

## An Invited Paper for *Journal of Energy Security*

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### First Draft

## Methanol Mirage: China's Energy Security and Policy Inconsistency

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In 2006, chemistry Nobel Laureate George A. Olah and his colleagues published *Beyond Oil and Gas: The Methanol Economy* and suggested the methanol economy is "a solution *for the future*." Note that they do not advocate methanol *per se*; rather they are pushing for an integrated methanol economy in which the technology of carbon sequestration is mature, and renewable and nuclear energies play a large role. To China, methanol could be a solution *in the future*---not now.

Methanol, a chemical with the formula  $\text{CH}_3\text{OH}$ , is an alternate fuel for internal combustion engines, either in combination with gasoline or directly. Existing gasoline engines normally can run on M15 gasoline (i.e. 15% methanol, 85% gasoline); they need to be modified in order to run on fuels with higher concentration of methanol. Methanol is less ready to be used in compression ignite (diesel) engines because its energy density is 2.2 times less than that of diesel, which means that the fuel tank must be larger than a conventional diesel fuel tank to provide the same amount of energy. The problem of energy density can be reduced slightly by dehydrating the methanol and turning it into dimethyl ether (DME,  $\text{CH}_3\text{OCH}_3$ ). But according to the second edition of *Beyond Oil and Gas*, "a DME fuel storage tank must be about twice the size of a conventional diesel fuel tank to achieve an equivalent driving range to a comparable diesel vehicle." (Olah et al., *Beyond Oil and Gas: The Methanol Economy*, Wiley, 2009. 200)

Methanol can be gained from coal or natural gas. Given the abundant coal reserves, China is the largest producer of methanol, which is obtained through coal gasification. In fact, except its negligible use in racing cars, methanol as a transport fuel is practically only used in China (particularly the coal-rich provinces), which consumed about 20 million tons in 2010. But because of the energy density problem, the use of methanol is confined to the partial replacement of gasoline in China; DME is overwhelmingly used for (often illegally) blending with LPG.

Interestingly, although some taxi and bus fleets are running on methanol blends ([Greg Dolan](#), China takes gold in methanol, *Journal of Energy Security*, 2008), the majority of the Chinese car users do not intentionally consume methanol. There has not been a clear national energy policy on methanol in China, and the recent rapid development of the methanol industry essentially resulted from the market behaviour of energy companies. Since 2009, the domestic prices of gasoline (and diesel) have exceeded those in US, encouraging oil retailers to blend oil with the cheaper methanol. [An insider](#) gave a ballpark figure: the price of methanol is RMB 2,000 in 2011 while that of gasoline is RMB 8,000. Amazingly, now virtually all the gasoline sold at the gas stations in China is "secretly" blended with 5-15% of methanol, except those sold by foreign companies. Since the profit margin is great, many investors jumped on the bandwagon, causing the bubble-like overcapacity problem recently: In 2010, China's methanol production capacity was 35 million tons, but the actual production was only 15 million tons, which was lower than the country's consumption. In September 2011, speaking at a forum on automobile industry, [Mr Zhang Guobao](#), chair of National Energy Administration, which is responsible for formulating and implementing Chinese energy development plans, talked about his experience on promoting alternative car fuels. He found that, when the Chinese car users know which gas stations sell methanol- or ethanol-blended gasoline, they are willing to drive to other far-off stations to get "neat" gasoline, because they have an stubborn impression that either methanol or ethanol is "not powerful/strong enough" (roughly translated from *jingbugouda*).

This short paper consists of four parts. Next, we will review why oil has traditionally been the center of China's energy security debate, attracting some policy-makers to replace oil with methanol. Then, we explored how road transport has risen to be the largest source of China's oil insecurity on the demand side. Finally, we concludes that methanol cannot help China's energy security, because (1) gasoline has a long-term oversupply problem in China, (2) methanol cannot effectively replace diesel, the fastest growing oil product with a tighter balance sheet, (3) methanol increases the demand for coal and contradicts China's long-term energy policy, and (4) most fundamentally, it essentially encourages the use of cars with alternative fuels but discourages the development of alternative transport modes.

## **China's Oil-centric Energy Security**

Energy security means different things to different countries for different reasons. Oil has traditionally been the center of the debate of China's energy security for four reasons. *First*, China's dependence on foreign oil deepened. China had been an important oil exporter in Asia before it turned into a net importer of oil in 1993. That China had to rely on oil supplied by the foreigners refreshed the frustrating memories of Chinese energy crisis when the Coordinating Committee for Multilateral Export Controls (COCOM) placed it an oil embargo in the 1950s and the Soviet Union added insult to injure by cutting the oil supplies in the 1960s. Not coincidentally, on 27th March 1994, the phrase "energy security" appeared in a newspaper for the first time since China's economic reforms. The oil gap that needs to be filled by imports keeps expanding. In 1993, China imported 7.6 barrels out of every 100

barrels of oil consumed; in 2010, the figure reached almost 60. Comparatively, China's dependency on natural gas imports is below 10% and that on coal imports is below 5%. *Second*, despite dedicate supply-side efforts of diversification of sources (from the going-out strategy of China's national oil companies to the transnational oil and gas pipeline projects), the Middle Kingdom still heavily depends on the Middle Eastern crude oils. The proportion of the Middle Eastern crude oils to China's total imports peaked in 1998 (at 61%) and since 2002 it stably hovered between 45% and 51%. The challenge is that China needs to foster its economic and political positions in the combustible region where historically it has rarely played an influential role (some call this "Persian Gulf Dilemma"). *Third*, China appears to be trapped in the Malacca Dilemma (*Maluijia kunju*), which arises from both the fact that about 80% of China's crude oil imports goes through this narrow and congested waterway, and the perception that the Strait is controlled by "certain major powers," according to the explanation of President Hu Jintao in November 2003.

### **The Rise of Road Transport**

*Fourth* and most importantly to our theme, the road transport sector, the main source of our mobility in modern economies, is heavily dependent on oil, providing a captive market for oil. In the last two decades, the road transport sector has emerged to be the largest consumer of oil in China. If we look at the official data from *China Energy Statistical Yearbook 2010* (published in 2011), we find that transport sector took up 37.5% of China's end-use oil demand in 2009. But this is still an understated figure, which silently excludes the oil used for personal driving (see Guy C.K. Leung, China's energy security: Perception and reality, *Energy Policy*, 39:3, 2011. 1330-1337). If we look at the data from *Energy Balance of Non-OECD Countries 2011*, published by International Energy Agency (IEA), we find that transport sector took up 46.2% of the country's end-use oil demand in 2009. In other words, the whole transport sector now contributes to almost half of the country's final oil consumption.

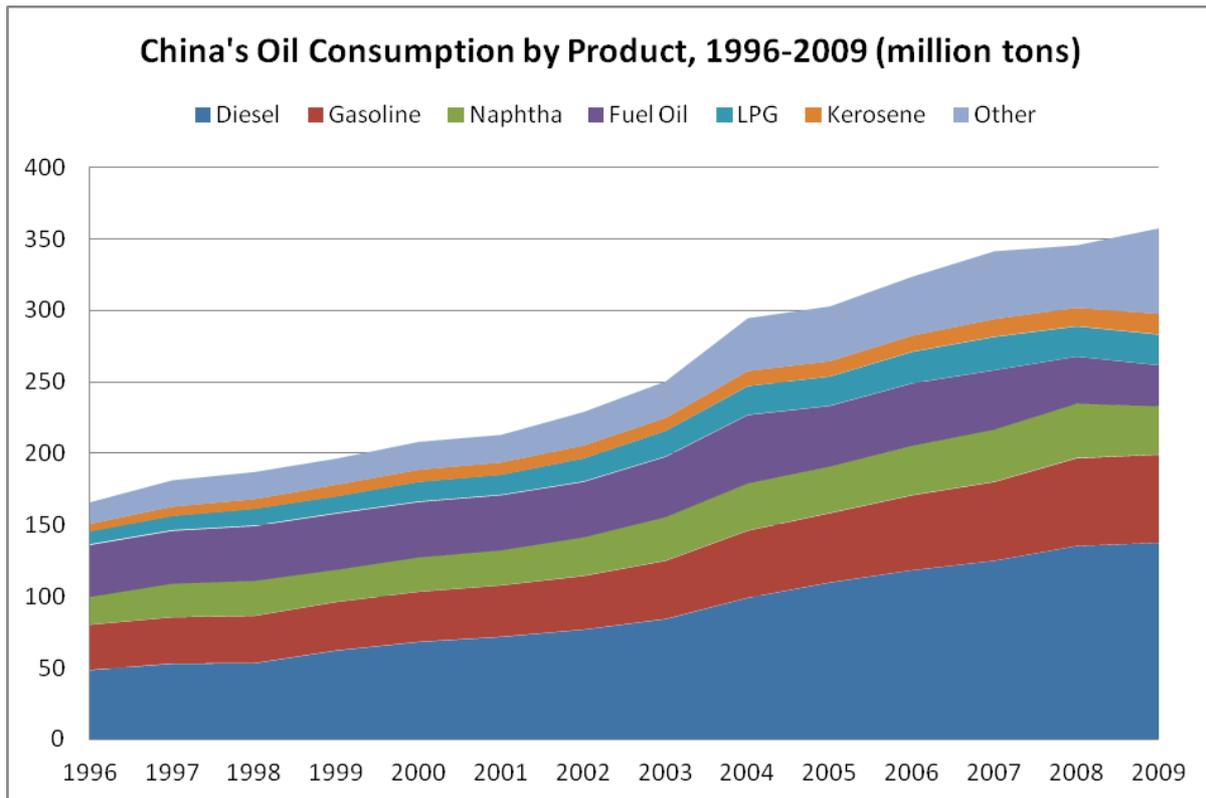
Road transport currently accounts for about 80% of total transport oil use. The emergence of the road transport sector as a dominant oil consumer is an institutional consequence. One year after China's becoming a net oil importer, Beijing released its auto policy and ironically regarded domestic auto industry as a strategic industry and a pillar of economy, as the government trusted that the industry would create jobs and demand for raw and intermediate materials and stimulate the economy via its spill-over (multiplier) effect. Since then, car represented a symbol of modernity in China. Car ownership was encouraged. Bicycles were progressively banned in many "advanced" Chinese cities. Highways were constructed and lengthened at a pace much faster than railways, causing the insufficient capacity of rail transport later (especially that for cargo logistics). But the inception of China's car era is not a linear process. In fact, two very different forces were at work. On the one hand, the rapid growth in China's industrial outputs generated huge needs for freight transport. Since China's freight rail system has been seriously insufficient, organizations all over the country had to rely heavily on road transport, making long-distanced, inter-

provincial transport unusually common. On the other hand, the growth in personal income increased road-based passenger transport in China. Studies suggest that when the per capita GDP of a country surpasses US\$1000, the vehicle ownership of that country takes off. The increase in Chinese personal income made vehicles increasingly affordable and desirable. Besides, China's entry into the World Trade Organization triggered a price war among domestic auto manufacturers, making vehicles even more affordable. As a result, Chinese vehicle ownership increased from 5.5 million in 1990 to 62.8 million in 2009, growing at 13.7 percent per annum on average. In 2010, China overtook the US to become the world's largest car market.

## **Methanol Mirage**

Since oil is the largest source of China's energy insecurity, and road transport is the largest source of China's oil consumption, attempts to introduce transport fuels alternative to oil (compressed natural gas, electricity, hydrogen or methanol) seem natural. Four reasons, however, persuaded us that methanol is unlikely the alternative fuel that could maintain, if not enhance, China's energy security.

*First*, although methanol can replace gasoline to some degree, gasoline is not a major source of China's energy insecurity in the first place. China published a new set of revised energy data early this year, which covers 1996-2009 (see the graph below). We find that China's gasoline demand grew more slowly than other oil products. During 1996-2009, China's gasoline demand grew at 5.3% per year while that of diesel demand grew at 8.5% per year, that of kerosene (mainly jet fuel) at 7.8%, and that of LPG at 6.9%. Gasoline use only grew faster than fuel oil (-1.4%). It is because gasoline has been constantly more expensive than diesel in China, making it a less attractive transport fuel. In fact, China has much gasoline for exports. From January to July 2011, China imported 101 tons of gasoline but exported 2,690,970 tons (60% to Indonesia, 25% to Singapore). In some sense, methanol is more useful to certain gasoline-importing countries, such as Iran.



**China's oil consumption by product, 1996-2009, in million tons**

Sources: Data from *China Energy Statistical Yearbook 2010*, naphtha data from IEA, compiled by the author.

*Second*, although diesel is the fastest growing oil product in China, methanol is unlikely to replace diesel. Diesel underpins Chinese economy. During 1996-2009, the real GDP of China grew at 9.8% while the country's diesel consumption grew at 8.5%, giving a diesel-GDP elasticity of 0.87. In the same period, the proportion of diesel in Chinese oil products market increased significantly from 29% to 38% (that of gasoline actually declined slightly from 19% to 17%). Also, the balance of diesel is much tighter. From January to July 2011, China exported 1,293,958 tons but it also imported 1,190,003 tons. The rapid growth of China's diesel demand is largely due to the country's heavy dependence on road-based freight transport. Methanol, or even DME, cannot replace diesel effectively because their energy density is much smaller than diesel's.

*Third*, judging from the book title of Oalh *et al.*, the methanol economy should be beyond oil and gas, but the methanol used in China is worse than oil and gas --- it is made out of coal. Methanol, like hydrogen and electricity, is only an energy source; it is an energy carrier. The methanol produced in China is completely obtained through coal gasification. Of course, given the abundance of its coal reserves, coal-based methanol, in a sense, can stabilize China's energy supplies. Currently China pledges to reduce the share of coal in

primary fuel mix from 70% to 50% by 2020 in order to increase overall energy efficiency and reduce the growth rate of carbon emissions. Should we pollute more in order to enhance energy security depends on two criteria: (1) Can methanol reduce China's oil import dependency? (2) How should we understand energy security?

In terms of (1), the fact that methanol cannot reduce diesel undermines the value of the fuel as an energy security measure. In terms of (2), China is embracing on "new energy security", a concept officially announced by President Hu Jintao at the G8 summit in St. Petersburg in 2006, setting targets to increase the country's energy efficiency and to spread renewable technologies. Chinese Communist Party (CCP) knows well that energy security is not an endpoint; rather, it is a means to maintain its governance and legitimacy. Although expanding the use of coal might reduce the country's external dependency to some degree, it will be not supported by the general public (50,000 "recorded" environmental protests in 2004) and the global community (this also might give the Western blocs an excuse to levy Chinese exports carbon tax, or force the RMB to appreciate through the threat of carbon tax).

*Finally*, methanol justifies the status quo without effecting a change in paradigm. As discussed above, the crux of the energy security problem in China is not the evil private cars of the new money, but the heavily road-based, diesel-driven freight transport system. The view that methanol can solve China's energy problem is technology-centric, but not reflective. That China's stock of motor vehicles is still very small provides a golden opportunity to change the development pattern of transport; once the stock is large enough, it locks down a long-term status quo. Although there is no denying that China should carry on exploring alternative transport fuels, it should first reflect on alternative transport systems, such as cargo railways and more energy-efficient land-use planning. It is true that energy problems have no silver bullets; this does not mean all bullets are equal. Even if we find the magic bullets, we need to get the targets right.

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