Who and How to Rein China's Industrial Energy?

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ABSTRACT

This paper aims to present and suggest, from a foreigner's angle, ways in which to better explain and understand the difficulties facing Chinese policy-makers and government agencies that seek to improve the sustainability of China's industrial development. In this context, improved energy efficiency in the industrial sector is crucial; constituting a central pillar for all such strategies. The paper takes as its point of departure the relations between, on the one hand, challenges in addressing sustainability issues connected to energy and electricity and, on the other hand, the existence of fundamental differences among international and Chinese stakeholders in preconceptions about the nature of these challenges. Three perspectives are highlighted: actor theories, conceptual frameworks of technology and futures studies; and examples of two existing scenario studies are given.

Addressing an international audience, the paper arrives at a set of messages, or clarifications. Thereby it also indicates a stance, from which one may choose to assess, select, or evaluate foreign efforts meant to constructively contribute to meeting China's challenges of improving the performance of its industry – in terms of energy, as well as of efficient and sustainable practices in general.

Introduction

The title of this paper is posed as a question: *Who and how to rein China's industrial energy?* The objective of the discussion, however, is not to suggest panaceas. The ambition is instead to point at some of the complexities that makes the question worth asking, and the discussion originates in the following normative statement. *The application, in modern societies, of industrial technologies and, specifically, the use of energy in industry are fundamental contributors to the global sustainability dilemma that has become increasingly topical over the past half-century. Industry, technology and energy, therefore, have to be integral elements of any attempt to address this dilemma.* The relevance of this statement in China is painfully obvious when viewing the consequences to human health and to the environment of the country's recent and current development trajectory (*cf.*, *e.g.*, Economy 2004). The Background section (below) addresses the importance, from an energy perspective, of China's industry as compared with other sectors.

As indicated above, the title question should be read rhetorically: industrial energy use in China is addressed as a sustainability and development problem. Neither the sustainability discourse as such, nor the field of development studies is elaborated on in this paper, however. Instead, it utilises and explores a set of three perspectives from which to view the topic: (i) actor theories, (ii) conceptual frameworks of technology and (iii) futures studies. The latter perspective is illuminated by examples of two recent energy projection studies. The selection of perspectives has been arrived at in an analytic process where, from a foreigner's viewpoint, empirical experiences and observations of industrial sustainability concerns in China have been collected in interviews and literature reviews over a number of years.

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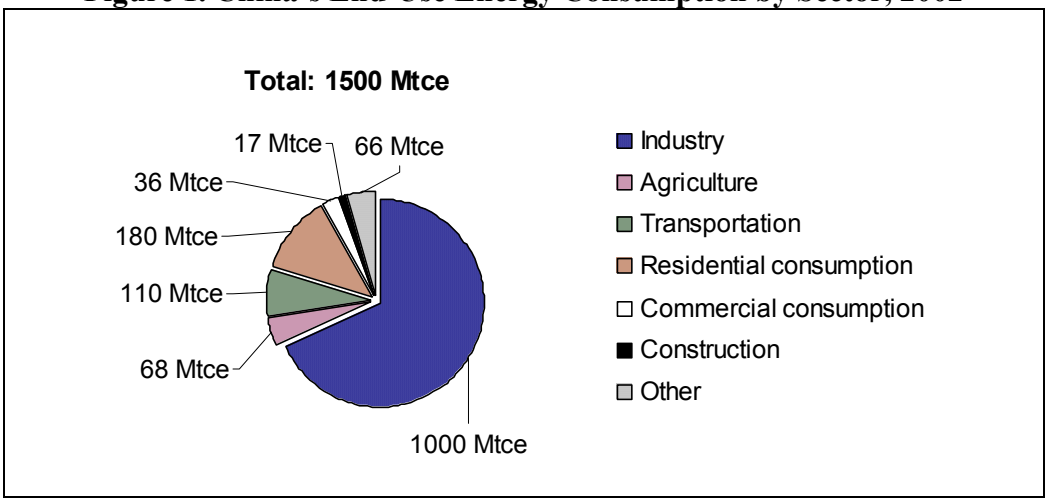
In this presentation, the foreigner's angle is deliberately highlighted. The basic reason for this is an assumption that cultural belonging influences (in a systematic way) every observer's preconceptions of the topics under discussion. Furthermore, an important objective of the paper is to demonstrate to an international audience that the selected three perspectives may be perceived in different ways depending on such preconceptions. This objective is motivated by the following pair of normative statements: (i) *international efforts to address sustainability issues in China are needed;* (ii) *their degree of success, however, suffers when appreciation and understanding of existing differences in relevant preconceptions and perceptions are low.* In general, the latter statement applies to all stakeholders that participate in an exchange, but the focus in this paper rests on the foreigner's understanding of Chinese conditions.

Background: Industry and Energy in China

Industry accounts for a significant portion of China's economy: about 50 % of GDP at the recent turn of the century (Sinton 2004). Furthermore, approximately 70 % of all (commercial) energy used in China is used in industry (Figure 1). It is clear that the continued safe supply of energy to industry constitutes an important (economic) sustainability concern in China, even though service and transportation are commonly projected to take increasing shares of total energy use in the future.

Figure 1. China's End-Use Energy Consumption by Sector, 2002



Source: Sinton 2004

During the first two decades of China's economic transition, after the launch of the Open Door policy in 1978, China's energy use followed a unique trajectory, increasing only moderately at half the pace of the economic expansion. Furthermore, in the last few years of the 1900s, official statistics suggested that energy use actually receded, even in real terms. The 21st century has brought on a new situation, however, with rapidly increasing energy use: between 2000 and 2002, primary energy consumption is reported to have increased by around twenty-five percent (Sinton 2004), while GDP "only" increased by sixteen to seventeen percent in the same time interval (Sinton 2004). Such extreme energy growth figures are not expected to last, however (Roberts 2004).

The way in which the supply and use of energy is distributed over energy carriers is significant from a sustainability point of view, both in economic and environmental terms. In China, electricity is an increasingly important energy carrier, not least in the industrial sector, where electricity's share of end-use energy has risen from around 25 % in the early 1980s to over 40 % in the early 21st century (Sinton 2004). Installed electric generation capacity currently increases by about 30 GW annually, and in 2004 alone, construction of an additional capacity corresponding to 180 GW was commenced (Roberts 2004). Industrial actors play major roles in this on-going expansion.

Three Perspectives on Sustainability and Development

The Actor Perspective – Who?

At first glance, an answer to the first part of the title question, *who?*, seems straight-forward. There is an internationally received perception of who the principal agents are that bear responsibility for the sustainability performance of societies; namely governments. For example, governments of sovereign nations are parties to international environmental treaties such as the Montreal Protocol and the Framework Convention on Climate Change. This view of the role and power of the political leadership is often taken for granted; not least within China, where the legacy of a hierarchically planned society is manifested in virtually all institutions from public administration to private enterprises.

Generally, in studies and analyses of large technical systems (such as, in this case, energy supply), it is common to focus on the stakeholders perceived to be key actors or "system builders" (Summerton 1998). Therefore, our proneness to first look upon the government is easily understood. This paper aims to expand this view and shed more light on some of the complexities or misconceptions, which complicate the conceptual model where the government is the primary strategic energy choice-maker and planner. Others have done this before. Bardouille (2001), when delving into thoughts and theories about sustainability in business (including industry), notes: "[a]lthough governmental bodies have customarily been viewed as the hub for sustainability discussions in the international arena, business is increasingly seen as a major actor in such efforts". This paper observes that there are indeed differences between opinions about actor relevance, and it suggests that inadequate recognition and understanding of such differences can in fact constitute an important barrier to improved energy efficiencies in industrial facilities.

The Technology Perspective – By Which Means?

In the introduction to this paper, technology is mentioned as a necessary element of efforts to deal with the wider dilemma of unsustainable development. Technology, therefore, has to be part of a possible set of answers to the title question: a part which concerns the instrumental aspect of *how* to go about addressing the problems of industrial energy use. And indeed, in comparison with many other countries, China appears to have significant untapped potentials for increased technical performance in industry, not least in terms of more energy efficient production (Mohanty and Visvanathan 1997).

Technology is not an unambiguous concept, however. Its connotations extend far beyond technical hardware and equipment; further even than digital software, industrial design and

immaterial patents. They encompass also intangible things such as know-how, skills and experience. They span from more or less common-practice routines to top-secret innovations and patents; they may be hi-tech or low-tech, protected property or publicly accessible. Thus, there is no single conceptual framework of technology that applies generally in discussions about technical innovation, development, diffusion or deployment.

The Futures Perspective – With What Methods?

Futures studies represent one way of combining the two perspectives already mentioned in order to formulate a comprehensive strategy for addressing the title question. A futures studies approach can offer a systematic way for assessment of the expected outcome of various policies, policy instruments and transition management efforts. It may therefore be used to provide an answer to the title question's *how?* – assuming *who* and *with what*, futures studies can help exploring *in what way?*

At the core of the complex of problems viewed in this paper lies the topic of China's energy future, which is an area intensely researched and the subject of many opinions, warnings, ambitions and pieces of advice. In an initiated narrative, bringing together decades' worth of research about China, Smil (2004) writes about the dynamics of Chinese politics and development, and about the difficulties of making projections to correctly predict the changes that will take place over the short- and long-term future. (While Smil uses the word "forecast", his reasoning is here understood to encompass other types of projective studies as well.[1]) In spite of the availability of good background knowledge due to existing infrastructures, Smil notes that "forecasters" of energy, food and environment trends often fail. Not only are the absolute numbers that are presented in such projections often completely wrong, "but their uselessness, for forecasts looking 5–50 years ahead, […] becomes obvious in just a matter of months or a few years after their publication" (Smil 2004). Two different sets of challenges may be addressed in this context:

- For the constructors of projections (forecasts and scenarios alike): how to identify, communicate and possibly reduce uncertainties and short-comings in their presentations.
- For their audience: how to interpret, value and use these projections constructively.

Methods, Means and Actors: The Chinese Context

China's political leadership shoulders the responsibility to address and remedy the country's unsustainable energy situation. The National Development and Reform Commission observes that "[i]f great efforts are not exerted to save energy, it will be difficult to support the sustainable, rapid, harmonious and healthy development of [the] national economy" (NDRC 2004). The following sections of the paper aim to give a short insight into how the three

[1] There is a need to address briefly a terminological issue of some importance in this context, namely the usage of the words forecast and scenario. Used by many as synonyms, they may also reflect two quite different approaches to the way in which we look upon the future. A forecast implies an element of prognosis and thus the concept of a high, and often quantifiable, likelihood of occurring. A scenario on the other hand need not be likely, only feasible. Scenarios, therefore, are often presented in groups which portray a span of possible futures. The arguments and discussion in this paper address the feasibility, rather than the probability, of projections of China's energy future. That is to say that the focus rests on the qualitative (scenario) aspect of such projections; not on the probabilistic and quantitative (forecast) ambitions, which they may – or may not – have.

perspectives are perceived from a Chinese point of view, starting with the latter, applied one. Opinions abound on how energy use in China will or ought to develop, and a number of thorough and solid projection exercises have been made in the recent past. Two of the more influential of these are the ERI study and the China Council study, which are briefly described below.[2] Two further sections comment on Chinese conditions pertaining to the instrumental technology perspective and to actor aspects.

Methods: Two Energy Projections

Two recent energy scenario studies provide inspiration to China's energy policy makers. Both these studies agree in the main and general conclusions that China, in the foreseeable future, (i) will continue to rely heavily on coal and fossil fuels for its energy supply, and (ii) will increase its total energy use over the coming decades. They also agree in the sense that they highlight the seriousness of the environmental as well as economic risks involved if China develops along the business-as-usual baselines that each of them envisions, suggesting the possibility of choosing instead alternative, and more benign trajectories.

The ERI study. The Energy Research Institute (ERI) is closely linked to China's National Development and Reform Commission (NDRC) (formerly known as the State Development and Planning Commission (SDPC)), which is a ministerial-level institution responsible, among other things, for China's recurring five-year plans. No longer enforced prescriptively, these plans still provide objectives and guidelines for authorities at all administrative levels regarding national priorities for the country's short-term development. The study referred to here was conducted in four stages from 1999 to 2003. The first stage constituted direct input to the SDPC during the process of formulating the energy conservation component of the current (tenth) five-year plan, which covers the period from 2001 to 2005. The results of the entire study are presented in Chinese in a comprehensive volume titled "China's Sustainable Energy Scenarios 2020" (Zhou *et al.* 2003), as well as in a summary in English by Sinton *et al.* (2003).

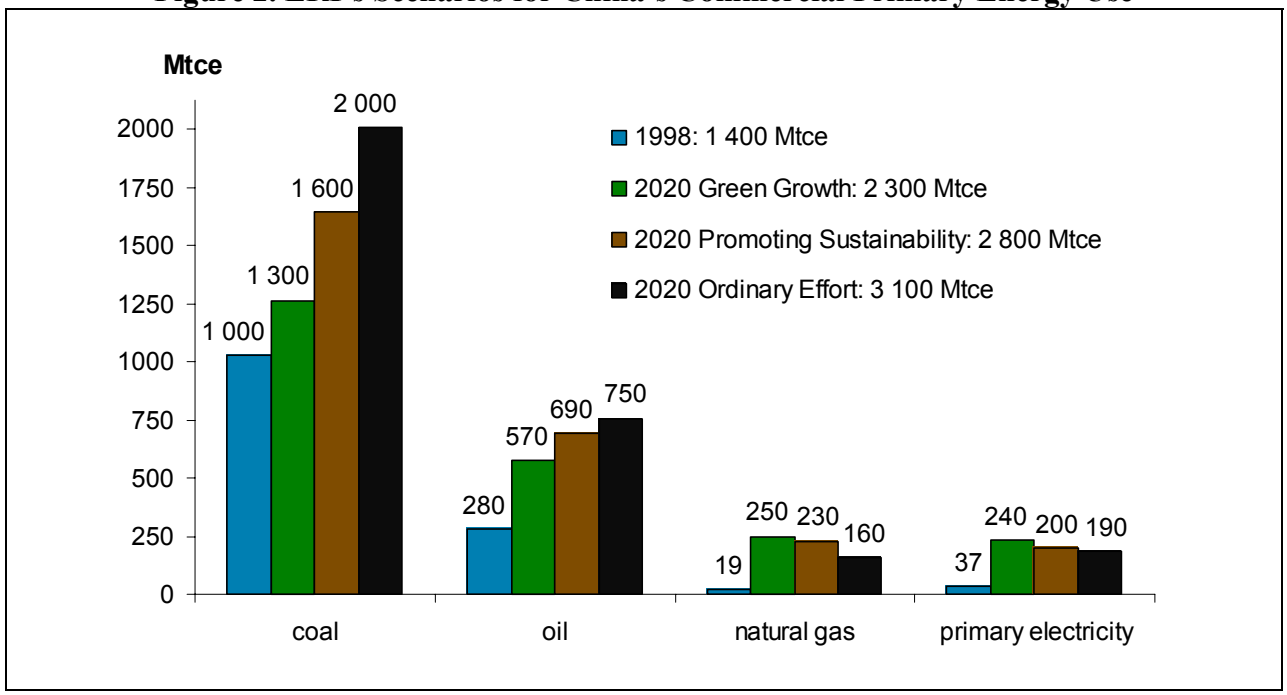
Three different scenarios, covering the time period from the base year of 1998 until 2020, were developed in the ERI study, using LEAP (Long-range Energy Alternatives Planning system) modelling. At a macro-economic level, all three scenarios are alike in that the objective of quadrupled economic activity in 2020 compared with 2000 is met. They differ, however, in how this is accomplished. A technically and environmentally progressive future is described by the scenario called Green Growth, which includes the adoption and successful implementation of new and forceful policies and measures. The least sustainable of the development trajectories presented has been named Ordinary Effort. It is described as a business-as-usual scenario, in which economic policies are prioritised over environmental and energy-saving policies, resulting in barriers to improvements in technical performance. The middle-way scenario is called Promoting Sustainability and is based on an assumption that current environmental and energy laws and policies will be successfully implemented – in line with the intentions expressed in the five-year plans. An overview of the differences in outcome between the scenarios is presented in Figure 2.

It is interesting to note how in these scenarios the ERI projects China's energy use to increase by a factor in the interval of 1.7 to 2.3, whereas the economy is assumed to quadruple.

[2] Here, "influential" refers to the closeness of both of these studies to the ears of China's central leadership.

Thus, the ERI suggests that economic energy intensity would continue to drop at an impressive rate, even in the least efficient case of Ordinary Effort.

Figure 2. ERI's Scenarios for China's Commercial Primary Energy Use



Source: Zhou *et al.* 2003

The China Council study. The China Council for International Co-operation on Environment and Development was established in 1992. It consists of Chinese and foreign experts and it reports annually to the State Council (the cabinet of China's central government). In 2003, the China Council's Task Force on Energy Strategies and Technologies presented the results of a study, in which six scenarios for China's energy future (from 1995) until 2050 were constructed. DeLaquil *et al.* (2003) describe how MARKAL (Market Allocation) modelling has been used to define and elaborate these scenarios, called Base (base technologies, *i.e.* business as usual), AdvTech (advanced technologies), Delay (delayed advanced technologies), LowEff (low end-use efficiency), HiTrans (high personal transport demand) and Shock (oil price shock). Unlike the ERI study, this study includes cost aspects into its scenarios. Another difference is that the China Council study specifically highlights energy security concerns by focusing on the use and development of domestic energy resources (particularly advanced coal and biomass gasification technologies) as a strategy for limiting dependence on foreign energy sources (essentially oil and natural gas).

The Task Force report (TFEST 2003) compares the Base and AdvTech scenarios, and summarises some concrete policy advice to China's leadership and the NDRC, needed for the realisation of the latter (and preferred) development path. For 2020, the China Council study scenarios suggest different values for China's primary energy supply, but interestingly they do not differ significantly from what is projected by the ERI (*cf.* Figure 2). In the AdvTech and Delay scenarios, as indicated by DeLaquil *et al.* (2003) approximately 2,200 Mtce will be needed. In the Base case, energy supply is only slightly higher, around 2,500 Mtce, whereas in

the LowEff scenario it climbs to about 2,800 Mtce.[3] (The HiTrans energy system is said to be similar to the LowEff case, and the Shock scenario differs from Base mainly in terms of cost.)

Means: Technology and Technology Transfer

In ERI's scenario Promoting Sustainability it is assumed that China's Energy Conservation Law is upheld and implemented so that "the energy efficiency of technologies in all sectors and industries […] is on the way to reaching levels currently prevailing in advanced industrialized countries by 2030" (Sinton *et al.* 2003). And, according to the China Council study, there is now, in the early years of the new century, a unique window of opportunity: of the coal-fired electric capacity expected in 2020, some two-thirds will have been installed after 2000 (TFEST 2003). It follows that China could, indeed has to, take this remarkable chance to influence how future electric production capacity is composed by promoting modern, advanced, efficient and clean facilities.

Efforts to achieve technological advancement are an important priority for China, where technology and science are icons of modernity, and where, in an international context, low-performing and outdated technologies in manufacture as well as in energy conversion are substantial reasons for serious environmental and social problems (Economy 2004). From a perspective of domestic policy, importance is attached to the promotion of innovation and of research and development. From another perspective, where terms such as technology diffusion and technology transfer are used, international relations and the obligations of the rest of the world towards China become instead one of the main issues. Generally speaking, there are great expectations in China about the impact and benefits for China of technology diffusion between countries. There is, however, no universally accepted terminology for diffusion and transfer of technology: words are open to interpretation. In China, with its tradition of state ownership and a planned economy, a materialist, hands-on, state- and control-oriented understanding of the terms prevails. Nation states are regarded as principal (or sole) agents – senders as well as recipients – and technology as equipment, objects that simply and easily change owners.

From a Chinese perspective, national occurrence or acquisition of technology on the one hand and national ownership on the other are understood to be in principle identical terms. This view is less pronounced in western countries, where rules of property ownership limit the room for manoeuvre of governments and protect ownership of technology by both physical and legal persons. This, in turn, opens up for a more complex actor model, where the state is expected to lead rather than to control. Regarding technology, there is also a more abstract view that transcends the equipment as such and that includes the way in which material objects are used. In China, however, technology transfer is seen as too important a matter to be given over to actors outside the government, to enterprises and industrial entrepreneurs, and uncontrolled diffusion of technology is not considered as true technology transfer. Such differences in perception are the source of a feeling in China that the western world is hypocritical and is not playing fair when issues such as technology diffusion and promotion of the international investment climate are raised in the same breath.

[3] 1 tce (tonne of coal equivalent), is equal to 29.3 GJ (and to 0.700 toe (tonnes of oil equivalent)).

Actors: Administration and Industry

In the positivist tradition that permeates Chinese ideals of development and progress, all parts of society are expected to strive in the same direction. The political leadership issues decrees and policies to promote desirable objectives, such as innovation and deployment of modern, advanced and benign technologies, and to eliminate that which is bad, for example by phasing out outdated technologies. In this conceptual model, there is no room for actors with different objectives or incentives. The model, of course, does not reflect the ways in which decisions are actually made and carried out in China, but it still represents an important ideal which is not often questioned. There is, however, a rich flora of literature about the structure and workings of Chinese administration, and about the conflict in China between what is sometimes called "the rule of law" and "the rule of man". *Zhifa nan* ("it is difficult to uphold the law") is a widely used phrase within the Chinese legal context (van Rooij 2002). One piece of learning which can be extracted from different writings in these fields, and which may be an eye-opener to the unfamiliar China observer, is how the concepts of hierarchy and consensus both apply within Chinese decision-making. They are otherwise often seen as mutually exclusive.

Hierarchy is an important characteristic of China's cultural Confucian heritage, which demands loyalty and obedience from the part of subjects, and benevolence and fairness from the part of rulers. Subordinate disagreement or defiance, however, cannot be tolerated: it must either be quelled by the leadership, or – when coercive means are not wanted or available – ignored. Hence, there is a widespread culture in China of feigned compliance (Pye 1992), which allows an outward show of unity and harmony, even when conflicts of interest do occur between hierarchical levels. And there are many such levels within China's huge administration. At the same time, there is also a multitude of actors on each of these administrative tiers, competing for influence over many of the same policy areas. The seeming uniform authority of the leadership unfolds, at a closer look, into a mesh of interdependencies and cross-relations. Notwithstanding this complex stage of authority actors, Pye (1992) points out how consensus leadership constitutes a public imperative, an iron law, practised to avoid or hide such conflicts of interests which might endanger the image of Chinese unity and damage the illusion that everyone works for a common good. This need for agreement among same-level authorities can make Chinese decision- and policy-making extremely slow and opaque. Moreover, as a result of these processes, the "omnipotence" one might have expected to find in the possession of China's central leadership is not an accurate representation of the factual situation. Displays of real power by the political leadership are possible but will only be shown in cases where examples need to be set, or where there is fear of a grave threat to society's stability.

Discussion

In many countries, differences in opinion and interest between industrial actors and political rulers are expected and recognised. With a legacy of politically controlled industry, however, this perspective is not embraced in China. Therefore, rule by command (a "government strategy") rather than building of incentives (a "governance strategy") remains, to most Chinese actors, the most sensible way to apply and enforce policies. There are programmes that aim to introduce new policy instruments, such as voluntary agreements (Price *et al.* 2003), to China, but there is a long way still to go before acknowledgement and understanding of the sense and

applicability of such efforts permeate the political actor mesh as well as the population of industrial actors.

According to Chinese policies and plans, outdated, too small or too inefficient electricity-producing units are to be phased out. The window of opportunity, of which the China Council study speaks, will be utilised: only the establishment of satisfactorily modern plants shall be allowed. Indeed, the same kind of policies apply to other sectors as well: coal mining, cement production, *etc.* Already in 1998, the now dismantled State Economic and Trade Commission clamped down on underachieving and substandard industries, forcibly closing a great number of different types of enterprises – at least formally and in the statistics. However, problems with enforcement of such policies and compliance among local actors are common in China. Consequently, in its energy projection exercise, the ERI did not present Promoting Sustainability as its business-as-usual scenario. Instead, Ordinary Effort represents the baseline in which deviations from national five-year plans and other policy declarations are expected. The implicit message, of course, is that action to better enforce policies is needed. All the while, local actors feign compliance with central policies, and governance strategies are rare.

The possible use of scenario studies as a method to assess plans and policies is one of the topics addressed in this paper. The potential of scenarios to remain helpful to policy-makers increases if the span of futures that they portray includes likely (and actual) short-term development trajectories, and where the behaviour of actors is an input parameter in scenario-making, one should remember that various actors have different rationale for their actions. Today, however, trends in China's electricity demand differ from plans and scenarios – not marginally but very much indeed. Massive shortages of electricity (due to bottlenecks in fuel logistics as well as to lack of installed production capacity) have lead to rationing and brown-outs in several parts of the country (Sandklef 2004). This, in turn, leads to a situation anticipated neither in the current five-year plan nor in scenarios (such as those by the ERI and the China Council). Presently, investments in electric power production soar as local actors seek to secure their supply. The guiding principles of these actors are quick, cheap and easy, rather than modern, clean and efficient. Thus, the envisioned window of opportunity for new, best-available technologies, as mentioned above, runs the risk of being filled-out instead by more-of-the-same and substandard technologies. The boom resounds in other sectors as well: the number of small, unsafe and policy-contrary coal mines is rising, the production of building materials in substandard facilities keeps growing, *etc.* And so, the (presently) near future seems decreasingly similar to the (described) future in any of the projections presented above; even the more cautious ones. It seems as if these scenarios have all failed to account for something in the link between the recently transpired (at the time of construction) and the possible events of the near future. In qualitative projections without claims to probability this is not necessarily a problem. However, according to both the ERI and the China Council, their studies are meant to provide assistance and input to China's environmental and energy decision-makers. If recent and current developments already in this early stage move too far off from the whole span of possibilities as projected in the studies, these scenarios run the risk of quickly losing their value as counsel. Smil's remark regarding the shelf-life of forecasts threatens to be applicable in these cases as well.

In the cases of strategic and long-term directives and policies that may be perceived as detrimental to local stakeholder priorities (such as employment or short-term economic or political gain), successful scenario-making needs to expand the cast of actors far beyond the central leadership so that it includes many more interests. The strategic choices actually made

regarding China's future rest not solely in the hands of government institutions in Beijing. This observation has become increasingly true as market reforms have progressed, and as local actors (in both administration and industry) wield more and more influence over decisions, the making of which was once the formal privilege of the central political elite and of the State Planning Commission. Nevertheless, traditional structures remain, and the framework of hierarchical consensus continues to play an important role. This means that divisions in opinion among the various significant stakeholders remain hidden, and that deviations from central policies (be it the reopening of a closed coal mine, or the installation of new but outdated power production units) can often be carried out without preceding discussions or impact assessments, and without ensuing sanctions.

If scenario studies are to be useful aids to policy-makers and planning authorities, it is important that they are well performed and that the projections represent feasible futures. However, high-quality scenarios are not in themselves keys to the unfolding of actual development trajectories. Svensson and Mogren (1984), in analysing projections and their role in strategic planning, suggest that the planning process may be seen to consist of three constantly and simultaneously on-going phases: debate, synthesis and propagation of expectations. They stress the importance of the debate phase, which needs to be kept vital through pluralism. Differences in actors' views and expectations have to be seen, acknowledged and allowed to clash. In Svensson's and Mogren's eyes, such debate is a prerequisite for the third phase, during which expectations about the future are propagated from the macro-planning level to micro-planners within subsystems, where individual stakeholders make their strategic choices. This kind of pluralism, however, is not in conformity with China's administrative traditions and structures. From this perspective, therefore, problems in China with the dissemination of policy imperatives are not surprising.

Concluding Messages

The main objective of this paper is to contribute to an increased understanding internationally of the present and future situation of Chinese industrial energy use. The challenges faced by China's industrial and energy policy-makers are daunting and singular in quantitative terms. Qualitatively, however, they differ less from the planning challenges of other countries or regions than one might be prone to think at first glance. China's authoritarian façade is deceptive as it can induce a false impression of predictable stakeholder incentive structures which are in conformity with government policies.

One of the fundamental ideas that underlie the discussion in this paper is the conviction that international efforts to contribute to a more sustainable industrial development in China are needed. However, foreign stakeholders should be aware that their contributions (in design, operation, and result) are influenced by how their own understanding of actors, technology and policy outcomes relates to that of their Chinese partners. International efforts ought to be assessed, selected and evaluated in light of such considerations, and the following points can be brought forth as seeds for thought:

- China may still be an authoritarian country, but this does not mean that the policy-makers of the central leadership are the only ones who influence the strategic development choices that are actually made. Independently acting (local) stakeholders should also be accounted for. This is an important challenge. Furthermore, one should allow for the fact

that interest variances occur also *between* and *within* China's administrative tiers, not only between representatives of public administration and industry.

- Only by knowing and accounting for the incentives that shape standpoints and actions within the whole stakeholder spectrum, can policy instruments by designed to target key actors and their behaviour. Finding ways in which to govern industrial energy by incentives and not only by command is another crucial challenge.
- Technology, *i.e.* the wider application in China of modern technologies, is a key part of received strategies, in China and abroad, for addressing pressing problems of industrial unsustainability. Expectations of how enterprises can and should acquire the new technologies they need, however, differ substantially. Efforts to conceptualise and bridge these differences are as significant as they are challenging.

While the responsibility for China's industrial sustainability and energy use may ultimately rest with the political leadership in Beijing, efforts to address the current, precarious situation need to involve, not simply address, the people and institutions that determine actual performance. This heterogeneous group of actors constitutes one possible (and an important) answer to the *who?* component of the title question of this paper. To the instrumental part of the *how?* component, technology constitutes a key, although widely diverging ideas about its shape and use makes it elusive. Recent and thorough projection studies of China's energy future address the applicational part of the title question's *how?* component. There is a risk, however, that the conclusions drawn from such studies go no further than to produce a selection of "suitable" policies, without reflecting on or questioning the extent to which the studies capture the instrumental and stakeholder perspectives commented on above.

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Acknowledgements

I want to gratefully acknowledge the contribution of Scott Roberts at Cambridge Energy Research Associates, Beijing, to the discussion presented here. This paper was written within a doctoral research project supported by the Swedish International Development Co-operation Agency, Sida (www.sida.se).