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INTRODUCTION

The theme of this issue is the Development of China's Carbon Markets: Opportunities and Challenges.

Carbon markets are established to ensure that the total social cost of reducing carbon emissions can be minimised through carbon emissions trading. The Kyoto Protocol advocated the use of market-based mechanisms to control global carbon emissions and their success in Europe has led to a proliferation of carbon markets in other countries, both developed and developing, and especially in Asia. The European Union Carbon Market and the California Carbon Market are the largest in the world. Countries in Asia that are considering or implementing carbon markets include Japan, Korea, China, Thailand, Indonesia and Vietnam.

As the world's largest CO_2 emitter, China has launched various policy measures, including the market-based mechanism, to control the increase of its domestic CO_2 emissions. Now nearing the end of the 12th Five Year Plan (2011-2015), China is reviewing its achievements therein, and is discussing new strategies for further mitigation of CO_2 emissions in the 13th Five Year Plan (2016-2020). In mid-2013, China's central government launched seven pilot emissions trading schemes – in Beijing, Tianjin, Shanghai, Chongqing, Hubei, Guangdong and Shenzhen – with plans to establish a nationwide scheme in 2016 and eventually become the largest carbon market in Asia. In December 2014, the Chinese National Development and Reform Commission further announced the "Carbon Emissions Trading Management Interim Measure", to serve as the guideline for developing its national carbon market.

In this issue ...

This issue of the Bulletin presents summaries of half the presentations delivered at ESI's *2nd Singapore-China Energy Forum*, held in October 2014. The previous issue (March 2015) had summaries of the presentations pertaining to China's energy markets. This issue's presentation summaries all relate to China's carbon market, notably the pilot emission trading schemes (ETS) and carbon taxation mechanism, the concerns and responses of Chinese businesses to carbon pricing, low-carbon technology opportunities, carbon finance and China's role in the international carbon market. The speakers at this event came from China, Singapore, Hong Kong, Japan, Australia, the United Kingdom, and Norway.

Dr. Ying Fan, Professor and Director of the Center for Energy and Environmental Policy Research at the Institute of Policy Management at the Chinese Academy of Sciences presented "The Transaction Costs and Cost Effectiveness of China's ETS Pilots". She highlighted the importance of transaction costs in emission trading schemes, which include the trading fees and monitoring, reporting and verification costs. Transaction costs can influence the cost-effectiveness of emission trading as they may offset cost savings. The firm-level abatement cost curves together with a cost-benefit analysis were used to investigate and compare the impacts of the transaction costs on the firms included in emission trading schemes. She concluded her presentation with some suggestions for enhancing emission trading development in China.

Dr. Chen Shiyi, Professor and Director of the Sustainable Development Institute at Fudan University in China, presented "Marginal Abatement Cost and Carbon Taxation Reform in China". The marginal abatement costs of CO_2 emissions in the industrial sector were estimated using the directional distance function and then utilised as benchmarks to calculate the possible future carbon tax rate. Carbon taxation has negative impacts on the industrial value-added output, especially for heavy industry in China. The forecasting results showed that a carbon tax could help China achieve the 40 to 45 per cent reduction in carbon intensity by 2020 compared with the 2005 level. He further explained that the gains from carbon taxation outweigh the losses, and ended by stating that China's environmental taxation reform should start with carbon taxation.

Dr. Cyril Cassisa, Visiting Scholar at the Institute of Energy, Environment and Economy at Tsinghua University in China, presented "Emissions Trading in China: Progress and Prospects". China's pilot emission trading was initiated by the National Development and Reform Commission in late 2011 to create cost-effective, market-based and internationally compatible mechanisms for emissions reduction. He gave a comprehensive overview of the current status of China's seven pilot emission trading schemes. By comparing their developments, the issues that have emerged in the design process such as legal and regulatory barriers and coordination of different instruments were identified, and some important next steps for developing national emission trading schemes were discussed.

Dr. Liu Xianbing, Senior Policy Researcher at the Institute for Global Environmental Strategies in Japan presented "Concerns and Responses of Chinese Businesses to the Pricing of Carbon Emissions". His presentation was based on the findings from a survey conducted between April 2010 and March 2013 on "Market-Based Instruments for Improving Company Carbon Performance in Northeast Asia". Chinese companies were found to have low awareness of carbon pricing policies like carbon taxation and emission trading. For most energy-intensity industries in China, energy costs rise by 7.7 to 9.9 per cent due to carbon price policies, i.e., carbon pricing at 40-80 RMB per ton of CO_2.

Mr. Ajay Gambhir, Senior Research Fellow from Imperial College London's Grantham Institute in the United Kingdom, presented "China's Technology Opportunities in a Low-Carbon World". He discussed China's significant investment in low-carbon sources such as solar, wind, nuclear and hydro in the 12th Five Year Plan. With more evidence on climate change, there will be a fast-expanding global market for low-carbon technologies where China is well placed to compete in some key technologies, e.g., nuclear, carbon capture and storage, wind, solar and electric vehicles. On the other hand, there are also many potential risks in the rapid development and deployment of low-carbon technologies, such as increases in technology costs in nuclear power deployment and incomplete regulatory reforms to integrate new low-carbon technologies (e.g., wind power) into power grids.

Dr. Wang Yao, Professor and Director of the Research Center for Climate and Energy Finance at China's Central University of Finance and Economics, presented "Carbon Finance in China: Recent Experience and Future Prospects". She gave definitions of green finance, climate finance and carbon finance and highlighted their relationships. Carbon finance is a concept under the broad "climate change" grouping, and is a mechanism for climate mitigation, including any financial innovations related to carbon reduction in carbon market and traditional financial markets. She then went on to examine the challenges in China's seven pilot carbon markets and offer suggestions for designing the national carbon market. Lastly she reviewed China's development of carbon finance and discussed the key points in issuing a carbon bond in China.

Dr. Alex Lo, Assistant Professor in the Kadoorie Institute at the University of Hong Kong presented "Could China's ETS Experiments Lead towards an International Carbon Market?". Following the establishment of the European Union's Emission Trading Scheme (EU ETS) in 2005, there has been increasing interest from developing countries to consider or implement emission trading schemes, particularly China. As a socialist market economy, China's emission trading scheme may operate quite differently from the schemes in mature capitalist economies such as the United States and the European Union due to variations in political, regulatory and intuitional structures. If China, as the largest CO_2 emitter in the world, can develop its own national carbon market, it could become the cornerstone of a carbon trading network across Asia, or even the developing world as a whole, in the next one or two decades.

We hope you find these presentation summaries of interest and welcome your views and comments.

Dr. Su Bin, Senior Fellow
(On behalf of the ESI Bulletin Team)

The Transaction Costs and Cost Effectiveness of China’s ETS Pilots

By Professor Ying Fan, Center for Energy and Environmental Policy Research, Institute of Policy and Management, Chinese Academy of Sciences, China

Boats and Ships on the South Side of the Haidian River, at Haikou New Port, Haikou, Hainan Province, China. Photo by Anna Frodesiak / Wikimedia Commons (Licensed under CCO).

As there are considerable differences in the abatement costs, and in the development levels among China’s regional economies, it is likely that a reasonable cost saving will be achieved through the country’s seven ETS pilots. However, the transaction costs have played an important role and could offset the cost-effectiveness of the ETS. Thus, some firms or sectors should not be included in the scheme. There are different provisions concerning the coverage among the existing ETS pilots. For example, the European Union Emissions Trading Scheme (EU ETS) covers combustion installations with a threshold of 20 megawatts (MW), and an additional emission threshold of 25,000 tons of CO_2 equivalent (tce) per year has been introduced in the third phase. This contrasts with the United States where only electricity generators with a threshold of 25 MW have been included in the Regional Greenhouse Gas Initiative (RGGI). The differences in the provisions indicate that the transaction costs could have distinct impacts among the ETS pilots as there could be some differences in the composition of the transaction costs or in the characteristics of the covered firms therein. It therefore seems to be quite important to study the transaction costs and their impacts on the cost-effectiveness of the ETS pilots.

The typical transaction costs in emission trading schemes consist of the trading fees and monitoring, as well as the reporting, and verification (MRV) costs. In theory, transaction costs can influence the cost effectiveness of the ETS as they may offset cost savings. Moreover, as the costs are not proportional to company size, small- and medium-sized enterprises should not be included in the ETS’.

Findings from surveys of pilot regions indicate that for a given firm included in the ETS, the annual MRV costs vary from RMB 20,000 to 30,000 in Shenzhen (the ‘Shenzhen pattern’) to RMB 80,000 to 100,000 in Beijing (the ‘Beijing pattern’), while in Shanghai, the government promised to bear the expenses during the pilot period.

The purpose of the reseach presented at the conference was to compare the differences in the impacts of the transaction costs on the cost-effectiveness of the ETS among the different regions as well as the different levels of the expenses. The findings yielded empirical evidence about the design of emissions trading schemes in China.

We estimated the firm-level abatement cost curves and then used cost-benefit analysis to investigate and compare the impact of the transaction costs (trading fees and MRV

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costs) on the firms included in the ETS. The industrial firms participating in “enterprise energy-saving low carbon action” in China’s ETS pilots were used as an example. The findings revealed: (a) the MRV costs rather than the trading fees imposed obvious impacts on the cost-effectiveness of the ETS; (b) the MRV costs should be less than RMB 20,000, or the reduction percentage should be greater than 10 per cent to ensure the cost effectiveness of the ETS; (c) the number of the firms, distribution of emissions among the firms, and their share in the regional emissions could be the critical factors in the impacts of the transaction costs; (d) the linkages among the ETS pilot schemes contribute a little to the cost effectiveness; and (e) increasing the reduction requirements will make more firms cost effective.

To enhance ETS development in China, we suggest that (a) the government cover a significant part of the MRV costs (one-third of the expenses at least) and provide much more support in reducing the MRV costs; (b) devote attention to the affordability of the transaction costs for underdeveloped areas, (a differentiation strategy for the transaction costs could be adopted); and (c) the emissions reductions targets should be increased moderately so as to overcome the adverse effects of the transaction costs.

Marginal Abatement Cost and Carbon Taxation Reform in China

By Professor Shiyi Chen, Fudan University, China

Qujing, Yunnan Province, China. Photo by PanShiBo / Wikimedia Commons (Licensed under CC BY-SA 3.0).

In order to transform China’s economic development model and help mitigate global warming, the State Council in November 2009 agreed to reduce CO_2 emissions per unit of GDP by 40 to 45 per cent by 2020 compared to the 2005 benchmark level. This is the first time for China to announce this type of CO_2 intensity goal, though it is only a relative carbon abatement target instead of an absolute reduction, as has been called for by most other governments. Nonetheless, it will still be quite a daunting target for China to realise due to the dominance of coal in the country’s energy consumption structure.

For this reseach project, the marginal abatement cost for CO_2 emissions in China’s industrial sectors over the reform period was estimated. A directional distance function was employed and used as the benchmark to calculate a carbon tax rate. Polynomial dynamic panel data model-based forecasting tells us that a carbon tax levy negatively influences industrial value-added output. However, the negative influence of a carbon tax on output is very small. Aggregated industrial value-added output increases 7.9 per cent each year over the 12th Five Year Plan period (2011-2015) and 6.88 per cent over the 13th Five Year Plan period (2016-2020), respectively. Though the carbon tax rate on heavy industry is low, heavy industry value-added output is influenced more by the carbon tax levy than is light industry value-added output due to its huge total CO_2 emissions.

A carbon tax levy would clearly be beneficial to the abatement of CO_2 emission intensity. The forecasting results reveal that the CO_2 intensity of aggregated, light and heavy industry in 2020 would be 42.7, 45.08 and 46.25 per cent, respectively, less than what they were in 2005, surpassing the above-mentioned target of 40 to 45 per cent. In sum, a carbon tax levy can directly promote carbon intensity abatement by increasing energy prices and improving energy efficiency, and indirectly by redistributing the carbon tax income, reinvesting in low carbon technology, adjusting the distortion of the traditional tax system, etc. Therefore, based on this study, the gains from a carbon tax levy outweigh the losses, and environmental taxation reform in China should begin with a carbon tax.

The design of China’s carbon tax should take the following points into account. A carbon tax levy is urgent in China due

China Eastern Airlines Airbus A321-211/B-2289 at Hong Kong International Airport. Photo by Aero Icarus / Wikimedia Commons (Licensed under CC BY-SA 2.0).

to climate change and also to help achieve an international carbon abatement agreement following the expiry of the Kyoto Protocol in 2012. Low carbon investment will reduce the shock in the early years of the carbon tax levy. The carbon tax should be levied on those production units which emit CO_2 directly into the atmosphere and be based on their total CO_2 emissions. Levying a carbon tax in such a manner is convenient because its calculation is very simple due to the fixed carbon emission coefficients of fossil fuels and electricity. It is also easier to urge firms to develop low carbon technologies and make major efforts to abate carbon than to levy a carbon tax based on the carbon content of fossil fuels.

The setting of a carbon tax rate could be based on the marginal abatement cost of CO_2 emissions estimated in this study which will inevitably increase over time and vary across industrial sectors.[1] As tested in this study, such a carbon tax rate could lead to a reduction of CO_2 intensity similar to the officially announced target. Of course, a carbon tax is only the first step in broad environmental taxation reforms in China.

Given President Xi Jinping's announcement at the APEC Summit held in November 2014 that China's total CO_2 emissions will approach their peak in 2030, and that renewable forms of energy will account for 20 per cent of the country's total energy consumption, it is critical for the government to levy the CO_2 tax as early as possible.

1. If calculated on the basis of carbon rather CO_2, the carbon tax rate can be obtained by multiplying the CO_2 tax rate measured in this study by 3.67.

Emissions Trading in China: Progress and Prospects

By Dr. Cyril Cassisa, Institute of Energy, Environment and Economy, Tsinghua University, China

The National Development and Reform Commission moved relatively quickly to establish China's ETS pilots. Their preparation and launch took place between 2011 and 2013. This is a short timeframe considering that the European Union's ETS was fully operational only after more than seven years of preparation. There is great interest in understanding how each of China's ETS pilots will develop and differ from the existing systems abroad.

China's seven ETS pilots differ in the extent of sectorial coverage, the size threshold for qualifying installations, and other design features (see Table 1) that reflect the diverse settings and priorities. In this research project, by comparing the development of the ETS pilots, we identified issues that have emerged in the design process, and discussed the important next steps for the development of a national ETS.

Based on evidence gathered from the political development of China's pilot carbon markets, this study investigated the extent to which the adoption of market-based instruments entailed a real "marketization" of climate policies in China and their impact on the effectiveness of these innovations on China's climate governance model. It aimed to demonstrate that the Chinese ETS pilots are developed according to China's traditional governance model, whereby market actors are barely involved in the design of the market they are called to take part in. Their attitude towards the new policy instrument therefore ranked from passive negligence

Yutong Bus in Guangdong, China. Photo by BinBin / Wikimedia Commons (Public Domain Image).

The Bund, Shanghai, China . Photo by Bahtiar1070 / Flickr (Licensed under CC BY-NC 2.0).

to tacit reluctance. This is apparent in Figure 1 which shows the very low daily traded volume compared to the trading potential from the total allocated volume (see Table 1).

The pilots have also faced legal and regulatory barriers. First of all, there is, as of yet, no clear legal mandate for establishing an ETS at the national level. If a national law on climate change were instituted, the provinces would have legal grounds for initiating the local legislation needed to establish an emissions trading system and also be able to move more quickly to develop ETS institutions compatible with a national trading system. Second, at present certain types of financial exchanges are prohibited by the existing Regulation on Financial Derivatives Exchange. To remedy this challenge, the government needs to grant explicit permission for trading carbon emissions rights in exchanges. Third, mechanisms for enforcing compliance with an ETS are still weak in China. Under a recently amended law, offenders can be punished severely for environmental pollution. For instance, fines may be much higher, or offending entities can be forced to close down. An important challenge is to extend a similar treatment to carbon, providing a more powerful incentive for covered entities to comply under a national ETS.

Moreover, the coordination of the use of market-based instruments with other instruments such as a possible carbon tax, as well as the harmonisation of diverse pollution and energy conservation targets is a real headache for local authorities. The resulting overlapping responsibilities and uncertainties reinforce the reliance of all the actors involved on the traditional "top-down" governance model in China, which entails a relative denaturation of the function of "market-based" low carbon policy instruments and limits their effectiveness in achieving China's ambitious climate policy goals.

Recently, many improvements have been made at both the provincial and national levels. The pilots have forced companies to be compliant. They have also opened market access to financial institutions (domestic and international), used auctioning to adjust the market supply and demand, extended the covered sectors and number of companies, and are looking at the possibility of using financial derivatives. At the national level, China has released regulations on a national ETS as well as MRV guidelines. All these clearly demonstrate the efforts and determination of China to succeed in the implementation of their ETS.

Figure 1: Daily Traded Volumes for China's ETS Pilots

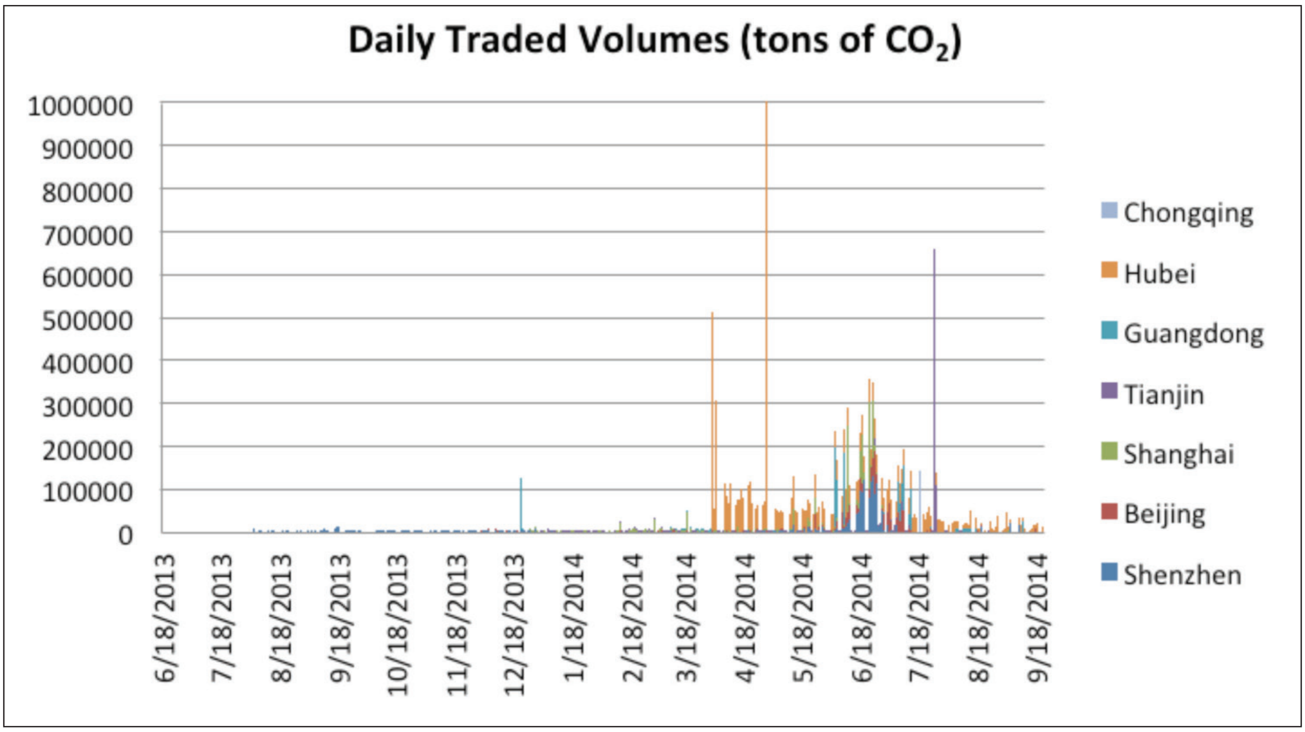

Table 1: Comparison of CO_2 Emissions Coverage under China's ETS Pilots (all values shown are for 2010).

Region	Covered CO_2 Emissions (Million tons)	Share of Total Emissions	Direct or Indirect Emissions	Number of Covered Entities	Emissions Threshold for Coverage (tons CO_2/year)	Historical Emissions Period
Beijing	58	50	Direct and indirect	approx.490	>10,000 (average stationary emissions)	2009-2012
Tianjin	90	60	Direct and indirect	191	>20,000	2009-2012
Shanghai	112	45	Direct and indirect	197	>20,000 for industry; >10,000 for other sectors	2010-2011
Chongqing	No data	Not yet available	Direct and indirect	No data	>20,000 (or 10,000 tce)	2008-2010
Hubei	117	33	Direct and indirect	107	> Approx. 120,000 (or 60,000 tce)	2010-2011
Guangdong	209	42	Direct and indirect	830	>20,000 (or 10,000 tce)	2009-2011
Shenzhen	32	40	Direct and indirect	635	> 5000	
All ETS pilots	>620	7% of China's total	Direct and indirect	>2535		1996-2004
EU-ETS (Phase I)	2014	47	Direct	11500*	> 10,000	

Sources: M. Duan, "Development of ETS in China", presentation at *ETS Conference*: *Towards a Global Carbon Market: Prospects for Emissions Trading*, held in Berlin, 11 April, 2013.

European Commission. European Union Transaction Log, 2013. Available at: http://ec.europa.eu/environment/ets/.

International Carbon Action Partnership (ICAP). *Interactive Emissions Trading Scheme (ETS)*, 2013. Available at: www.icapcarbonaction.com.

S. Qi, "Development of Hubei Pilot ETS", presentation at the *Second Annual Stakeholders Meeting of Tsinghua-MIT China Energy and Climate Project*, held in Beijing, June 2013.

H. Xu, "Progress of China's Low-carbon Pilot Development", presentation at the *Sino-French High-Level Workshop on Climate Change* held in Beijing, 2013.

* There is a difference between the EU's covered entities (a site) and China's (a company). A company can have different sites under the ETS pilots.

Concerns and Responses of Chinese Businesses to the Pricing of Carbon Emissions

By Dr. Xianbing Liu, Kansai Research Centre, Institute for Global Environmental Strategies, Japan

Remote View of Shijiazhuang, Hebei Province, China. Photo by Khalidshou / Wikimedia Commons (Licensed under CC BY-SA 3.0).

As the largest greenhouse gases (GHG) emitting country in the world, China has been taking various steps to improve its energy efficiency and to mitigate carbon emissions. However, China's climate policies are dominated by command-and-control regulations. It is a high priority for China to introduce and implement market-based instruments, in particular carbon pricing policies such as carbon taxation and greenhouse gas emissions trading schemes (GHG ETSs), to mitigate the emissions in a cost-efficient manner.

Resistance from the industrial sector is typically the most significant barrier hindering the introduction of carbon pricing policies. Policymakers are also seriously concerned about the negative impact of carbon pricing on production costs and

Xiamen Railway Station, Fujian Province, China. Photo by Xmhaoyu / Wikimedia Commons (Licensed under CC BY 3.0).

international competitiveness, and are reluctant to adopt these policies. Thus, success largely depends on how the individual businesses react to the policy.

There is currently scant research which identifies the necessary conditions for smooth implementation of climate policies from the business viewpoint, especially in developing economies. To help rectify this, between April 2010 and March 2013, the Kansai Research Centre of the Institute for Global Environmental Strategies carried out a project addressing this question entitled, "Market-based Instruments for Improving Company Carbon Performance in Northeast Asia". This summary shares the major findings of this project relating to the concerns and responses of Chinese businesses to the pricing of carbon emissions.

The study confirmed that companies in China have been actively practicing energy-saving activities and tend to adopt managerial counter-measures rather than technological and engineering approaches. This is particularly true of small and medium-sized businesses. They are sensitive to the energy efficiency performance of their business competitors and worry about the loss of comparative advantages. Positive attitudes alone cannot lead to actual energy saving practices since their business efforts are largely limited by their internal capacity.

Chinese companies are well aware of the economic incentive policies offered by the goverment, such as financial subsidies and rewards, but have low awareness of carbon pricing policies such as carbon taxation and GHG ETS. The sampled companies would not simply offload the policy burden onto their customers. This implies the effectiveness of carbon pricing for enhancing business efforts in carbon mitigation. Most of the surveyed companies can only accept a payback period of less than three years for energy saving and carbon mitigation investments. This reveals the need to apply carbon pricing policies that improve the profitability of this kind of project.

Applying the format of a multi-bounded discrete choice (MBDC) and willingness-to-pay (WTP) model, it is estimated that a mean of 7.7 to 9.9 per cent in energy cost increases due to carbon pricing policies would be acceptable for the most energy-intensive industries surveyed in China (see Table 1). These ratios are equal to a carbon price ranging between 40 and 80 yuan per ton of CO_2 (about USD 6 to 12 per ton). Therefore, it is confirmed in this study that the carbon prices that are affordable for Chinese businesses are similar to the carbon tax rates proposed by Chinese experts and the market prices of the GHG ETS pilot projects around China.

The preferences of Chinese companies in terms of the design options of carbon tax and GHG ETS were measured by a choice experiment. The carbon tax policy analysis achieved some interesting findings. As shown in Table 2, the companies strongly preferred lower tax rates generally. Allowing preferential tax treatment, either to energy-intensive or to energy-efficient industries, increases company preference to this policy. The companies preferred to earmark the tax revenues for climate change. It would

Table 1: Estimated Affordable Carbon Prices for Chinese Companies by Sector

Energy Type	**Energy Use Ratios (%)**			**Current Energy Price**	**Emission Factor**
	Iron & steel (N=34)	Cement (N=17)	Chemical (N=27)		
Electricity	27.9	31.2	18.6	0.618 yuan/KWh	0.8592 t-CO_2/MWh
Coal	61.8	61.7	32.1	746 yuan/t	1.9383 t-CO_2/t
Fuel oil	0.6	2.4	34.9	4450 yuan/t	3.0358 t-CO_2/t
Natural gas	1.0	0.0	2.0	2.78 yuan/m^3	2.1731 t-$CO_2$1,000 m3
Steam	0.7	0.0	6.5	230 yuan/t	0.3231 t-CO_2/t
Mean	8.8%	7.7%	9.9%		
Affordable Carbon Price (yuan/t-CO_2)	42.7	38.6	83.7		

Source: X. B. Liu et al., "Company's Affordability of Increased Energy Costs Due to Climate Policies: A Survey by Sector in China", *Energy Economics* 36 (2013), 419-30.

be feasible to launch a carbon tax in China sooner since the starting time was not significant in influencing the policy preferences of Chinese businesses.

There remain many important topics for further research. The various business concerns should be further discussed in terms of policy mix. Also, the effects of carbon pricing policies for the innovation and diffusion of low carbon technologies should be tested for the industries concerned.

Table 2: Modelling Results for the Choices of Carbon Tax Policy

Attribute Model	Multinomial Logit (MNL) Model	Random Parameter Logit (RPL) Model	Latent Class (LC)	
			Class 1	Class 2
TAXRATE	-0.011***	-0.012***	-0.029***	0.004
RELIEF-B	0.972***	1.030***	2.671***	0.356
RELIEF-C	1.249***	1.328***	2.220***	1.834***
REVENUE-B	0.342**	0.340**	1.106**	-0.449
REVENUE-C	1.031***	1.075***	0.586	0.675
TIME	-0.175	-0.230*	-0.528	0.887
Class probability			0.671	0.329
Log-likelihood	-559.33	-554.65	-308.53	
Pseudo R squared	0.225	0.231	0.572	
Observations	1041	1041	1041	

Notes: Standard errors are not reported to save space. Asterisks *, ** and *** denote parameter significance at 10%, 5% and 1% levels, respectively.

Source: X. B. Liu et al., "An Analysis of Company Choice Preference to Carbon Tax Policy in China", *Journal of Cleaner Production*, article in press, http://dx.doi.org/10.1016/j.jclepro.2014.12.084.

China's Technology Opportunities in a Low-Carbon World

By Mr. Ajay Gambhir, Grantham Institute, Imperial College, London

China's greenhouse gas emissions continue to increase rapidly, with economic growth outpacing carbon intensity reductions. Nevertheless, the ambitions stated in China's 12th Five Year Plan (spanning 2011-2015) appear to be in reach, with significant investments in low-carbon power sources such as solar, wind, nuclear and hydro, a serious focus on vehicle emissions standards and alternative energy vehicles, and great efforts being made to curb coal consumption. Apart from the local and global environmental benefits that these measures are certain to bring, there is a strong case for considering what tangible economic benefits a low-carbon transition will also offer. If the evidence on climate change continues to stack up and an increasing number of nations see the obvious risk management strategy of mitigation, it means there will be a fast-expanding global market for low-carbon technologies. The question of the day will therefore inevitably shift from asking how to protect manufacturing industries from higher energy and carbon prices, to considering how to support low-carbon technology manufacturers in attaining an international competitive advantage in these technologies.

Beijing Bus Rapid Transit Line 1 in Beijing, China. Photo by Robert McConnell (Port of Authority) / Wikimedia Commons (Public Domain Image).

China is well placed to compete. Several recent low-carbon pathways studies of China have demonstrated the importance of some key technologies, including nuclear, carbon capture and storage (CCS), wind, solar and electric vehicles (see Table 1). These technologies will also be of critical importance globally. The economics of innovation have long shown us that it is not just fundamental laboratory research and development that brings about innovation in technology performance and cost reductions, but also demonstration and deployment, which together foster cost reductions through learning-by-doing and scale effects in the manufacture, field testing and deployment of those technologies.[1] Hence, if China continues with its ambitious low-carbon development plans domestically, it is increasingly likely to have firms which are developing and deploying low-carbon technologies at the international cost and performance frontier.

Port of Shanghai, China. Photo by Reb 42 / Wikimedia Commons (Licensed under CC BY 3.0).

Table 1: Recent China Mitigation Scenarios for Low-Carbon Technology Deployment and Penetration

Technology	Deployment by 2050	Technology	Deployment by 2050
***ERI (2009) High growth, low-carbon scenario*[2]**		***Gambhir et al (2013)*[3]**	
Nuclear	388 GW	Nuclear	288 GW
Wind	288 GW	Wind	530 GW
Solar	39 GW	Solar	1,160 GW
Electric vehicles	50%	CCS	390 GW
Hydrogen vehicles	30%		
***Wang and Watson (2009)*[4]**		***Gambhir et al (2014)*[5]**	
Nuclear	up to 400 GW	Electric vehicles	20% of new vehicles
Wind	up to 700 GW	Hydrogen vehicles	20% of new vehicles
Solar PV	up to 800 GW		
Electric vehicles	up to 60% (private road)		
	up to 80% (public road)		

China's ability to manufacture high-tech products at scale has already been demonstrated through its capture of the majority of the world market for solar photovoltaic modules. Chinese organisations' involvement with nuclear and high speed rail projects in the United Kingdom demonstrates that other international low-carbon technology markets are now being addressed.

The Chinese government identified several clean energy sectors in its 12th Five Year Plan. Three of the seven strategic industries to develop during this period are directly related to low-carbon technologies: the new energy automotive industry, the energy-saving and environmental protection industry, and the new energy industry. Analysis suggests that the clean automotive sector alone could generate export revenues of USD 200 billion (about RMB 1.5 trillion) by 2030.[6]

Although the opportunity therefore appears to be large, there are a number of potential risks in the rapid development and deployment of low-carbon technologies. Technology costs can increase unless economies of scale are achieved, designs are standardised and lessons learned through repeated deployment, as evidenced by the significant cost escalations of nuclear power deployment in the USA and France during the 1980s.[7] Additionally, ensuring that new low-carbon power sources are effectively integrated into China's energy system will be critical. Wind power, for example, has suffered from inadequate physical access and grid balancing,[8] incomplete regulatory reform, and local economic development incentives which still favour coal-based generation.

A clear and consistent set of policies is essential. The imposition of regional carbon caps through the new trading schemes is to be welcomed. The continued removal of fossil fuel subsidies is also an important policy towards ensuring that energy prices are not distorted towards sub-optimal (i.e., excess) levels of fossil fuel consumption, and that carbon prices can be fully felt throughout the chain of extraction, transformation, distribution and combustion of fossil fuels. It will also be critical to consider the role of other fiscal instruments, such as carbon taxes, in those sectors not covered by trading schemes. The introduction of a range of low-carbon policies has also highlighted the importance of environmental monitoring and reporting to underpin the operation and credibility of these polices. There are many lessons to learn from the past 10-15 years of low-carbon policy implementation across the world. Achieving an efficient and effective set of policies will help China realise the tremendous opportunity to compete in a rapidly expanding global market for low-carbon technologies.

1 M. Grubb, "Technology Innovation and Climate Change Policy: An Overview of Issues and Options", *Keio Economic Studies* 41 (2004): 103–32.

2 Energy Research Institute, NDRC, *Low-Carbon Economy Scenario Studies up to 2050*, 2009.

3 A. Gambhir et al., "A Hybrid Modelling Approach to Develop Scenarios for China's Carbon Dioxide Emissions to 2050", *Energy Policy* 59 (2013): 614–32.

4 T. Wang and J. Watson, "Scenario Analysis of China's Emissions Pathways in the 21st Century for Low Carbon Transition", *Energy Policy* 38 (2010): 3537–46. doi:10.1016/j.enpol.2010.02.031

5 A. Gambhir et al., "Reducing China's Road Transport Sector CO_2 Emissions to 2050: Technologies, Costs and Decomposition Analysis", Research paper in submission, 2014.

6 The World Bank, Development Research Center of the State Council, People's Republic of China, *China 2030: Building a Modern, Harmonious and Creative Society*, 2013.

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8 Energy Research Institute, NDRC, *China Energy Outlook 2012*.

Carbon Finance in China: Recent Experience and Future Prospects

By Professor Yao Wang, Central University of Finance and Economics, China

To begin, it is important to clarify the definitions of green finance, climate finance and carbon finance which all fall within the environmental finance category. Environmental finance means using diversified financial instruments to protect the environment and bio-diversity. Green finance is more of a description than an academic definition. Broadly, perhaps we can define green finance as environmental finance, and say that it focuses narrowly on domestic environmental finance issues. Carbon finance is a part of climate finance. It is related to reducing emissions and mitigation, but also includes financing for adaptation. The main aim of carbon finance is to reduce GHG emissions through financial innovation. It is a concept under global climate change and includes mechanism innovations for climate change mitigation including any financial innovations related to GHG reduction in carbon markets and traditional financial markets.

After one year's operation, all of China's seven regional pilot carbon markets are basically running smoothly, but there are still some problems:

1. Lack of historical emissions data and limited legally binding forces;
2. Lack of transparency in the allowance allocations;
3. Lack of liquidity;
4. Most enterprises not having awareness of carbon asset management and lacking professionals.

According to the National Development and Reform Commission's (NDRC) plan, there will be a nationwide ETS test run in 2016. At present, at the top of the design stage, we have some suggestions for the national carbon market:

1. Promote a "top-down" and "bottom-up" dual path;
2. Improve system design and related impact assessment;
3. Adopt a flexible allowance allocation, combined use of the grandfathering, benchmarking and auction;
4. Boost the liquidity of the secondary market;
5. Develop carbon finance.

Jin Mao Tower, seen from the 100th floor of the Shanghai World Financial Center. Photo by Mätes II / Wikimedia Commons (Licensed under CC BY-SA 3.0).

A carbon bond refers to the debt obligations that are issued to investors by the government or enterprises, to raise money for low-carbon projects. They come with a promise to pay a certain rate of interest and repayment of the principal at maturity. The first carbon bond in China was issued by a unit of the China General Nuclear Power Group (CGN). It raised about RMB 1 billion (US$160 million) and will mature after five years. The bond was issued at an interest rate of 5.65 per cent per year. Its future value will be decided by a combination of a fixed rate and the floating price of carbon offsets from the CGN's five wind power generation projects, as traded on the Shenzhen Emissions Exchange. The floating price is between 5-20 basis points.

Motorbikes Parked in a Pudong Street, Shanghai, China. Photo by Daniel Case / Wikimedia Commons (Licensed under CC BY-SA 3.0).

On the basis of this first carbon bond, it seems that the key conditions for issuing a carbon bond in China are:

1. It should be a bond and comply with China's rules. China's bond market system is very complicated. There are two markets, an exchange bond market regulated by the China Securities Regulatory Commission (CSRC) and an inter-bank market regulated by the central bank, and three corporate bonds, corporate bond regulated by the CSRC, enterprise bond regulated by NDRC and debt financial instrument of non-financial enterprises regulated by China's national association of financial market institutional investors (NAFMII).
2. As a carbon bond, the basic asset should be carbon-related. Issuing a bond could be based on the cash flow of projects or based on the credit of the issuing body. In this case, the bond was issued on the basis of CGN's credit as a AAA bond. The fixed rate was good enough for the investors, and the floating rate was decided by the cash flow of five wind projects.
3. Funds must be raised to repay the bank loans, but not the carbon-related investment.
4. The pricing for a carbon bond should consider how to lower the financing costs of the issuing body, and how to ensure the investors' benefits. In this case, there was a fixed rate plus a floating rate price for the bond. The fixed rate interest guarantees a floor return for the investors, and the floating rate was an incentive for the investors to become involved in low carbon development, and also gain compensation.

Could China's ETS Experiments Lead towards an International Carbon Market?

By Dr. Alex Lo, Kadoorie Institute at the University of Hong Kong, Hong Kong

Emission trading schemes were first established in a number of mature capitalist economies governed by liberal democratic states, and then later in non-traditional capitalist states. They are now being considered in major developing countries such as Kazakhstan, Mexico, Brazil, Thailand, Turkey, Ukraine and Chile.

As a socialist market economy, China's seven pilot ETS pilots are operating in a political-economic context significantly different from that of the western capitalist economies. This is important because significant variations in political, regulatory and institutional traditions have profound implications for delivering the expected environmental results.

Carbon markets usually need a healthy financial sector to help with emission trading activities. In China, private finance has not

Barges on the Yangtze River near Nanjing, China. Photo by Cheol Ryu / Wikimedia Commons (Licensed under CC BY-SA 3.0).

Guilin, Guangxi Zhuang Autonomous Region, China Photo Clay Gilliland / Wikimedia Commons (Licensed under CC BY-SA 2.0).

played a key role in the domestic carbon markets. China's carbon markets are created, financed, and operated by the Chinese government, either directly or indirectly.

In July this year, I conducted interviews with several Beijing-based senior executives from top domestic enterprises with established operations in carbon finance. They are all keen to become involved in the domestic carbon market, but do not find the current market financially attractive. The market remains illiquid.

The private sector in China is generally not very keen to reduce GHG emissions voluntarily. Certainly, businesses included in the ETS pilots are motivated to curb emissions, but they mainly seek to comply with regulatory requirements. Most have a poor sense of comprehensive corporate carbon management and have low interest in trading emission credits. As a result, corporate demand for advanced financial products linked to emissions trading is weak. Many financial institutions, notably banks, lack the motivation to engage with the domestic carbon market. The market therefore has little energy to thrive. In addition, many of the firms participating in China's emissions trading schemes are state-owned. The regulated parties are not all "private" actors. Power companies are not entirely free to pass the cost impacts of carbon prices to electricity users by raising retail prices; the central government has the authority to decide.

Further, environmental NGOs are neither politically influential nor financially capable of playing an active role. To secure environmental benefits, efforts by the government are therefore profoundly important. But the reality is that the Chinese ETS pilots, and climate change policy generally, are not principally coordinated by a designated environmental authority.

The main player is the National Development and Reform Commission (NDRC), the top macro-economic planning agency of China. The first priorities of the NDRC are economic and social development. National climate change policies, including the ETS programs, are formulated and implemented by its subsidiary climate change department. This organisational arrangement suggests that environmental imperatives are subordinate to economic and social objectives.

There is room for some cautious optimism, however. In theory, the larger the market, the greater the potential for reducing the costs of GHG mitigation. The lower the costs, the more attractive it is, both politically and economically. Now an increasing number of developing countries have put emissions trading into consideration. If China - the world's largest GHG emitter and a key market player - introduces a national ETS, it could become the cornerstone of a regional carbon trading network in Asia or the developing world in the next 10 or 15 years or so. The Chinese carbon market – if well managed – can potentially take leadership in the global scene.

This is particularly important as the Kyoto Protocol looks fragile. Several original signatories, such as Japan, New Zealand, Canada, and Russia, have withdrawn from the Protocol. Demand for carbon credits created under the Protocol has declined as a result of the weak national commitment to GHG mitigation under the UNFCCC. Thus, domestic initiatives, such as these nationwide ETS pilots, become important. Such a 'bottom-up' approach, as what China is doing, may be able to drive regional and perhaps global actions.

The caveat is that the Chinese emissions trading programme might operate quite differently from the European Union ETS or what is currently operating in the United States. Prospects for international linking are uncertain. Transaction costs are high because the state-led system is not originally designed to run market mechanisms. And most importantly, there is no way of knowing whether the initiative can really deliver substantive environmental and economic outcomes.

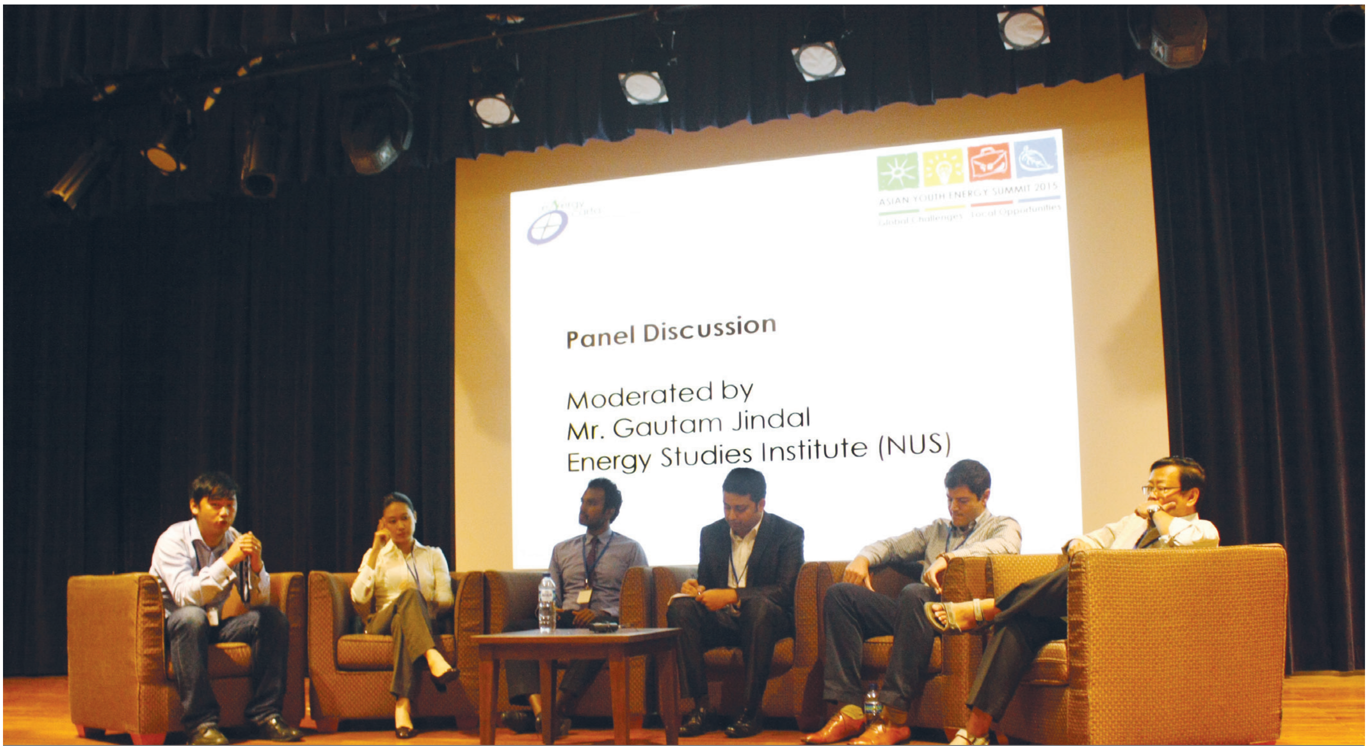
Staff Publications

Book Chapters

Philip Andrews-Speed, "China's Energy Sector: Stranded between the Plan and the Market", in Andrey Belyi and Kim Talus (eds.) *States and Markets in Hydrocarbon Sectors: General Trends and Regional Specificities* (Basingstoke: Palgrave Macmillan, 2015), pp. 214-39.

Reports

Philip Andrews-Speed, Lixia Yao, Nahim bin Zahur, Abhishek Rohatgi, Hari Malamakkavu Padinjare Variam, Tony Regan and Praveen Linga, "International Outlook for Unconventional Gas and Implications for Global Gas Markets", ESI Report (ESI/PG/01F/2014-06).



Speakers and moderator at the Asian Youth Energy Summit 2015 from left to right: Mr. Zachary Wang (Rezeca Renewables), Ms. Hum Wei Mei (NCCS), Mr. Bharath Sesadhri (Energy Research Institute @NTU), Mr. Gautam Jindal (ESI), Mr. Edward Chiverton (Chevron) and Prof. Michael Quah (NUS Energy Office).

Staff Presentations and Moderating

31 March Melissa Low presented "Many Smart Cities, One Smart Nation: Singapore's Smart Nation Vision" and "Energy Smart Cities: Perspectives from a City-State, Singapore" at the *Designing Smart Cities: Opportunities and Regulatory Challenges Conference* jointly hosted by the University of Strathclyde; CREATe (the RCUK Centre for Creativity, Regulation, Enterprise and Technology) and Horizon Digital Economy Research, held at the Technology and Information Centre (TIC) in Glasgow, United Kingdom, (see photo on page 15).

31 March Victor Nian presented, "Progress in Nuclear Power Technologies and Implications for ASEAN" at the *2015 International Conference on Applied Energy*, Abu Dhabi, (see photo on page 16).

21 March Gautam Jindal moderated at the *Global Challenges and Local Opportunities Conference*, organised by Energy Carta at the *Asian Youth Energy Summit 2015,* National University of Singapore, (see photo above).

19 March Philip Andrews-Speed chaired a panel discussion on "Investing in Green Growth in Asia: How to Promote Clean Energy Development?", hosted by the Energy Association at the Lee Kuan Yew School of Public Policy, NUS.

18 March Philip Andrews-Speed presented "The Outlook for Unconventional Gas in Asia " to post-graduate students in the Renewable Energy Management Program at the University of St. Gallen, Switzerland, in the ESI conference room.

16 March Victor Nian presented "Communicating the 'Sustainability' of Atomic Energy", for the module *Topics in Science Communication* in the NUS Faculty of Science.

11 March Elspeth Thomson presented "Southeast Asian Energy Market Dynamics" at the United States Embassy, Singapore.

7 March Philip Andrews-Speed presented "Nuclear Energy Developments in non-OECD Asia" at the *Annual Conference of the Windsor Energy Group,* Windsor Castle, UK.

5 March Philip Andrews-Speed participated in a panel on "The Scope and Relevance of the Resource Nexus" at a symposium on *New Perspectives on Resources, the Environment and Security*, hosted by the Institute for Sustainable Resources, University College London, UK.

4 March Kamalakannan Soundararajan presented "Flexible Solar Photovoltaic Deployments for Singapore" at the *International Conference on Renewable Energy Sources and Sustainability*, Mauritius.

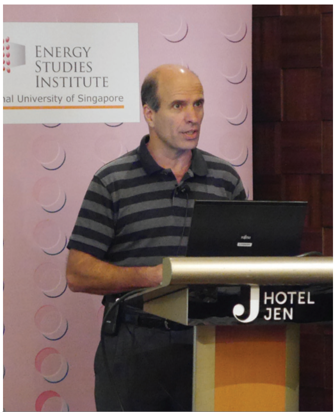
2 March Victor Nian presented "From Megatons to Megawatts and the Future of Atomic Energy in ASEAN", for the module *Senior Seminar on Radiation and Society* at Tembusu College, NUS.

Staff Media Contributions

Philip Andrews-Speed was interviewed by *The New York Times* on China's overseas oil investments, 2 March 2015.

Recent Events

Mr Michael Waldron, Senior Analyst, Renewable Energy Division, International Energy Agency (IEA), France



Mr Christophe Inglin, Managing Director, Phoenix Solar Pte Ltd, Singapore

Dr Sopitsuda Tongsopit, Researcher, Energy Research Institute, Chulalongkorn University, Thailand

Mr Shiva Susarla, Director, RENERGii Asia Pte. Ltd, Singapore

Professor Gooi Hoay Beng, School of Electrical & Electronic Engineering, Nanyang Technological University (NTU), Singapore

Mr Eugene Toh, Director, Policy Department, Energy Market Authority (EMA), Singapore

Mr Anton Finenko, Research Associate, ESI , Singapore

Dr Paul Denholm, Senior Analyst, National Renewable Energy Laboratory (NREL), USA

9 April, "Singapore's Future Solar PV Strategies", ESI Conference

In Singapore, solar power PV is considered the main option for increasing the use of renewable forms of energy. In view of its projected growth, it is imperative for us to understand and quantify its "value". While it is widely acknowledged that the cost of solar PV has declined in recent years, questions remain about how the system costs, integration costs and benefits of solar PV can be assessed. In addition, the revenue generation process is a key component determined by the business model of a PV project.

In recent years, innovative business models have been shifting various aspects of PV ownership and financing from private owners to third parties. In this rapidly changing business environment, an assessment of the suitability of the new innovative models is necessary to better understand if and how they could operate in the Singapore context. Therefore, the purposes of this conference (see photos of the speakers above), held at the Jen Hotel, were to learn from the experiences of regional and international solar PV experts, and to find out how Singapore could formulate future PV strategies. Three of the seven speakers were from abroad, namely, France, the US, Thailand and Singapore. The next issue of the Bulletin will include summaries of all the presentations made at this conference.

Melissa Low presenting at *Designing Smart Cities: Opportunities and Regulatory Challenges Conference.*

Kamal Soundararajan (third from left) at *1st ASEAN Literacy Conference.*

4 February, 1st ASEAN Energy Literacy Conference

ESI Energy Analyst, Mr. Kamal Soundararajan, participated in the *1st ASEAN Energy Literacy Conference*, held in Bangkok. This event was organised by the Petroleum Institute of Thailand and hosted by Thailand's Ministry of Energy. The event focused on the role of energy literacy as the "Foundation of Public Trust" for the energy industry. The invited speakers shared their views on the principles and concepts of energy literacy.

The participants discussed a broad range of energy issues, ranging from pricing and subsidies, to energy and the environment, energy efficiency and renewable energy, and ASEAN energy practices. Kamal delivered a presentation on Singapore's energy efficiency policies and also spoke about key policies for the industrial, building, transport and residential sectors.

He was also invited to share his views in a panel discussion on energy literacy together with five other panellists:

- Mr. Sergev Tulinov, Economic Affairs Officer for the United Nations Economic and Social Commission for Asia and the Pacific;
- Dr. Siri Jirapongphan, Executive Director of the Petroleum Institute of Thailand;
- Mr. Nopporn Chuchinda, Secretary in Charge of the ASEAN Council on Petroleum;
- Mr. Sayiful Bakhri Ibrahim, Secretary in Charge of ASEAN Power Utilities, Indonesia;
- Mr. Tang The Hung, Deputy Director of the Planning Department at the General Directorate of Energy, Vietnam.

Victor Nian at the *2015 International Conference on Applied Energy*, held in Abu Dhabi.

Contact

- Collaboration as a Partner of ESI (research, events, etc)
- Media Enquiries
- ESI Upcoming Events

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The *ESI Bulletin on Energy Trends and Development* seeks to inform its readers about energy-related issues through articles on current developments. Our contributors come from ESI's pool of researchers, local and overseas research institutes, local government agencies and companies in the private sector. You can download past issues from www.esi.edu.sg.

We welcome your feedback, comments and suggestions. The views expressed in each issue are solely those of the individual contributors.

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