

The Dynamics of China's Energy Economy

Summary for policy makers

The growth of its economy means that the People's Republic of China ranks at the top of many energy related league tables. It produces and consumes roughly 50% of the world's annual coal demand, while also being the largest importer of coal (accounting for 16% of total coal imports). China is the world's largest oil importer, yet is still the world's fifth largest oil producer. Also, it has the world's most ambitious nuclear program, the world's largest renewable energy industry and one of the fastest growing demands for natural gas. China's appetite for energy is huge and is set to grow substantially over at least the next decade.

There appear to be two main challenges facing research into China's energy economy:

- Necessary specialism can narrow scope and undermine opportunities for cross disciplinary synergy; and
- While data are the foundation stones of any approach, understanding the limitations of Chinese data is one thing, overcoming these limitations another.

Three non-traditional approaches that may deliver greater insight comprise:

- Mixed Complementarity Problem (MCP) formulations. MCPs can provide a bottom-up

modeling approach that complements alternative traditional, top-down Computable General Equilibrium (CGE) models, deepening understanding of what is happening in China's complex energy economy and how it could respond to future policies;

- Bargaining models, which can allow practitioners to set out competing policy priorities and draw conclusions on plausible policy outcomes that can help bound the research space; and
- Theories of institutions that allow more critical examination of the policy making environment in China, thus improving our understanding of plausible future responses.

However one looks at China's energy and environmental policies, decisions made in Beijing will have ramifications for both its domestic energy economy and for global markets. Understanding the potential for such decisions, whether they appear rational to an external observer or not, is critical for policy makers globally in preparing their own energy economies for the consequences of China's continued economic growth and burgeoning energy demand.



About KAPSARC

The King Abdullah Petroleum Studies and Research Center (KAPSARC) is an independent, non-profit research institution dedicated to researching energy economics, policy, technology, and the environment across all types of energy. KAPSARC's mandate is to advance the understanding of energy challenges and opportunities facing the world today and tomorrow, through unbiased, independent, and high-caliber research for the benefit of society. KAPSARC is located in Riyadh, Saudi Arabia.

Legal notice

© Copyright 2014 King Abdullah Petroleum Studies and Research Center (KAPSARC). No portion of this document may be reproduced or utilized without the proper attribution to KAPSARC.



Background to the workshop

In April 2014 KAPSARC hosted a workshop in Hong Kong to explore approaches to analyzing the Dynamics of China's Energy Economy.

All too often China's highly complex and multidimensional energy economy has been viewed through the lens of quantitative economic modeling. This presents two problems:

- All models are simplifications of complex systems that can overlook details that turn out to be important; and
- Theories of Western-style rational economics may not be best suited to understanding or guiding China's future policy.

Economic forces are just one of many guiding policy makers; others may be less quantifiable. In satisfying multiple stakeholders China has made decisions that may not appear rational when viewed through a single economic lens, derived from Western traditions. It is therefore necessary to deploy a wider toolkit.

KAPSARC's research agenda seeks to provide greater clarity around the impacts of domestic Chinese energy and environmental policy decisions on global markets. This will be achieved by:

- Gathering data on such policies into an accessible form (a policy database, translated into English);
- Building energy systems models for China jointly with local and international collaborators; and
- Developing bargaining models that help characterize (and perhaps expand) the locus of viable policy and so prevent blind spots arising from viewing outcomes through a conventional western paradigm.

Opportunities for cross disciplinary synergy

In research, as in economics, specialism works. By specializing, researchers have made great progress, enhancing both our methodological sophistication

and the depth of analyses and resulting insights. These advances have not been without cost. As practitioners have become ever more specialized, so they have risked becoming more isolated. Inter-disciplinary links have been weakened and possible insights foregone.

The story of the blind scientists and the elephant - each feeling the bit of the elephant he is closest to and so arriving at a narrow, misguided idea of what an elephant is and what it is for - may be an appropriate metaphor. Specialism is inevitable and desirable, but can be partially overcome through better communication.

Cross-disciplinary collaboration can force us to reassess implicit assumptions. Standard neoclassical economics, behavioral economics, institutional economics, and other schools of economic thought can give different answers to the same question. The differences in interpretation become even more profound when non-economist social scientists are brought in. At a very fundamental level, evolutionary (often thought of as bottom-up) and equilibrium (usually imagined as top-down) models can lead researchers and policy makers in very different directions. There is a risk that individuals (and institutions) restricting themselves to just one of these two approaches may become trapped by their own assumptions, specialization, and expertise.

Overcoming data limitations

All models require data. As research on China has intensified and the call for data grown to a clamor, its quantity and quality has improved, especially after WTO accession. China now publishes a wealth of statistical information, a boon to researchers seeking official and widely accepted data on which to base their analyses. Yet China has in many ways developed far faster than its institutions' ability to keep pace. Its data are not of uniform quality in terms of accessibility, consistency and accuracy. It is a stock criticism that numbers in China sometimes do not add up. Taking coal as an example,



production, net import and consumption numbers do not always balance; nor do national and provincial figures always balance without recourse to more in depth reconciliation. These differences can arise through simple differences in accounting, but they can also be a product of targets and incentives skewing reporting. Data quality does not emerge overnight. Countries such as the USA, vaunted for their data, took many years to achieve high standards, and challenges still remain. But they are not insurmountable.

Surveys are one way of teasing out insights. An example comes from work in Japan, looking at whether societal pressure or government policy was more effective in constraining energy use post-Fukushima. At a more trivial level, analysis of China's social media developed a set of inferred data: that bed time is half an hour later in Guangzhou than in Beijing (or at least people are still blogging half an hour later). The key lesson is that, while direct data are often replete with problems, inferred data drawn from multiple sources allow researchers to gain an understanding of real-world behaviors, even if they are not always explicitly articulated. This is referred to as data triangulation.

It will take time, creativity and effort, but problems of poor data can be at least partially overcome. There are an increasing number of organizations focused on just this and, in the longer term, Chinese data will likely become as accessible and reliable as those from countries further along the development path.

Additional analytic techniques

Mixed Complementarity Problems (MCP)

Bottom-up, MCP approaches can augment the insights from traditional, top-down, Computable General Equilibrium (CGE) models. Top down CGE models have made great progress in furthering our understanding of China's energy economy and its

related environmental concerns. For example, a CGE might provide insight into possible carbon dioxide emission trajectories under various policy scenarios (capturing the ways in which changes in one part of the economy may impact other parts as the system re-equilibrates). Such models have become the workhorses of this kind of research, their usefulness backed up by a wealth of literature. However, accurately describing economic outcomes in a system in which prices may exert only a weak influence on the market requires moving beyond conventional theories and techniques.

MCPs provide an approach, among others, to investigate just such situations. The Chinese energy market is not a perfect market; there are a host of government interventions, direct and indirect. MCP models allow one to optimize the economy against some property (such as minimizing production or transport costs rather than maximizing profits) and understand how it affects various measures of social welfare - insight that can be gleaned from a more real-world approach. Methodologically, MCP allows for simpler models; analytically it provides a more flexible tool.

Bargaining models

Bargaining models can allow practitioners to set out competing policy priorities and draw conclusions on plausible policy outcomes that can help bound or expand the research space. Policy is made in the face of competing concerns over energy security, environmental sustainability, and continued economic growth. Separate from the network of priorities, questions may also involve multiple stakeholders which vary depending on the level at which the question is posed.

Bargaining models can deliver useful ways of explicitly delineating the competing concerns and the spectrum of possible solutions. They also provide a way of rigorously identifying the



stakeholders pertinent to a particular question. In this way they can reveal insights into what policy makers might decide and what they might be able to deliver, especially because such models are free from the constraining simplifications of some other approaches. As such they become a useful tool for setting expectations and framing debates in such a way as to allow constructive engagement between stakeholders. Most importantly, such models define the universe of plausible (rather than merely conceptually possible) policy outcomes and sometimes identify options that might have been too quickly dismissed. For China, these sorts of models are of growing importance, especially as the influence of emerging stakeholders to affect government policies and agendas is increasing.

Electricity price liberalization, long called for by energy economists, provides a case in point. Fears over inflation, social stability and competitiveness stymied previous reform, while lack of alignment between the central and provincial governments undermined previous attempts. Mapping the network of stakeholder preferences and their relative degrees of influence allows a more nuanced view of possible outcomes for future electricity price reform than economics in isolation would allow.

Theories of institutions

Theories of institutions can allow us to examine more critically the policy making environment in China and, from that, improve understanding of plausible future responses. Parallel to economic and bargaining models, an understanding of China's institutions may reap dividends by approaching the issue in two ways:

- Institutions may be defined as the suite of social norms and beliefs; the political, economic, bureaucratic and legal systems; the players within these systems; and the uncountable behaviors and transactions that drive daily life; or

- Institutions can be viewed, more narrowly, in terms of the structure of the polity: the Politburo; the Leading Small Groups; the National Development and Reform Commission (NDRC), National Energy Administration (NEA) and other ministries; the State Owned Enterprises.

Both approaches yield insight; the first helps understand the weft and weave of the fabric of Chinese society, while the second focuses on the explicit process of policy formation. They can provide invaluable interpretive support for wider analyses of China's energy policy-economic nexus. Why do the economics not trump all other considerations? Why do stakeholders take the positions they appear to take? Perplexing behaviors are often only perplexing to outsiders: understanding Chinese society and explicitly linking it to models so that it both informs their inputs and validates their outputs makes it easier to understand the bounds of what is practicable.

Whenever researchers look for the best approach or policy makers call for the identification of the top priority, an opportunity is missed. There is no single best research approach or analytical technique, just as there is no single top priority. Priorities are in the eye of the beholder and every appropriate research approach can bring new insight and enrich understanding.

Conclusions

Over the last decade and a half, commentators around the world have repeatedly underestimated China's growth while oft predicting imminent collapse in the face of modern dangers. That past forecasts did not come to fruition does not mean that the commentators were necessarily mistaken in their underlying observations. Rather, they interpreted these observations through too narrow a lens; often, also, too Western a lens. By understanding the broader framework in which China's policy making occurs, there may be fewer surprises. Researchers



may benefit by stepping beyond their traditional comfort zones and embracing a range of alternative and non-traditional techniques.

Models can help us lay out uncertainties; they do not contain absolute answers. As George Box once wrote, "essentially, all models are wrong, but some are useful". Well-constructed models, grounded and evaluated with empirical data, are useful tools to help provide insight. It is the presence of disagreement and challenge that exposes flawed assumptions or failures of logic. If we step beyond the models of today's orthodoxy and embrace a wider set of techniques then we can start challenging conventional wisdom; to look beyond the presence of an argument and to the truths that lie therein.



About the workshop

KAPSARC convened a workshop in April 2014 with some 30 international experts to facilitate a discussion to explore approaches to analyzing the Dynamics of China's Energy Economy. The workshop was held under the Chatham House Rule of capturing the discussion on a non-attribution basis. Participants comprised:

[Naif Al-Abadi](#) - Director General, Saudi Energy Efficiency Center

[Abdulhameed Al-Hashem](#) - Senior Research Scientist, Kuwait Institute for Scientific Research (KISR)

[Philip Andrews-Speed](#) - Principal Fellow & Head, Energy Security Division, National University of Singapore

[Jean-Pierre Cabestan](#) - Professor in Political Science, Head of Department, Hong Kong Baptist University

[Chen Wei Dong](#) - Chief Energy Scientist, CNOOC Energy Economics Institute

[Dai Jiaquan](#) - Vice Head of Market Research, ETRI, China National Petroleum Corporation (CNPC)

[Brian Efird](#) - Research Fellow, KAPSARC

[Philipp Galkin](#) - Research Associate, KAPSARC

[David Hobbs](#) - Head of Research, KAPSARC

[Nicholas Howarth](#) - Research Fellow, KAPSARC

[Christopher Johnson](#) - Senior Adviser and Freeman Chair in China Studies, Center for Strategic and International Studies (CSIS)

[Ayaka Jones](#) - General Engineer, Energy Information Administration (EIA)

[C.S. Kiang](#) – Professor, Sustainable Development Technology Foundation

[Leo Lester](#) - Research Fellow, KAPSARC

[Li Lailai](#) - China Country Director, World Resources Institute

[Li Yuanpu](#) - Executive Director, Chinese Renewable Energy Society

[Liu Xiying](#) - China Energy Economic Research Center, Xiamen University

[Liu Zihan](#) - CEO, Lanbao Inc

[Frederic Murphy](#) - Visiting Fellow, KAPSARC

[Shyy Wei](#) - Executive Vice President & Provost Chair Professor of Mechanical and Aerospace Engineering, The Hong Kong University of Science and Technology

[Chris Urzaa](#) - Director, Commercial Services, HDR-Salva

[Wang Tao](#) - Resident Scholar, Energy and Climate Program, Carnegie-Tsinghua Centre for Global Policy

[Ben Wise](#) - Visiting Fellow, KAPSARC

[Wu Jun](#) - Vice President of Hebei Province, Hebei Wu Jun Industrial Group

[Xu Xiaojie](#) - Head and Fellow of the World Energy Research Division, Institute of World Economics and Politics, CASS

[Yukari Yamashita](#) - Board Member, Director, Institute of Energy Economics, Japan (IEEJ)

[Yang Fuqiang](#) - Senior Advisor on Climate and Energy, NRDC, Beijing

[David Youtz](#) - Senior Consultant, National Committee on United States-China Relations

[Zhang Zhongxiang](#) - Distinguished Professor and Chairman of the Department of Public Economics, Fudan University

[Zou Lele](#) - Associate Professor, Institute of Policy and Management, CAS



About the team



Brian Efirid PhD is a Research Fellow and Program Director for Policy and Decision Sciences at KAPSARC leading teams on China, Transportation, Demography, and Bargaining Models.



Leo Lester is a Research Fellow leading the China Research Program. Formally a macroeconomist and China specialist, he has a PhD and is a CFA and FRM



Philipp Galkin is a Senior Research Associate specializing in economic and policy analysis. He holds a PhD in International Economic Relations and an MBA.



Frederic Murphy is a Senior Visiting Fellow collaborating with the energy systems modeling work at KAPSARC. He is also Professor Emeritus, Fox School of Business at Temple University.



Nicholas Howarth is a Research Fellow coordinating KAPSARC's Energy Productivity research, especially global investment. He holds a Ph.D. degree from Oxford University



Ben Wise KAPSARC visiting fellow since April 2014, holds a PhD in Engineering and Public Policy from Carnegie-Mellon University and a BS in Physics from MIT.