. The Japanese are, of course, famous for items ranging from low-power-use electronics to high-efficiency electric motors. The disastrous earthquake and tsunamis in early 2011 have given Japan impetuses to use energy more efficiently while conserving energy at the same time.

The Chinese have made great strides in the manufacturing of important energy-efficient appliances, notably refrigerators and water coolers. After achieving a reduction of energy intensity by 19.06% in 2010 from the 2005 levels, the Chinese government set new targets under the 12th Five-Year Program (FYP), which covers the 2011-2015 period. These new targets for 2015 include (1) reducing the energy intensity by 16%; (2) reducing the intensity of carbon emissions by 17%; (3) increasing the share non-fossil energy in total energy use from 8.3% at present to 11.4%. All these are part of the Chinese government's efforts to reduce the intensity of carbon emissions by 40-45% by 2020 from 2005 levels and increase the share of renewable energy to 15%. In the US, EPA certification of consumer equipment, on a comparable basis, allows buyers to contrast annual energy use and costs before purchase. Moreover, in an effort to increase energy efficiency, CHP has received renewed attention in the US as a mature and capable technology for greater gains though policy, legislative, and implementation hurdles have to be overcome first.

But, the best practices developed in one economy does not necessarily apply or flow to another. This is particularly true in the industrial and commercial sectors, where the measures adopted by a particular business may remain unknown to similar businesses in other countries. Also, efficiency initiatives in various APEC economies need to be translated to energy savings. While China has included the target of reduction in energy intensity into its five-year programs, there are still gaps for APEC as a whole to come along to achieve the goal of a "reduction in energy intensity of at least 25% by 2030." However, the good news is that the emission targets set by developed economies in APEC are much tougher than mere reduction in energy intensity.

Even if knowledge and transfer of best practices are not an issue, the barriers to applying them result from various organizational and institutional behaviors which may hinder the optimal use of best practices. In some cases, it is represented by market failure, like principal-agent problems afflicting landlords and tenants over efficient home appliances. In other cases, the application for certain best practices of energy conservation may not make sense for business, at least until carbon taxes or very high energy prices have a major impact on companies' bottom lines. On the positive side, however, harmonization of standards across economies should is beneficial for consumers and manufacturers.

Energy efficiency must be measured by end-use if it is to be meaningful. The US EPA and various agencies in other nations track energy efficiency in various end-uses and industries, but there is only limited technical interchange on this topic on an international basis. APEC should consider sponsoring a program to determine best practices by end-use, and to promote exchange on conservation issues. Saving energy is not as glamorous as procuring additional supplies, but it usually costs less, and has an even greater effect on energy security.

Addressing the rising demand for oil in APEC in the context of energy efficiency is important, particularly among the developing economies. Improving transportation efficiency will be the key in achieving the goal of managing transportation fuel demand. In this regard, APEC economies should work more closely on developing fuel standards for the automobile industry. Cooperation is also very much needed in APEC on alternative fuels, such as biofuels and electricity (for electric cars).

Conservation services are generally viewed as a local rather than a global business, and there is some sense to this (a Swedish firm specializing in winterizing homes might not have applicable expertise for residential energy savings in, say, Bangkok). Nonetheless, much energy conservation expertise is transferable, and APEC members should do all they can to ensure that these kinds of services can be provided across borders without encountering barriers, such as quotas, and tariffs, etc.

Finally, it should be mentioned that many consumers, including consumers at the industrial level, are unenthusiastic about making investments in energy savings unless the payback is quite rapid. This is a place where governments can help by getting utilities involved in rebates and financing for well-established energy-saving investments. Since this can forestall additional expenditures on fuel and investment in generating capacity, providing utility-based financing and expertise can be very cost effective.

Key questions to be addressed:

- *How can APEC collaborate in ensuring that all end-uses move towards best practices? How can information on conservation best be shared between consumers in member states?*

- *Is saving energy given the same priority in APEC plans and forums as procuring new supplies? How can government best act to encourage private investments in conservation?*

V. Objective 3: Promote Open and Efficient Energy Markets

Efficient operations of the energy market remain a key to minimize the cost of any transaction. Many economies, particularly those of the developing world, have incurred high cost for energy market operations as a result of excessive regulations, government intervention, price controls, and other regulations that create market distortions. APEC economies have to work harder to address issues related to market distortions and promote open and efficient energy markets.

A. Removing Barriers to Trade and Investment

In 2011, the APEC EWG released *Reducing Trade Barriers for Environmental Goods and Services in APEC Economies*. The report found that APEC economies: (1) Use a dual approach to address energy efficiency across various product categories; (2) Voluntary energy labels are used but applicability varies (3) Developed economies have more robust MEPS (Minimum Energy Performance Standards) and labeling programs; (4) Harmonization of energy standards presents more technical obstacles; (4) Industry Voluntary Standards are adopted by some economies; (5) ENERGY STAR voluntary labels are used by some APEC economies; (6) Voluntary labels are used more often than mandatory standards; (6) Few economies' domestic energy policies support energy standard harmonization; (7) Australia and New Zealand have a successful harmonization S&L (Standards and Labeling) program. In other words, due to dissimilar economies and standards, regional applicability of various labeling schemes varies. Furthermore, obstacles remain due to unsupportive domestic policies, except for Australia and New Zealand.

Overall, barriers should be removed to allow the free flow of goods and services, and investment. This topic has already been and will be touched upon elsewhere in this report, including the matter of clean coal technology, renewable energy development, conservation services, and access to resources. Here we underline some of the steps APEC members may wish to undertake to lower barriers to trade in this vital area.

Reduction in tariffs and harmonization of import policies. Monitoring the conditions of energy-related trade regulations in APEC economies with an eye to eliminating barriers and harmonizing practices ought to be an ongoing task within APEC. Baseline studies should be supplemented with regular updates. This could serve not only to encourage government policies to converge on a common practice, but could also help potential exporters and importers understand the trade issues they will face in each market. In this regard, the issue of rare earth availability and free trade should also be addressed in order to facilitate expansion of the hybrid car market and development of hybrid technologies, which has a high rare earth demand.

Harmonization of environmental specifications. The APEC economies are as diverse a group as can be imagined, and there is no reasonable one-size-fits-all approach to specifications on traded energy such as refined products. Nonetheless, the profusion of constantly changing standards can create an oft-unnoticed barrier to trade. When an economy chooses an unusual specification not used by other economies, this not only cuts the fungibility of the product, but also tends to raise the price of the niche-specification product to the importer. For example, if standard diesel sulfur specifications for products sold out of Singapore are 0.25% and 0.05%, adopting a new specification of 0.12% will only complicate the market by creating a new grade that few can produce and that only one economy wants to import. Moreover, with climate change taking up much concern, policy issues of carbon-content taxes on imports (and hence forms of protectionism) and carbon trade need to be examined seriously to harmonize environmental specifications within the APEC region.

Recognition of the singular importance of energy technology trade. Customs and import authorities are by their nature conservative bureaucracies. They are expected to enforce rules, not pursue their interpretation of the national interest. But in many cases, needed technology imports in the energy sector can find themselves either excluded, or enmeshed in customs disputes, with parts sitting on the dock while contractors wait at job sites. The first step in resolving these sorts of problems is formal recognition that energy technology has a special role in national security (witness the fact that when countries have trade sanctions enforced against them, defense and energy technologies are usually the first items on the list). Beyond this, individual nations may wish to consider giving some sort of fast-track import authority to their Energy Minister, or design some other means for expediting trade in energy technology.

Removing investment and other market barriers. Despite the fact that many APEC economies openly welcome foreign and private investments in the energy sector, barriers—explicit or implicit—do exist to hinder such investments. The investment and other market barriers include various constraints to access: restrictions on visa, workforce controls, nationalization issues, local content regulations, cabotage, undue influences by NOCs/regulators over budgeting and other activities, domination of NOCs in key energy sectors, and numerous other issues.

B. Phasing Out Inefficient Fossil Fuel Consumption Subsidies

APEC made commitments in November 2009 to phase out inefficient fossil fuel subsidies. This mirrored the September 2009 G20 commitments on the same subject. Inefficient fossil fuel consumption subsidies tend to distort markets in various ways, encourage wasteful consumption, hasten decline of exports, encourage smuggling, threaten energy security by increasing imports, discourage investments in infrastructure and create barriers to clean energy investments, and increase emissions and exacerbate pollution.

Inefficient fossil fuel subsidies directly violate the requisite for efficient energy markets, efficient energy products, diversified energy resources, and technological innovation. The IEA defines an energy subsidy as “any government action directed primarily at the energy sector that lowers the cost of energy production, raises the price received by energy producers, or lowers the price paid by energy consumers.” Therefore, fossil fuel subsidies are not desirable, as they result in inefficient allocation of energy resources, create market distortions, and fail to accomplish their objectives.

Potential objectives of subsidies may include: boosting domestic supply, rebuilding national resource wealth, alleviating energy poverty, protecting the environment or protecting employment. However, evidence shows that fossil fuel subsidies merely distort markets by manipulating supply and demand forces, thereby discouraging energy diversification, increasing consumption and therefore, increasing CO_2 pollution. In fact, all of these are very real causes of energy insecurity.

Notably, the diminution in fossil fuel subsidies is actually beneficial to energy efficient technology producers, governments, energy diversification, energy security, and the environment. As mentioned, when the prices of fossil fuels are subsidized, supply and demand forces are distorted. Energy prices that do not reflect fundamental value induce higher consumption than would exist under normal market conditions, because consumers have less of an incentive to conserve or increase efficiency (efficient cars, appliances) if they are not persuaded to do so by higher prices. Subsidies result in prices being lower than they should be, consumers using more than they should, and energy becoming more insecure in the world.

In addition, governments that import energy and provide subsidies could save a tremendous amount of money by phasing out fossil fuel subsidies. These governments will benefit in the short run and long run by saving money on imports, saving money from eliminating subsidies, and encourage national interest in efficiency, energy technology, and diversification.

In short, the elimination of inefficient fossil fuel subsidies is an extremely critical issue. For developing economies like Indonesia, and even for middle income developing countries such as Malaysia, it is absolutely critical that resources and fuels are priced appropriately, not only to alleviate their weak fiscal balances but also to constrain consumption growth by market pricing. Inefficient fossil fuel subsidies exist not only in developing economies but also in developed economies. The US, for example, has subsidies for coal for political reasons, which has nothing to do with an optimal energy policy.

C. Studying the Futures Market

The creation of an international futures market in gas was discussed in a previous section of this report. Today, with most oil prices already linked to the futures markets of New York or London, some believe that increases in price and increases in volatility are the result of speculative activity. Some blame the high price of everything, even from the high price of food to the fluctuation of currencies on futures market speculators. It is important for policymakers and industry participants to understand the important role that futures markets play in price discovery and risk management, and the need for liquidity in these markets. Speculators are participants in these markets, and their activity should not be singled out without also taking into account global events, policy actions, or the myriad of supply and demand factors which may also impact the price and volatility of commodities in world markets.

In the 2008 Study, we stated that we do not believe that futures markets raise oil prices to artificially high levels on any prolonged basis. It should be noted that among many leaders in the OPEC nations, the belief is that the futures market has kept prices artificially low for decades. We do believe that the futures market tends to increase price volatility, but over a shorter period than in their absence. We asserted "this volatility over a short term is preferable to prices that are too high or too low over longer periods, as these would result in larger economic dislocations because they seem to be more permanent and are more likely to cause incorrect decisions about major investments." The implication was the presence of a trade-off between price stability and price accuracy in the question of whether to have or not have a futures market.

The main use of the futures market is for price discovery and hedging by oil companies and end users, who use various tactics to manage their risk of price fluctuations, and by hedge funds, that are often hedging currency risks or hedging exposure in other commodities. For the sophisticated risk manager, futures contracts are a form of insurance against disastrous movements in price, and by taking complex countervailing positions, they can keep their actual revenues within an acceptable band no matter what the market does. In this system, speculators inject capital and information into the system; their positions are actually a form of data on where people expect prices to move. Some of these are experts taking into account detailed data on reserves, production, and demand, while others are simply betting; but in either case, they are taking positions, backed with their own money, about where they expect the price to settle, and this is a vital component of price discovery.

Some comments regarding the experience of the Dubai Mercantile Exchange Limited's (DME) Oman crude oil futures contract are warranted. The DME oil futures contract started trading in 2007, and was designed to be a new pricing benchmark and risk management tool. From the onset, it was hailed as an important step in the more general shift in the international pricing system to the futures market for crude oil price discovery, particularly for sour crudes headed to the Asia-Pacific region.

While the short track record has been less than convincing, the contract has been under utilized, and given the highly unusual market conditions of the past four years, is not necessarily representative of the full effects under ideal circumstances. Our assessment calls for more substantial research, so while not attempting to be comprehensive, we point to several technical factors that may have hindered the DME oil futures more full adoption by market participants.

The lack of liquidity in the market is the primary detriment of market efficiency. Lack of liquidity hinders price discovery and risk management, which keeps major buyers such as the national oil companies sidelined. Two obstacles to increased liquidity and therefore confidence in a futures contract are ownership diversification and physical settlement. In the first case, Horsnell and Marbro (1993)[8] identified the need that crude production and futures contracts should be available from a wide variety of entities as in the Brent market. The second case finds that DME Oman futures contracts settle for physical delivery in

[8] See P. Horsnell and R. Mabro, 1993, *Oil Markets and Prices: The Brent Market and the Formation of Word Oil Prices*, Oxford University Press.

proportions higher than in other benchmark markets. As a result, open interest on the DME contract has tended to increase as contract expiry approaches, implying its use to secure physical supplies. This contrast with other benchmark oil futures is noteworthy. For instance, ICE launched the Middle East Sour Crude Oil Futures Contract in 2007 as a purely financial instrument settled on cash against a Platt's Dubai assessment.

Beyond the control of the DME, but not an inconsequential issue with DME futures trading, is the lingering effects of the global financial crisis of 2008. As described above, at the writing of the 2008 Study, the effects were acute and severe. Crude price volatility reflected rapidly changing and contrasting views. Nearly three years later, price volatility has subsided, but the challenge for healthy markets remain. The world faces the long-term effects of the crisis through lost economic potential in terms of high unemployment, limited credit availability, and slower growth. These effects are felt dramatically different across the globe, but one area of potentially wide-ranging consequences is in financial regulatory reform. In particular, the Dodd-Frank legislation that became law in the US in 2010 requires overhauling over-the-counter (OTC) futures trading by bringing much of the activity onto exchanges. The exact rules and regulations continue to be teased out through the American system, but given the depth and breadth of the US derivatives markets, the potential impact on other markets is apparent. Given the uncertainty over this process at the time of this writing, and in all likelihood at the time this report is distributed, it is not possible to prescribe policy recommendations other than to be flexible and cognizant of developments. It is important for policymakers however, as they implement reforms of derivatives markets, not to impede risk management of end users and not to make risk management prohibitively expensive. Regulations that make hedging a hedge-able risk more expensive will only create more risk for the economy—that would be an unfortunate outcome of regulation designed to reduce systemic risk.

Key questions to be addressed:

- ***What are the best approaches for expediting trade in energy technologies? Should existing procedures be simplified or fast-tracked—or is it better for all trade to be treated uniformly?***

- ***How would an APEC study on speculation and the futures market be structured so as to satisfy possible critics?***

VI. Objective 4: Promote Clean Energy Use and Technology Innovation

Like energy efficiency and conservation, clean energy use has been given a high priority in APEC. In its May 2007 Darwin Declaration, the APEC Energy Ministers stressed the importance of clean energy use repeatedly in the following context:

- Development of clean energy is important for APEC's long-term energy future;
- Development and deployment of cleaner and more efficient technologies are important for the need to address environmental challenges;

- Cleaner power generation technologies—including renewables, clean coal, natural gas/LNG, and for interested economies, nuclear power technologies—can provide for more secure, diversified systems of energy supply, and use with lower carbon emissions.
- It is important for APEC to further contribute to policies and technologies that promote the development of cleaner energy and the improvement of energy efficiency, thereby enabling economies to meet increasing energy needs with a lower environmental impact and to address climate change objectives.

Clean energy encompasses a wide spectrum of options. Two of these are identified here are most relevant to the APEC-wide applications, namely, use of clean fuel and renewable energy. Though not covered in this report, moves toward "zero emission" power generation and smart grid in Asia, development of advanced technologies for the transportation sector (hybrid, plug-in hybrid, EV, fuel cells, etc.), and their implication to energy security are also important in terms of clean energy development as well the impact on oil demand growth.

A. Expanding the Use of Clean Coal through Technology Innovations

Coal resources are plentiful, and, in comparison to gas and oil, relatively cheap. Although reserves of good-quality coal are not available in every country, it is a widespread resource, and many exporters stand ready to expand production capacity if import demand increases.

Since the Fukui Declaration, one study entitled "Technology Status and Project Development Risks of Advanced Coal Power Generation Technologies in APEC Developing Economies" has identified risks and barriers to clean coal technology and recommended policies in order to facilitate the proliferation of this technology. However, major risks and barriers include lack of investment, uncertainties with new technology, lack of managerial experience, and environmental awareness.

Yet, the benefits of this technology include lower unit heat rates (thus, higher overall efficiency and less emissions per unit of power), local employment opportunities, and will facilitate eventual technology transfer. Disadvantages included higher installation costs, lack of experienced workforce, lack of critical spare parts, and lack of a historical database on operations/maintenance and engineering. Therefore, in order to diminish these disadvantages, it is recommended to have a well-planned and well-executed manpower training program, spare parts inventory program, paid membership to fossil-based management info system network, and hire expatriate consultants in the early stages of operation.

As in gas, the transport infrastructure can be a major barrier to expanded trade and use. Although a coal supply chain is neither as complex nor as specialized as an LNG chain, both port and rail transport facilities can become significant hurdles to expanding coal use in areas where it is not already established. Clean coal technology (CCT) is by its nature limited in scale and scope, competing with oil and gas almost exclusively in power generation (although there are important co-generation options in the industrial sector). Although this cuts off many substitution possibilities, it also means that clean coal use does not require a complex distribution system like that seen in oil products or a well-reticulated gas system.

Assisting the expansion of fuel-import infrastructure for CCT projects is thus usually a relatively localized task.

Although new coal technologies are often far more efficient and are always far less polluting than traditional coal technologies, coal use still releases more carbon dioxide than the use of other fossil fuels. Considerable research is being devoted to the problem of carbon sequestration (also referred to as CCS, carbon capture and storage), but the engineering is still in such early stages that no one is certain what approach or approaches will be best, nor what the costs might be (though one widely quoted study estimates it adds 35% to the capital cost of a plant). In addition, CCS parasitic power losses from running the equipment can be quite large (20% or more), eliminating many of the gains from advanced technologies. Payback times for CCT will probably need to be spread over a plant's primary lifetime, suggesting an investment that must be recouped over 20-30 years.

Most analysts believe that CCT will have a role to play in the world's future energy supply. But any investor considering a power plant based on clean coal faces huge uncertainties in the area of climate change legislation. No one is sure what future policies will be, what sort of taxes might be levied, or what control technologies will be best—or even allowed. (For example, some experts feel that ground injection of carbon dioxide poses significant hazards.) The combination of a long horizon to recoup investment coupled with uncertainty about future climate policies is a major barrier to the construction of clean coal plants.

Some of this uncertainty might be alleviated by carbon emissions trading—especially in cross-border trading. Since carbon dioxide is a global rather than local issue, arguments for a multinational or international trading scheme are strong. Based on experience in Europe, however, stringent measures would have to be enacted; some experts contend that the price of carbon dioxide credits would have to double or triple before CCS becomes economical. In any case, an emissions-trading market could encourage investment in CCS technologies. Absent of that, no investor wants to risk plant shutdowns or massive additional capital investment because standards change. Buying emission credits in future years is an unknown operating cost, but it is on a smaller and less concentrated scale than the need to suddenly invest hundreds of millions of dollars in CCS because of unforeseen changes in emissions laws.

Moreover, almost any specialized, capital-intensive technology like CCT will face various kinds of import barriers in at least some economies. If clean coal is to provide a substantial alternative to oil, barriers to imports of CCT equipment need to be dismantled wherever they are found.

In a broader sense and for fossil fuels in general, technology can unlock resources, lower emissions, and improve recovery rates. This is evident in the areas of enhanced oil recovery, development of unconventional gas, development of oil sands and shale oil, expanded use of supercritical and ultra-supercritical coal-fired plants for power generation, future application of carbon capture and sequestration, and zero-emission or near zero-emission power plants.

Perhaps the most unpredictable and overlooked variable in energy forecasts is the impact of technology. The future of the energy industry will be determined by the rate of change of innovation. Ultimately, that depends on proper market prices, research and development, and government investments. Ideally, the price of technology will decrease and the price of CO_2 emission will increase. Thus, as long as the price of energy is not suppressed by fossil fuel subsidies, developing new technologies that lower emissions, improve recovery rates, and unlock resources will remain economical.

The IEA predicts that world energy demand will grow by 40% by 2030; of this 80% of 2030 supply will come from fossil fuels. However, fossil fuel production is becoming characterized by a decline in conventional resources; of the existing conventional reserves, nearly 75% are held by OPEC countries and national oil companies (NOCs). Therefore, international oil companies (IOCs) are compelled to explore new terrain in remote locations and complex geologies such as offshore Greenland and Brazil, the North Sea, Siberia, and the Caspian region.

Unconventional resources such as ultra deepwater, arctic oil drilling, oil shales, oil sands, and conversions (coal-to-liquid, gas-to-liquid) also have a huge potential in supplying the future energy needs. In fact, the IEA predicts that they will meet about 10% of world oil demand by 2035. However, these methods will require profound technological development in order to extract the full potential from the resources. Fortunately, such technologies are already in operation such as hydraulic fracturing and horizontal drilling; nevertheless, there is substantial room for improvement. One of the highly anticipated technologies is nanotechnology, which will allow greater precision and efficiency throughout operations.

As the largest contributor of emissions, the power sector is the primary focus in energy efficient initiatives. The main options are to create carbon cost incentives and to transition to gas-fired generation. In particular, carbon capture and storage (CSS) plays a key role in alleviating environmental pressures from power plants and energy intensive industries (metals, chemicals, etc.). Overall, this will require a radical transformation to low carbon technologies that remain efficient, affordable, and reliable. However, international financial, regulatory, and technical collaboration is necessary in order to succeed. Government mandates such as discouragement of fossil fuel usage by making CO_2 more expensive will be especially important. In addition, the developed countries are expected to lead the development and deployment of CSS technology. If successful, CSS technology has the potential to reduce emissions from industry by 40% (IEA).

B. Reconsidering the Use of Nuclear Power

The 9.0 magnitude Great East Japan Earthquake followed by tsunamis on March 11, 2011 in Tohoku had a widespread effect not only on Japan's energy industries, including damage to the basic infrastructure of nuclear power plants, but also on long-term policy implications globally.

The ongoing nuclear crisis at the Fukushima Daiichi nuclear power plant[9] highlighted to the general public the potential dangers associated with Japan's ambitious nuclear power targets[10] and its preparedness for catastrophes. While the threat to public health is the immediate and top concern, the situation has widespread policy implications worldwide as many countries have begun reevaluating the role of nuclear power in their economies. There is no doubt that the Fukushima crisis has made energy security challenges more complex than ever, not only for Japan but also for the rest of the world.

The APEC Energy Ministers' consensus on nuclear power was summarized in the June 19, 2010 declaration "Fukui Declaration on Low Carbon Paths to Energy Security: Cooperative Energy Solutions for a Sustainable APEC."

"A growing number of interested economies are using nuclear power to diversify their energy mix and limit carbon emissions. These economies are reaffirming their international commitment to safety, security, and non-proliferation as the fundamental elements for the peaceful use of nuclear energy. We therefore need to assess the emissions reduction potential of nuclear power in APEC. Solid financial frameworks, as well as cooperation among member economies and with relevant multilateral organizations, can help to support new nuclear power plant construction consistent with this commitment."[11]

For many economies, including Japan, nuclear power development has been an essential means of ensuring a stable energy supply and accommodating environmental issues such as global warming. However, the key elements of nuclear energy policies after the Fukushima disasters have shifted to safety and emergency management, and public acceptance.

Despite the Fukushima disasters, within APEC, policy support for nuclear power in some economies (including South Korea, China, and the US) continues. Many other economies, who own nuclear power plants, are likely to continue their programs but at a slower pace. While some Southeast Asian economies, who had expressed interest in building nuclear power plants, will take more time to conduct nuclear power safety reviews, other smaller economies will reevaluate the need for nuclear power.

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[9] Tokyo Electric Power Co. owns the 4.7-GW Fukushima Daiichi nuclear power plant in Fukushima Prefecture. They have two more nuclear power plants, the 4.4-GW Fukushima Daini plant in Fukushima Prefecture and the 8.2-GW Kashiwazaki-Kariwa plant in Niigata Prefecture. Of the total 9.1 GW capacity in Fukushima Prefecture, 6.4 GW were in operation at the time of the March 11 earthquake/tsunami. It has been officially decided that four units (Fukushima Daiichi 1-4) will be dismantled and it is reasonable to believe that the remaining six units (Fukushima Daiichi 5-6 and Fukushima Daini 1-4) will be out of circulation indefinitely.

[10] Currently, Japan has 55 nuclear power units that provide 49.6 GW of capacity, almost 30% of Japan's power needs under normal circumstances. The Japanese government set ambitious targets to increase the share of nuclear power generation many years ago. This strategy aimed to achieve Kyoto climate change goals and diversify Japan's energy mix away from oil, thereby reducing its energy reliance on the Middle East. Over 85% of Japan's total crude oil imports come from the Middle East. The government targets before the Fukushima disasters called for nuclear power to comprise 50% of the country's total power generation by FY2030. To achieve this, Japan would need to build 12-14 additional nuclear power units and boost the utilization ratio of operating units to 85-90% from the pre-disaster level of around 70%.

[11] http://www.mofa.go.jp/policy/economy/energy/pdfs/emm_declaration201006.pdf

Final decisions regarding the use of nuclear power lie with the sovereign power, but the exchange of knowledge and experience, particularly in evaluating the safety risks to nuclear reactors, among APEC are something that can strengthen international ties and security. There is an opportunity for transfer of knowledge related to designing, safety/security, and emergency response from economies with deeper experience with commercial nuclear power to economies that are just establishing nuclear power programs.

The set of problems that caused the crisis for the Fukushima Daiichi plant are believed to be site specific and there may be risks for other reactors located in high risk seismic regions exposed to tsunamis in other economies. More generally, the disaster highlighted the risk that may come from the coincidence of events that have low probabilities. While the specific circumstances may be different, based on the problems experienced at the Fukushima Daiichi nuclear power plant that lost electricity connection to run water pumps to cool the reactors and eventually lost internal safety controls, *disaster response protocols* are very important. Policymakers are urged to do a better job of establishing best possible practice for safety and emergency management.

The real challenge for Japan and other economies that have or are considering nuclear power is to create truly independent regulatory and licensing authorities that operates in an open and transparent manner. Japan's structural issues in its regulatory system were pointed out after the Fukushima disasters. Essentially, Japan is considered to have no independent checks and balances. Japan's nuclear power safety regulatory body, the Nuclear and Industry Safety Agency (NISA), belongs to the Ministry of Economy, Trade and Industry (METI) who devised an energy policy that has long promoted nuclear power as the best solution to Japan's energy-sufficiency and environmental goals. METI's nuclear power promoter-regulator conflict, however, makes Japan an unusual case. The US successfully split the promoter and regulator functions between two agencies: the US Department of Energy promotes nuclear power, while the Nuclear Regulatory Commission (created by Congress) is in charge of safety issues.

The problems of nuclear fuel disposal remain unresolved. Even in the US, the longest-standing nuclear power nation, the debate drags on over the formally adopted underground storage plan. And while the nuclear power plants themselves can be hardened or protected in various ways, the inevitable nuclear waste becomes vulnerable during transportation for disposal. The Fukushima incident clearly illustrated the dangers associated with the stored fuels. Meanwhile, Japan's fuel cycle program will be reassessed and potentially delay other nations' similar programs/efforts. Resource-poor Japan has long strived to achieve a nuclear fuel cycle program, emphasizing the important role the nuclear fuel cycle plays in utilizing limited uranium resources effectively and efficiently. Following the 1995 accident at Japan's prototype fast breeder Monju reactor, however, the fast breeder project continues to face difficulties. Eventually the government pursued an interim "pluthermal" strategy in which a mixed plutonium-uranium oxide fuel, commonly called MOX, and using uranium and plutonium extracted from spent nuclear fuel, is used in commercial nuclear power plants. Despite opposition and delays, since late 2009, a few Japanese utilities have begun to use

MOX. Following the Fukushima crisis, already some Japanese governors have called for a reassessment of plans to use MOX fuel at plants in their prefectures.
It must be emphasized that it is essential for all economies that are considering expanding or starting their own nuclear power programs to plan their waste disposal/storage and fuel recycle programs simultaneously.

In summary, despite the Fukushima crisis, many economies are expected to continue their nuclear power programs but at a slower pace. The economies considering nuclear power will likely continue with their plans as nuclear power can offer an attractive source of *base-load power generation* for rapidly growing economies, in terms of reducing carbon emissions and fuel imports. Furthermore, for many who host nuclear power plants, a combination of employment and government subsidies relating to the nuclear power industry plays an important role in their economic activities. Smaller economics will likely reevaluate the need for nuclear power.

There is a dire need for an integrated energy policy that is grounded in a new post-Fukushima reality. Such an energy policy will require a reassessment of all kinds of renewable energy, including nuclear power, and a review of future energy use in APEC. The role of nuclear power in the region's future deserves wide-ranging discussion and debate. This is an opportunity for APEC to take what lessons can be learned from the Fukushima incident and determine the best practice for nuclear power safety and emergency management.

C. Expanding the Use of Renewables

Renewable energy sources cover such a diverse range of technologies that it is difficult to generalize about them. Most, though not all, renewable energy projects are characterized by a smaller scale than most fossil fuel projects (though some—such as central-station solar power, some biofuel projects, and many geothermal projects—are comparable to fossil fuel plants). Many small-scale uses of renewable energy go unrecorded. To take a simple example, no one counts the energy provided by solar water heaters. At best, the number of solar water heaters might be tracked, and the reduction in electricity or gas demand might be estimated. To the commercial energy system, stand-alone renewable energy systems look like conservation.

To date, most APEC economies have focused on applying their own renewable energy capabilities to their own resources and needs. While this is understandable, some of the most technologically advanced nations, such as Japan and South Korea, have the fewest opportunities for accessing renewable energy, if nothing else because of lack of space. But partnerships between economies might offer whole new vistas for development of alternative energy.

Over the years, a great deal of renewable-energy interest in Asian countries has focused on small-scale, low-tech projects, with an emphasis on providing power or fuel for remote and impoverished locations. While this is laudable, it does little to affect the overall issue of energy import dependence. It may be time to re-examine the possible role of renewable energy on a regional rather than national basis. Rather than looking at what individual countries can do to exploit their own alternative energy resources, the goal should be to identify resources that could be tapped—no matter which economies provide the expertise and technology.

Limiting the "test beds" for technologies to the economies conducting the research means that in many cases, renewables are evaluated against suboptimum conditions. For example, the performance and economic feasibility of new solar technologies may be judged in a climate where sunshine is a scarce resource. The conclusions of such studies may be valid where they are conducted, but taking a regional perspective might lead to very different results.

Ideally, the renewable energy industry should look much like other energy industries. Engineering skills, capital, and manufacturing capabilities should be drawn from the best sources, regardless of national boundaries, and projects should be built at sites where they have the best economics. It is possible to imagine binational or multinational projects, based on, for example, technology licensed from Japan, equipment manufactured in Singapore, and applied to resources in Mexico. Conventional energy systems are already manufactured on this basis, but renewable energy is still more restricted in focus. The goal should not be "technology transfer" but rather the creation of ventures that can make a significant contribution to energy supply. When new energy supplies are brought to market, no matter where, they ease the pressure on energy supplies in international trade.

As in many other areas, priority should be given to the removal of barriers that slow the import of needed technology or act to raise its costs. A standing committee to identify possible commercial potentials and barriers to commercialization and trade may be a first step in increasing this form of cooperative development.

There are also developing techniques in renewable energy technology that should be closely monitored by policymakers. An example is found in polymer solar cells designed to harness longer wave length radiation; these cells have the potential of gathering energy from heat waves as well as direct sunlight, and hybrids of these with more standard cells could produce systems capable of gathering more energy across a broader range of lighting conditions. (They also might create a means for turning waste heat into electric power.)

Another area where rapid change is possible is in biofuels. At present, biofuels seem to present an ethical dilemma, as the feedstocks to make them are foods: carbohydrates from grains or tubers (ethanol) or oils from plants such as soybeans or canola. But this could change; there are significant advances being made in bioconversion of inedible plant waste or grasses (cellulosic ethanol). In addition, biofuels from algae may be far more productive than biofuels from crops—estimates run as high as 30-100 times more productive per unit of land area. And, although investments are higher than for farming, land unsuitable for other purposes can be used for algal diesel, and such projects need not tax water resources, either, since many of the species of interest live in salt-water. The first algal biodiesel plant (which is based on salt-water species) began production in April 2008.[12]

[12] Under the APEC Biofuels Task Force initiatives, a project on the resource potential of algae for biofuels was approved in May 2009. The project, entitled "Resource Potential of Algae for Biodiesel Production in the APEC

This is an example of why it is vital for decision makers to follow the research in these areas closely, as major breakthroughs and novel approaches are constantly emerging. As mentioned above, there has been considerable concern over the ethics of producing biofuels at a time when food prices are soaring. Some have urged governments to take a position condemning or even banning biofuels. But adopting blanket anti-biofuels policies runs the risk of banning fuels made from waste or algae along with those made from food crops. If policies are adopted strictly on the basis of current commercial technologies, the policies may discourage the development of unforeseen possibilities that could be of immense benefit.

To expand renewable as well as alternative energy use, the issue of scale and commercial viability is important, which may be barriers to innovation and new technologies in the energy markets. Even under the most aggressive scenarios, projections are that alternatives cannot meet more than a small fraction of total demand because of the economic realities. For the same reason, time and resources are needed to bring alternatives to scale as they become economic. There is no doubt that continued research and development (R&D) of new energy technologies is important for growing global economies over the long term. Despite the need for more R&D for renewable and alternative energy—we need them all, there is no silver bullet—it is important to note that technologies that can be commercialized without significant government subsidies have the greatest chance of being economically sustainable. Under the 12th FYP mentioned earlier, China is promoting technologies and policies aggressively for renewable and alternative energy. Their efforts may lead to scalability but the market has to eventually take over to sustain any renewable and alternative energy developments.

D. Smart Grid, Intellectual Property Rights, and Other Issues

There can be a long list of other issues to address to promote clean energy use and technical innovations. A few areas are singled out below that we deem important but it is by no means an exhaustive effort to cover all topics.

Development of smart grid technologies. Smart grid technologies are being promoted by some APEC economies and considered in others. This is in the right direction as development of smart grid technologies may potentially advance renewable energy use and improve energy efficiency. The Fukui Declaration from the 9th Energy Ministers Meeting, June 2010, states that "smart grid technologies, including advanced battery technologies for highly-efficient and cost-effective energy storage, can help to integrate intermittent renewable power sources and building control systems that let businesses and consumers use energy more efficiently, and they can also help to enhance the reliability of electricity supply, extend the useful life of power system components, and reduce system operating costs." The Energy Working Group of APEC has since started an APEC Smart Grid Initiative to evaluate the potential of smart grids to support the integration of intermittent renewable energies and energy management approaches in buildings and industry. The EWG envisaged four phases

Region," attempts to assess the amount and location of algal biomass suitable for the production of biodiesel. See http://www.biofuels.apec.org/pdfs/meeting_201004_kualalumpur.pdf.

of activity for smart grids: 1) Survey of smart grid status and potential; 2) Smart grid road map; 3) Smart grid test beds; and 4) Development of smart grid interoperability standards.

Protection of intellectual property rights (IPR). This is really one of the key issues. Developed and developing economies should discuss and agree on issues related to IPR. Multilateral international framework should focus on this issue and play a role to promote the discussion. IPR is important for creating incentives for inventors and innovators. However, IPR should be such that incentives for further research and development are not blunted by over-generous protection for IPR. There should be a balance. However, it is also important to note that transparent strong protections will promote innovation in all economies.

Staying away from picking winners and losers. Records demonstrate that legislating or enacting benefits for one technology over another depresses innovation and may delay needed discoveries, or advance certain products that are not the most efficient and that may have other drawbacks—e.g., methanol and groundwater, or ethanol and the impact on food security.

Key questions to be addressed:

- *What particular measures are needed to promote the free flow of clean energy goods and services?*

- *Can government assist in expanding coal-import facilities where they are needed? Can coal exporters take a stake in import ports and terminals? Can industrial facilities be co-located to make use of waste heat? Does coal deserve special treatment?*

- *How can APEC economies cooperate to establish a sustainable carbon-trading system? Does a workable system require widespread coordination, or can a successful system be launched based initially on only a few pioneer economies?*

- *How can APEC economies lower the uncertainty associated with future government climate policies? Should permanent carbon exemptions or offsets be offered for pathfinder or demonstration CCT projects, or does this send the wrong signals to the industry?*

- *Where are the possibilities for joint-venture companies in renewable energy? Can high-tech solutions under development in one country be manufactured more cheaply in another? Can high-tech solutions be modified to be more applicable to developing nations?*
- *Overall, how much support should governments provide to promote the use of renewables?*

VII. Conclusions and Policy Recommendations

Energy security has multiple dimensions. A key element argued repeatedly by this brief is that ensuring energy security today requires a dual approach to the problem of oil. On one hand, alternatives to oil need to be expanded and encouraged, and oil use needs to be made more efficient so as to minimize demand. On the other hand, governments need to help ensure high levels of oil production and efficient and smooth trade in oil, both to stabilize prices and to avoid disruptions. Any framework to enhance energy security in APEC will have to recognize the necessity for doing both simultaneously without giving priority to one over the other.

Policy recommendations are featured throughout the study. They are also summarized briefly as follows.

Policy recommendations for diversifying energy resource supply

- Producing economies should consider opening access to foreign participation in order to attract private capital and technology
- Producing economies should consider promoting competitive bidding for resources and encourage NOCs to compete in the international marketplace in order to stabilize domestic energy security
- Producing economies should consider pursuing infrastructure developments by streamlining permitting and routing processes and/or acting as a participant in the negotiation process
- APEC governments—who wish to expand the role of natural gas—should address the issues of poor infrastructure and price controls

Policy recommendations for promoting energy conservative and improving energy efficiency

- Sponsoring a program to determine best practices by end-use and promote exchange on conservation issues
- Improve transportation efficiency. APEC economies should work together to develop fuel standards for the automobile industry. Promote cooperation on alternative fuels (biofuels and electricity)
- Ensure transferable energy conservation services and technologies without encountering barriers

- Incentivize industries and consumers through rebates and financing for well-established energy-saving investments

- APEC economies should work more closely on developing efficiency standards for the auto industry and find an acceptable way on alternative fuels, especially for electricity.

Policy recommendations for promoting open and efficient energy markets

- Excessive regulations, government intervention, price controls, and other regulatory impediments only distort markets

- Fast-track import authority to the Energy Minister, or other design to expedite energy technology trade

- Consent to a long-term path to establish energy trade specifications in the region

- Inefficient fossil fuel subsidies should be removed.

- An international gas futures market should be considered in order to provide liquidity to buyers and sellers. A futures market will allow participating parties to pursue projects without meeting the full volume of their contracts and will allow buyers to easily enter the market

Policy recommendations for promoting clean energy and technology renovations

- International emissions-trading market to encourage investment

- Promote free trade for alternative energy technologies. Priority should be given to the removal of barriers that slow the import of needed technology. Establishing a standing committee to identify possible commercial potentials and barriers to commercialization and trade may be a first step in this cooperative development

- Develop partnerships for developing alternative energy. Approach renewable energy on a regional basis (any country can provide expertise and technology)

- Exploit new supplies and projects regardless of national boundaries and wherever they have the best economics. Energy is an interdependent resource, so no matter where supplies are brought to market, they ease the pressure of international trade.

- APEC governments should establish best practices for nuclear power safety and emergency management. Based on the Fukushima disasters, APEC need to consider formulating disaster response protocols.

- Solutions to the problems of nuclear waste disposal and the future fuel cycle programs need to be worked in APEC. Multilateral solutions among APEC seems best, however, given sovereignty issues, there must be a limit to how much multilateral bodies can do to negotiate and agree on potential sites for spent fuel storage.

- Effectively exchange knowledge and experience in order for each APEC government to have an independent check and balance system.

- APEC economies should promote the development of smart grid technologies, protect IPRs, and avoid picking winners and losers.