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ON THE HORIZON — RENEWABLE ENERGY IN ASIA

A PRACTICAL GUIDE

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On The Horizon – Renewable Energy in Asia

A Practical Guide

Prepared by Meritas Lawyers in Asia

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About this Book

On The Horizon — Renewable Energy in Asia was prepared by lawyers in Asian Meritas firms. It offers practical insights targeting foreign investors and business people who are interested in pursuing opportunities throughout Asia. The twelve chapters provide general information, not legal advice. Do not rely upon the materials without prior consultation with legal advisors familiar with the specifics of your particular areas of interest.

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RMB	Chinese Renminbi	PHP	Philippine Peso
HKD	Hong Kong Dollar	SGD	Singapore Dollar
INR	Indian Rupee	TWD	New Taiwan Dollar
IDR	Indonesian Rupiah	THB	Thai Baht
JPY	Japanese Yen	USD	United States Dollar
KRW	Korean Won	VND	Vietnamese Dông
MYR	Malaysian Ringgit		

ON THE HORIZON — RENEWABLE ENERGY IN ASIA

As this book goes to press, the global economy is still struggling to climb out of its worst downturn since the Great Depression. At the same time, Japan faces its most significant crisis since 1945 as it deals with the impact of the tsunami and damaged nuclear reactors at Fukushima. While some countries such as China, Singapore, and India have successfully rebounded, most nations are facing dual threats of exceptionally slow economic growth combined with chronic levels of high unemployment. Unlike past recessions, this one has hit developed economies just as hard as less developed countries, which have traditionally borne the brunt of economic downturns.

No matter how the world economy performs over the next few years, two factors stand out that will strongly influence global economic prospects over the next decade. One factor is population growth. Most experts predict that the world's population will grow from 6.9 billion today[1] to 8 billion by 2025 and will add another billion by 2050. This projected increase is as many people who currently live in China and India. Continual population growth places high demands on the world's resources, as more people are demanding more goods and services. Equally significant, the large and rapidly growing economic powerhouses like China and India are accelerating their demand for energy and the goods and services it provides. Between just these two countries, over 3.5 billion people will be pushing their governments to promote rapid industrialization in order to meet the demands of their burgeoning middle classes. These are pressures that neither China nor India, nor any government for that matter, can resist for political reasons.

Economics aside, the combination of these two factors is also putting a heavy strain our world's delicate environmental balance. The problem is that the energy resources supplied today to meet a growing population's increasing needs for goods and services are mainly derived from carbon-based sources that have significant long-term impacts on the environment. Coal is the dominant fuel in Asia and accounts for 54 percent of energy used today. While this share will go down over time (to an estimated 44 percent share in 2030), the use of coal in developing Asia is expected to increase by nearly 40 percent by 2030.[2]

[1] U.S. Census Bureau estimate at www.census.gov/main/www/popclock.html

[2] Estimates from USAID ECO-Asia Clean Development and Climate Program, based on data from International Energy Agency, Asian Development Bank, and Asia-Pacific Energy Research Center

For example, the Peoples Republic of China in 2011 is over 70 percent dependent on coal for its total energy needs, and it is the fastest growing economy in the world. As energy needs increase, so does the degradation of the environment. Adding another 2.5 billion people over the next 40 years will magnify the imbalance even more.

Another consideration involves the political climate where carbon-based energy is extracted and consumed. For example, much of the global oil supply is located in geographic areas that regularly experience bouts of political instability. Think about Venezuela, Nigeria, Libya, and points throughout the Middle East. As we have seen time and time again since the oil crisis of the 1970s, any even minor disruption in the assured supply of oil, gas, or other energy sources can and will have a significant impact on global prices.

And the trends of oil import dependency are going in the wrong direction. Over the past decade, oil imports to Asia have increased by 140 percent, and in 2010 the Asia region imported 60 percent of its oil.[3] China's dependence on foreign oil is expected to keep rising, reaching 65 percent by 2015 and 80 percent by 2030.[4]

For all of these reasons, the current global energy mix, which is primarily carbon-based, is untenable over the long run. China, India, and other nations need to find alternate ways to fulfill their energy demands. The only real answer — and our best chance to bring balance back to the environment — is to turn toward alternative sources of energy, which can at least in part replace existing coal and oil sources.

The most cost-effective way of weaning ourselves from fossil fuels is through energy efficiency, and this can be done by taking actions to make homes, buildings, factories, and our transport systems more efficient.[5] But at the same

[3] National Association of State Energy Officials, "What's Hot in Trade and Imports," available at: http://www.naseo.org/committees/energyproduction/oil/Trade_Hot.htm#What's%20Hot:%20The%20Asian%20Magnet

[4] Estimates for China's oil import dependency in 2030 range from 75%-82% based on these references: The World Bank, "Winds of Change: East Asia's Sustainable Energy Future," available at: http://www.recoalition.com/re2010/userfiles/files/Winds%20of%20Change%20(Full%20Text).pdf and Japan Times, "What is Beijing willing to do to secure oil and gas supplies?" (stating US Dept. of Defense predicts oil imports will amount to four-fifths of oil consumption by 2030), available at: http://search.japantimes.co.jp/cgi-bin/eo20101227mr.html

[5] Based on estimates in International Energy Agency (IEA), World Energy Outlook 2010

time, it is also important to aggressively develop the most feasible alternatives for supplying sustainable fuel and power directly – through renewable energy. Some examples of renewable energy with real potential are solar, wind, hydro, biomass, biogas, and tidal. While some of these technologies have been commercialized and entered the market, none of them has yet reached anywhere near their full economic and market potential.

Such renewable energy sources cannot become commercially viable without long-term financial incentives and comprehensive pricing policies backed by national governments around the world. Just the sheer size of the capital investments required in order to develop and exploit renewable energy demands that governments underwrite part of those costs, at least initially. This includes government-backed targeted incentives and grants for research and development of these emerging technologies, funding renewable energy demonstration projects, and adopting tax regimes for renewable energy that will attract private investors over the long run. Without the right policies and regulatory incentives, renewable energy sources are unlikely to succeed in Asia or elsewhere.

Globally, investments in clean energy have quadrupled over the past five to six years, from USD46 billion in 2004 to USD173 billion in 2008, and then falling slightly to USD162 billion in 2009.[6] And the upward trend is expected to continue, as technological developments, in combination with the policies and incentives mentioned above, boost the market for clean energy. The total expected investment in clean energy, for just the G-20 countries alone, is expected to be USD2.3 trillion over the next 10 years.

The real growth in global energy demand will occur in developing Asia — most notably China and India — which will demand access to greater and greater levels of energy over the next several decades. The overall demand for energy in the developing Asia region is expected to increase by 65 percent in the next 20 years, and electricity consumption is expected to increase by 114 percent.

Given these strong trends, we wanted to find out where key countries in Asia stand now on renewable energy as a workable alternative and what we can expect in the future.

[6] UNEP, 2010, Global Trends in Sustainable Energy Investment 2010. Sustainable Energy Initiative (SEFI), in cooperation with Bloomberg New Energy Finance

In order to find the answers, we approached 12 of the leading Asian law firms and asked each to comment on 10 basic questions about renewable energy policies and the regulatory framework in their individual countries:

1. *What are the driving factors for increasing renewable energy production?*
2. *Which renewable energy sources are viewed as the best opportunity for your country and why?*
3. *What role does your government play in regulating the energy industry? Describe the regulating environment and trends in deregulation in your country.*
4. *What agencies or bodies of government oversee the energy sector? What goals or mandates has your government set for electricity generation or fuels production from renewable sources?*
5. *What are the opportunities for private ownership (vs. public ownership) in clean energy development and technologies?*
6. *What is the level of government investment or what incentives are in place to support these goals and targets?*
7. *What kind of emphasis is placed on researching and developing renewable energy technologies versus looking to outside energy resources?*
8. *Is your country on track to be a clean energy importer or exporter from the standpoint of power production supply and manufacturing?*
9. *How developed is your country's workforce to support innovation, development and the production of renewable energy?*
10. *What are the key barriers to increasing renewable energy as a part of your country's energy mix?*

Each chapter of this book is devoted to insights on a specific country in Asia. Our hope is that this book will spark the beginning of an ongoing dialogue among government officials and planners, venture capitalists, individual entrepreneurs, researchers, multinational corporations in the energy sector, and NGOs as they focus their attention on how best to accelerate the deployment of renewable energy resources in Asia and elsewhere. The stakes are high for all of us. We cannot afford to step back from the challenges and ignore the great opportunities renewable energy technologies offer.

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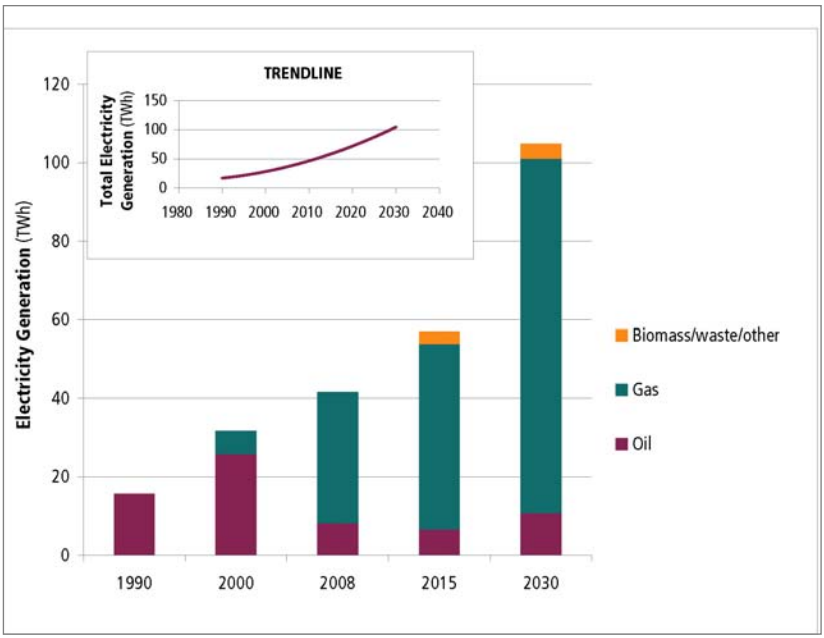
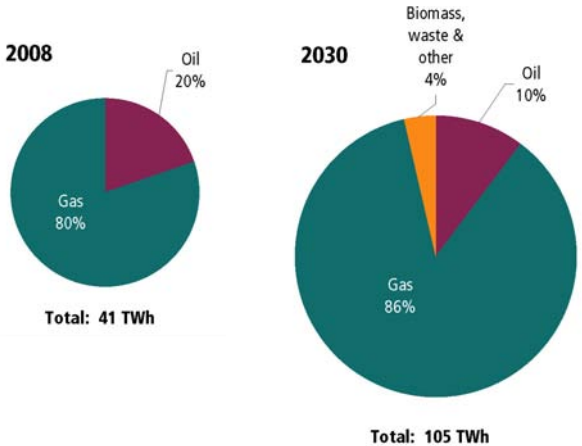
USAID's ECO-Asia CDCP program uses policy and market interventions to promote the scale up of investment and implementation in clean energy in developing Asian economies. The program is active in China, India, Indonesia, the Philippines, Thailand, and Vietnam. ECO-Asia CDCP partnered with Meritas in the development of this guide as part of its Asia Clean Energy Policy and Regulatory Dialogue, which is aimed at building capacity in the region to design and implement effective policy, regulatory, and legal frameworks for energy efficiency and renewable energy.

Electricity Generation by Fuel Type: Singapore





Source: Asian Development Bank, International Energy Agency, Asia-Pacific Energy Research Center, and The World Bank

1. What are the driving factors for increasing renewable energy production in Singapore?

Prompted by concerns about climate change, fossil fuel depletion, and increasing urbanization, Singapore, a low-lying, densely populated, urban island in the tropics which is particularly vulnerable to climate change, is following the global shift toward energy security and the production of sustainable and renewable energy sources.

Singapore's lack of indigenous natural resources makes it almost entirely dependent on oil and natural gas imports to meet its energy needs. Singapore is also susceptible to supply risks such as under-investment in energy production by energy exporters, geopolitical conflicts that may disrupt energy supply, and the vicissitudes of rising energy prices. It is thus both crucial and timely that Singapore join the global race to secure adequate and reliable energy supplies from diverse sources.

The bid for environmental sustainability, energy efficiency, and "clean-tech" is very much in line with Singapore's reputation as a Garden City, which was established some 40 years ago with Singapore's program to "green" its largely urban and commercial developments. The greening of Singapore is thought to have played a significant role in the social and economic development of Singapore's thriving economy, and the current move toward finding alternative and renewable sources of energy is a natural one for Singapore. As a result of a history of environmental and developmental planning, Singapore is well placed to refine existing energy measures to better address climate change and the ensuing consequences.

2. Which renewable energy sources are viewed as the best opportunity for Singapore and why?

Diversification Policy

In its February 2010 report, the Economic Strategies Committee, which was established in May 2009 and is chaired by the Minister for Finance, recommended the diversification of energy sources in Singapore, whereby:

- Coal and electricity imports are to be explored as an option in the medium term, to diversify the available fuel types and source countries, as such imports can free up valuable land space in

Singapore and allow Singapore to tap the renewable energy potential in the region, for example, in the form of hydro-electricity and geothermal power; and

- Although nuclear energy is not currently a feasible option in land-scarce and densely populated Singapore (considering international guidelines on the siting of nuclear power stations a minimum distance away from population centres) nuclear energy is nevertheless to be explored in the longer term, as a source of electricity generation that is relatively inexpensive, secure, and sustainable, since Singapore would be in a position to bear the high capital cost of producing nuclear energy.

The Economic Strategies Committee also recommended:

- Investing in critical infrastructure and acquisition of know-how to support future development of renewable energy and support national energy security and efficiency, such as a liquefied natural gas terminal, which would allow Singapore to gain access to global gas markets and reduce the costs of electricity; and
- Optimizing efficient energy consumption in industrial parks and homes (e.g., channeling waste heat from industries to be recycled for desalination of water, which would be routed back for industrial cooling processes).

Solar

Due to Singapore's location in the tropical sunbelt, the clean energy industry in Singapore has a natural focus on solar power. This geographical advantage is enhanced by Singapore's position as a major semiconductor hub as well as the availability of the full range of capabilities from the precision-engineering and chemicals industries.

Although electricity produced from solar photovoltaics is relatively expensive, it is believed that solar energy prices may achieve grid parity in the medium term, and Singapore has recognized the need to develop the infrastructure for efficient installation and integration of solar panels.

Consequently, the use of solar energy in the public domain commenced in 2008, when Singapore mandated green designs for all new buildings. Public buildings actively participate in solar test-bedding and industry development initiatives, the most prominent being the Zero Energy

Building, which was completed in 2009 as a collaborative effort among:

- the Building and Construction Authority;
- the National University of Singapore;
- the Solar Energy Research Institute of Singapore; and
- partners from the private sector.

The Zero Energy Building serves the dual role as showcase and test-bed of cutting-edge green building technologies as well as a research and development hub for energy efficiency and green buildings.

Waste

Singapore practices waste incineration to minimize the amount of waste dumped into landfills and to generate electricity. Since 2000, Singapore's waste-to-energy plants have contributed an estimated three percent of local energy supply.

Wind

Due to low wind speeds in Singapore, wind energy is not currently a viable option. However, Singapore serves as the Asia regional headquarters for Vestas Wind Systems, a top wind technology company. Vestas opened its largest research centre outside Denmark in Singapore in 2007, and has plans to invest up to SGD500 million over the following 10 years.

3. What role does the government play in regulating the energy industry? Describe the regulating environment and trends in deregulation.

For more than 30 years beginning in 1963, the energy market in Singapore was regulated by a statutory body, the Public Utilities Board (PUB), which was responsible for the generation, transmission, and supply of electricity to consumers, as well as the supply of piped gas and water to the entire population of Singapore.

The first phase of liberalization of the energy market in Singapore began in October 1995 when:

- the electricity and piped gas undertakings of PUB were corporatized under Singapore Power Limited (a holding company wholly owned by Temasek Holdings Pte. Ltd., the Singapore

government's umbrella company for holding most state-owned enterprises) operating through various subsidiaries in respect of the generation, transmission/distribution, retail and supply of power and gas; and

- PUB was reconstituted to
  - assume its new role as regulator of the electricity and piped gas industries; and
  - continue its role as the authority responsible for water supply in Singapore.

In this early phase, licensed independent power producers/suppliers were only authorized to supply to Singapore Power Limited or its subsidiaries, as a prelude to opening the retail market segment to competition.

Following the above initiatives and in a second phase of liberalization of the energy market in Singapore around 2000 and 2001, a new competitive framework was introduced, whereby:

- the contestable and non-contestable segments of the energy industry were separated; and
- a new pro-competitive legal and regulatory framework for the electricity and natural gas sectors took effect, with a restructured and liberalized power sector, opening up electricity generation and distribution, and gas importation and distribution, to full competition immediately in some areas and in stages in other areas.

So far, liberalization has opened up 75 percent of the total electricity sales in Singapore to competition. The final phase of retail market liberalization, i.e., full retail contestability, is currently under review. This phase will involve the remaining consumers – mainly small business and household consumers – which collectively represent 25 percent of the total electricity sales in Singapore and currently purchase electricity from the only licensed support services provider at the regulated tariff.

It is expected that the trend toward deregulation of Singapore's energy industry will continue, particularly in the electricity industry. It was reported in Singapore's Parliamentary debates on the 2010 Budget that ways to inject more competition into the household electricity market were being studied, to enable consumers to purchase electricity directly from different suppliers through a range of retail packages.

Changes in the regulation of the energy industry have been made with a view to safeguarding consumer interests while ensuring that companies operating in the liberalized energy industry remain financially viable and have an incentive to operate efficiently and to balance between these conflicting requirements.

4. What agencies or bodies of government oversee the energy sector? What goals or mandates has the government set for electricity generation or fuels production from renewable sources?

AUTHORITY AND REGULATORY FRAMEWORK

The energy industry in Singapore is regulated by the Energy Market Authority of Singapore (EMA), a statutory body established in 2001 pursuant to the Energy Market Authority of Singapore Act (Cap 92B) to assume regulatory responsibilities over the electricity and gas sectors. EMA is responsible for the administration of the:

- Electricity Act (Cap 89A) which creates the competitive market framework for the electricity industry and provides for the safety, technical, and economic regulation of the generation, transmission, supply, and use of electricity in Singapore; and
- Gas Act (Cap 116A) which creates the competitive market framework for the gas industry and provides for the safety, technical, and economic regulation of the transportation and retail of gas in Singapore.

EMA is responsible for the framework for energy market competition and oversees activities in the energy industry to ensure a competitive, secure, and reliable electricity and gas supply to consumers.

Under this regulatory structure, the policy framework for competition is set out and the roles of players in the market are designated through the type of license issued to each of them. No player can participate in the market without a license or approval from EMA. The different license categories in relation to:

- Electricity market regulation are for:
    - electricity generation;
    - electricity retail;

- electricity wholesale;
- electricity transmission;
- electricity import and export;
- electricity market support services; and

◆ Gas market regulation are to:

- convey gas;
- ship gas;
- retail gas;
- manage a gas receiving facility or terminal;
- produce town gas;
- import gas; and
- undertake other gas-related activity.

EMA's functions and duties include, among other things, to:

◆ Create a market framework for the supply of electricity and gas that promotes and maintains fair and efficient market conduct and effective competition, or in the absence of a competitive market, prevents the misuse of monopoly or market power;

◆ Promote the development of the electricity and gas industries;

◆ Promote the efficient use of energy utilities;

◆ Exercise licensing and regulatory functions for electricity and gas systems and services, including the establishment of standards and codes relating to any connected matter; and

◆ Advise the government on national needs, policies, and strategies relating to energy utilities.

Furthermore, under subsidiary legislation pursuant to the Constitution of the Republic of Singapore:

◆ The Minister for Trade and Industry is charged with the responsibility for, among other things, EMA, energy policies as well as energy utilities; and

◆ The Minister for the Environment and Water Resources is charged with responsibility for, among other things, National Environment Agency (NEA), PUB, clean energy, energy efficiency and conservation.

GOALS AND MANDATES

Presently, renewable sources make up two percent of the energy sources in Singapore, without any existing renewable energy targets set by the government to specify the proportion of energy that should be generated by renewable sources within any time period.

However, a new Energy Conservation Act has been proposed and would come into force in 2013. It would help Singapore achieve the target of a 35 percent improvement in energy intensity by 2030 from 2005 levels, and would ensure a coordinated approach to standards-setting for energy efficiency across all sectors. This proposed Energy Conservation Act would introduce minimum energy management standards for large energy users in the industry sector, including:

- appointment of energy managers;
- monitoring and reporting of energy use; and
- submission of energy efficiency improvement plans.

In anticipation, NEA introduced the Energy Efficiency National Partnership in April 2010 to help companies build up the necessary capabilities and ensure a smooth transition to implement the Energy Conservation Act, the main components of which include a learning network, recognition scheme, and high-level committee on energy-efficiency partnerships.

With its constraints as a small country without natural resources such as wind and hydropower, energy efficiency is a key component in Singapore's energy strategy, along with research into clean and renewable energy, to decrease reliance on carbon-intensive fossil fuels and development of energy-efficient technology to reduce the impact of growing energy needs. The government is taking an active role in driving this research and development.

The interagency Energy Policy Group, established in 2006 and chaired by the Permanent Secretary of the Ministry of Trade and Industry, has developed a National Energy Policy Framework. This framework aims to balance the policy objectives of economic competitiveness, energy security, and environmental sustainability, in order to pursue the key strategies of Singapore's energy policy. Singapore is committed to taking a diverse and competitive portfolio approach towards energy.

In 2007, clean energy was officially endorsed as a key growth area for Singapore with the target of generating SGD1.7 billion in added value by 2015. The Economic Development Board (EDB) thereafter set up the Clean Energy Programme Office as the key interagency workgroup in Singapore and tasked it with implementing and coordinating research and test-bedding public programs in Singapore. The objective is to leverage the strengths of government agencies and implement a comprehensive approach to develop the clean energy industry in Singapore by focusing on cluster development, technology development, and internationalization, with an emphasis on solar energy.

In the area of energy efficiency, NEA is working with relevant government agencies, academics, and industry to identify suitable areas and technologies for research to support Singapore's energy efficiency efforts. Following the formation of the Energy Efficiency Programme Office in 2007 by NEA, several initiatives targeting households and businesses have been introduced, including the 10% Energy Challenge, where households are encouraged to reduce about 10 percent of their household energy consumption in five years.

In Singapore Parliamentary debates on the 2010 Budget, it was reported that the energy policy goal is to make Singapore a Smart Energy Economy with an energy ecosystem that is secure, sustainable, and competitive. The strategy to meet the global energy challenges rests on two key thrusts: diversification of energy sources and competitive energy markets.

5. What are the opportunities for private ownership (vs. public ownership) in clean energy development and technologies?

Energy Industry

Singapore serves as the Asia-Pacific base for many researchers, developers, and manufacturers in the energy industry, due to its advancements in other sectors such as electrical engineering and mechanical engineering, which can be applied to energy generation and efficiency. Notwithstanding the lack of natural resources in Singapore, leading players in the clean energy industry command substantial presence in Singapore.

Renewable Energy Corporation (of Norway) has established an integrated manufacturing complex in Singapore, with SGD2 billion invested to date, which incorporates wafer, cell, and module production facilities on a scale that will create a surge in its production capabilities. Singapore also serves as Asia-Pacific headquarters for many global energy companies such as SolarWorld Group and Solar-Fabrik AG. As mentioned above, Vestas Wind Systems, a top wind-technology company from Denmark, has a significant research centre in Singapore and plans to invest up to SGD500 million over 10 years from its opening in 2007.

Private Buildings

The Clean Energy Programme Office established the Solar Capability Scheme in 2008 to encourage businesses to diversify their energy resources and develop ground-breaking approaches in innovating and integrating solar panels into new private buildings that have attained "Green Mark Standard" (under the "Green Mark Scheme" established by the Building and Control Authority in 2005 on the accreditation of environmentally friendly buildings). Grants will be given to offset up to 30 percent of the total capital cost of the solar technology, capped at SGD1 million per project, while the amount will vary in accordance to evaluation criteria of innovation, design, effectiveness, and skill development.

Research Grants

In 2010, under the third call for proposals of the competitive funding initiative known as the Clean Energy Research Programme, research grants totaling SGD13 million were awarded by the Clean Energy Programme Office to five research teams in Singapore, with a focus on improving solar cell efficiency and storage systems developed for renewable energy and encouraging collaborative efforts between government agencies and private companies.

Private-Public Sector Interaction

In 2008, the Agency of Science, Technology and Research (A*STAR) established the Singapore Initiative on New Energy Technologies Centre (SINERGY Centre) to provide the technical infrastructure for development of clean energy technologies and sustainable energy solutions and to work and interact with independently funded research groups from both the public and private sectors. SINERGY Centre will support successful commercialization of new energy solutions in the marketplace.

6. What is the level of government investment or what incentives are in place to support these goals and targets?

NEA Incentive Schemes

NEA administers various incentive schemes to advance the cause of environmental sustainability, such as:

- The SGD20 million Innovation for Environmental Sustainability Fund which provides financial grants for companies to test-bed innovative technologies that contribute to environmental sustainability, pursuant to which NEA funded:
  - SGD1 million to test-bed building-integrated photovoltaics, an innovative photovoltaic (PV) technology in which solar PV cells are integrated into the facade of buildings; and
  - the building of a 5 MW and 9.2 MW trigeneration facility respectively, which are expected to help reduce CO_2 emissions by 17 percent and 24 percent yearly.
- Energy Efficiency Improvement Assistance Scheme, which provides up to 50 percent funding for companies to carry out detailed energy appraisals;
- Design for Efficiency Scheme, which provides up to 80 percent funding or SGD600,000, whichever is lower, for large consumers of energy to conduct workshops on the design of more energy-efficient facilities;
- Grant for Energy Efficient Technologies, which provides up to 50 percent funding capped at SGD2million per project to encourage owners and operators of industrial facilities to invest in energy efficient equipment or technologies;
- Accelerated Depreciation Allowance Scheme, which allows capital expenditure on qualifying energy efficient or energy saving equipment to be written off in one year instead of three years; and
- Clean Development Mechanism Documentation (CDM) Grants, which co-fund up to 50 percent of the cost of engaging carbon consultants to develop documentation needed for CDM projects under the Kyoto Protocol, capped at SGD100,000 per project.

Green Mark Incentive Scheme

On the heels of its company accreditation "Green Mark Scheme," the Building and Construction Authority launched the Green Mark Incentive

Scheme, which offers cash incentives to:

- Developers, building owners, project architects, and M&E engineers who make efforts to achieve at least a Green Mark Gold rating or higher in the design and construction of new buildings (SGD20 million has been set aside and is already fully committed; and
- Building owners to retrofit and upgrade their existing buildings to improve energy efficiency and/or undertake energy audit to determine energy efficiency of such buildings, for which SGD100 million has been set aside.

Clean Energy Research & Test-bedding Programme

In 2007, the Clean Energy Programme Office launched the SGD17 million Clean Energy Research & Test-bedding Programme, under which buildings and facilities in Singapore can be used as a "field laboratory" for clean energy technologies to be tested and integrated, before commercialization. The goals of the test-bedding include examining the prospects for large-scale renewable energy adoption in Singapore, particularly in solar energy.

MND Research Fund for the Built Environment

In 2007, the Ministry of National Development set aside SGD50 million for the MND Research Fund for the Built Environment to intensify research and development efforts in green building technologies and energy efficiency over the ensuing five years.

Market Development Fund

In 2007, EMA established a SGD5 million Market Development Fund to facilitate test-bedding of nontraditional generation technologies that have significant value in the electricity market and to support other ideas/technologies that have development potential in the energy market.

Energy Technology R&D Programme

A*STAR established the Energy Technology R&D Programme in 2007 to coordinate and enhance existing research and development efforts in clean energy technologies, and to act as a focal point for coordinating, integrating, and expanding efforts and capabilities in clean energy, especially in the areas of fuel cells, alternative fuels such as biofuels and hydrogen, as well as solar photovoltaics technologies.

National Research Foundation Funding Initiatives

In 2008, the National Research Foundation set aside SGD170 million for research into clean energy to boost the development of the local clean energy industry over the ensuing five years. Through this funding, the Clean Energy Programme Office launched the Clean Energy Research Programme worth SGD50 million as well as the Clean Energy Scholarships worth SGD25 million.

Solar Capability Scheme

In 2008, the Clean Energy Programme Office established the SGD20 million Solar Capability Scheme to encourage innovative design and integration of solar panels into buildings, as well as to strengthen the capabilities of designers, architects, and system integrators in solar energy companies through increased implementation by lead users in Singapore.

SINERGY Centre

The SINERGY Centre established by A*STAR in 2008 reflects the forward-thinking and holistic approach to the clean energy industry in Singapore, and serves as a test-bedding facility and platform for research and development collaboration and development of thought leadership in alternative energy and distributed (or on-site) generation of electricity. It will work with independently funded research groups from both the public and private sectors to develop expertise in systems integration and evaluation of technologies, with the eventual goal of providing this expertise in the form of consultation services that address issues such as energy efficiency, as well as fuel management and grid management.

Sustainable Singapore Blueprint

In April 2009, the Singapore government unveiled a sweeping SGD1 billion Sustainable Singapore Blueprint to help build a greener, more energy-efficient and sustainable nation. Almost SGD700 million has been set aside for research and development and manpower training to grow the clean technology sector under this blueprint.

Energy Research Development Fund and Smart Energy Challenge

In 2009, EMA also set up a SGD25 million Energy Research Development Fund to provide financial support for the implementation of new and innovative energy solutions to diversify Singapore's energy sources and improve Singapore's energy security, help achieve Singapore's energy intensity reduction targets and develop Singapore's energy industry. This

fund is intended to seek out projects that are close to deployment and have the potential to provide impactful and tangible results. It will also be used to complement and support proposals for projects submitted through the Smart Energy Challenge, which provides funding of up to SGD5 million per project for the development of ideas that address Singapore's energy goals.

Electric Vehicles Taskforce

A multi-agency Electric Vehicles Taskforce, chaired by EMA and the Land Transport Authority, has been set up to lead tests and research into the introduction of electric vehicles in Singapore from 2010, in which the Singapore government is investing SGD20 million to support infrastructure development and tests. This is the first government-funded initiative to help pave the way for electric vehicles on Singapore roads.

7. What kind of emphasis is placed on researching and developing renewable energy technologies versus looking to outside energy resources?

Singapore places a strong emphasis on researching and developing its own renewable energy technologies, as is evident from the various government incentive schemes and funds set out above. Singapore also strives to be a global hub where clean energy solutions are developed, tested, and exported overseas and has allocated nearly SGD700 million to develop the five key pillars in the energy field:

- Research and development
- Manpower development
- Grooming Singapore-based enterprises
- Branding the industry internationally
- Growing a vibrant industry ecosystem

In this strife, Singapore's strategy is essentially three-fold:

- Cluster development:
  - attract and anchor major international companies;
  - groom local-based companies to be world class players; and
  - proliferate startup companies.
- Technology development:
  - initiate Clean Energy Research Programme;

    - build research and development competence centers and global linkages;
    - make Singapore a global test-bed and site of early adoption; and
    - groom energy technology talent and manpower;
- Internationalization:
    - export clean energy products and solutions by Singapore-based companies; and
    - market and brand Singapore's clean energy industry.

Singapore's emphasis on local energy technology development is also illustrated by the existence of many research centres and curricula on the subject:

- The Energy Studies Institute was established in 2007 at the National University of Singapore to promote and develop policy-oriented research on the economic, environmental, and international relations aspects of energy, as well as contribute to energy dialogue and collaboration within the region.
- The Solar Energy Research Institute of Singapore was established in 2008 at the National University of Singapore as one of the most comprehensive solar research centres in Asia. It draws upon the university's strengths in research areas such as nano-science, silicon thin film technology, and semiconductor processing.
- The Energy Research Institute was launched in 2009 at the Nanyang Technological University with an investment of SGD100 million over five years, as another pillar to diversify Singapore's energy research and development competence. The Institute will develop industry-oriented innovations in clean energy, focusing on areas such as wind and marine renewables, green buildings, energy storage and fuel cells, and will train specialists with expertise in these areas.
- The Diploma in Clean Energy is offered by Singapore Polytechnic as its response to the need to look to alternative clean and green energy resources.
- The Singapore Environment Institute, the training division of NEA, regularly offers industry-specific short courses deemed relevant to environmental protection and conservation.

Furthermore, besides advancing its own know-how and technologies

through various research organizations such as the Temasek Life Sciences Laboratory, the Institute of Chemical and Engineering Sciences, and the Institute of Environmental Science & Engineering, Singapore is also attracting new players from the United States, Europe, and Japan to conduct research and development on biofuels and to set up biofuel pilot plants in Singapore.

8. Is Singapore on track to be a clean energy importer or exporter from the standpoint of power production supply and manufacturing?

In tune with Singapore's export-oriented and energy-intensive economy, most of the energy consumed by industrial processes is expended for export purposes and not local consumption. For example, the industrial sector consumed about half of Singapore's total energy use in 2005, mostly to support key exporting industries like refining, petrochemical, pharmaceutical, and wafer fabrication industries. Despite its lack of domestic oil resources, Singapore is one of the world's major oil-refining and trading centres. Singapore currently houses one of the largest oil-refining centres in the world, and its three oil refineries in aggregate consume one-fifth of Singapore's total energy use. In addition, Singapore accounts for 15 to 20 percent of the world's physical oil trade, with an annual value above USD300 billion.

As one of the key strategies put forth in the National Energy Policy Framework, Singapore aims to build up the energy industry (including the clean energy industry) by investing in energy research and development. Singapore intends to continue its role as a major exporter in refined oil and premier energy-trading hub. In particular, it is envisioned that Singapore will widen its lead in the oil industry, especially by increasing the levels of investment and output in petroleum refining. There are also plans to increase the range of energy products traded in Singapore, more specifically in liquefied natural gas, biofuels and carbon dioxide emission credits.

9. How developed is Singapore's workforce to support innovation, development and the production of renewable energy?

In the labour market overview of the Singapore Ministry of Manpower in August 2010, the energy, environment, and water technologies industry was identified as one of the emerging industries in Singapore that is expected to create employment opportunities, as the levels of investment in the industry are very promising.

National Policy

The development of the Singapore workforce is an integral part of the National Energy Policy Framework which strives to maintain a balance between the policy objectives of economic competitiveness, energy sustainability, and environmental sustainability, based on the "whole-of-government approach." This has led to the establishment of multi-agency workforce development programs.

Capability Development

SGD25 million has been invested under the prestigious Clean Energy Scholarships to groom talent and train the next generation's leaders locally and overseas, for clean energy research in Singapore, and to support the growth of the industry.

Many educational programs relating to the development and promotion of the energy sector are also available, the training and curricula of which have been specifically designed to meet the challenges of the emerging energy industry, including those mentioned in section 7.

In a 2004 initiative, the National University of Singapore and its Energy Sustainability Unit (School of Design and Environment) established the Singapore Certified Energy Manager Programme, which is jointly administered by NEA and the Singapore Institution of Engineers. This programme:

- Is designed for engineering professionals who intend to build their careers as energy managers;
- Gives a thorough understanding of the key energy issues either in the building or industry sector;
- Helps participants to develop the technical skills and competence needed to manage energy services and management work within the organization they serve; and

- Certifies a trained energy manager who is envisioned as a competent energy professional equipped to perform technical and managerial functions as a qualified person in the areas of:
    - energy audits, management, and measurements;
    - energy retrofitting services;
    - financial advisor for energy-efficiency measures and contracting;
    - energy consultation and procurement services;
    - energy facility and management; and
    - energy-engineering works.

Company Accreditation

Supported by NEA, the National University of Singapore and its Energy Sustainability Unit (School of Design and Environment) also established the Energy Services Companies Accreditation Scheme in 2004, with the objective of enhancing the professionalism and quality of services offered by energy services companies. This is intended, in turn, to enhance confidence in the energy services sector and help promote the growth of the industry. It is an important market development measure for Singapore and is further intended to reap the following benefits:

- Develop professional and qualified energy services companies and energy engineers;
- Enhance the standing of energy services companies, and in particular energy auditing services;
- Support energy services procurement and selection procedures;
- Support public sector incentive schemes in the promotion of energy efficiency; and
- Reduce waste and false claims among industry players.

Private Sector

Reflecting the prevalence of clean-tech training consciousness, various private firms and associations have developed and are offering training programs geared toward the development of the energy industry workforce. Some of these are training courses for current and potential professional and/or skilled employees in the energy industry and can be found in the training courses directory, maintained by the Singapore Workforce Development Authority.

10. What are the key barriers to increasing renewable energy as a part of Singapore's energy mix?

Land and Natural Resources

The key barriers to increasing renewable energy as part of Singapore's energy mix include the fact that Singapore is a land-scarce city-state with limited natural resources and geographical constraints. This means that Singapore does not itself possess economically viable renewable energy resources. In addition, there is currently little necessity to introduce new renewable energy sources for electrical uses since Singapore's installed power capacity is much higher than its peak demand. The applicability of ocean energy technologies is also restricted by Singapore's limited coastline and the fact that most of its sea space is used for ports, anchorage sites, and shipping lanes.

Cost

The incentives and schemes offered by various Singapore governmental agencies as discussed above encourage new participants to overcome the cost entrance barrier of the clean energy industry. Although Singapore has a clear focus on solar energy as the most viable source of renewable energy, the technology used to implement it is still cost-prohibitive in comparison with fossil fuels. To illustrate, solar photovoltaic systems have great potential in Singapore due to the high year-round incidence of solar radiation. However, this solar power is currently two to three times more expensive than Singapore's low tension tariffs, due to the high upfront costs of installing the systems. The cost of building materials, advancements in technology, and increase in know-how will also drive the costs of such installations.

As Singapore pursues its aim of building a diverse portfolio of renewable energy sources, it is keenly aware that a limitation of intermittent renewable energy sources such as wind and solar energy is that they either have to be fully backed up by other power sources or require investments in energy storage to maintain reliability of power supply. As the share of intermittent renewable sources increases, there will still be a need to invest in back-up or storage systems to ensure energy security.

Technology

Technology can also pose a barrier to Singapore's bid to increase its supply of renewable energy. For example, notwithstanding the substantial investments being made to increase economic viability of solar power and its integration into everyday use, lack of widely available commercial technology renders this close to impossible at the present. Similarly, low wind speeds in Singapore cannot be harnessed by existing technology to create a viable source of wind energy. Singapore is therefore seeking energy technological advances that may allow it to harness and/or create more varied energy sources in the future.

Information

Lack of information on energy-efficient measures in the commercial and financial markets also poses a market barrier to implementing such measures. To remedy this problem, in 2007 NEA established the Energy Efficiency Programme Office, an interagency committee led by NEA to drive energy-efficiency programs and address market barriers to energy efficiency, raise awareness and reach out to the public and businesses, and promote research and development to enhance local capabilities in energy-efficient technologies.

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