TRANSPORT REVOLUTIONS

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This is a summary of some of the themes of *Transport Revolutions: Moving People and Freight Without Oil*, published by Earthscan (London, UK) in December 2007. See www.transportrevolutions.info for a table of contents, 24 of the book's 376 pages, ordering information, and information about the authors.

Much of *Transport Revolutions* is taken up with reviewing previous revolutions in transport and describing transport today, its impacts and energy use. The energy analysis notes that 95% of motorized travel and freight movement by land, sea, and air is fuelled by products of petroleum liquids, accounting worldwide for consumption of some 60% of crude oil. Just over 50% of oil-based transport fuels moves people, just under 50% moves freight.

Motorized movement of people grows by about 2% per year worldwide, totalling some 30 trillion person-kilometres; about a quarter of this comprises travel in, to, and from the US. Motorized movement of freight grows by about 4% per year, totalling some 60 trillion tonne-kilometres; about a sixth of this comprises freight movement in, to, and from the US. Oil use for transport grows more slowly than transport activity but more quickly than use for other purposes. Among these other purposes are use of oil products as lubricants and as feedstock in the production of fertilizers, pesticides, pharmaceuticals, and plastics.

Overwhelmingly, motorized movement of people is by land, about 90% of total person-kilometres, and movement of freight is by water, about 75% of total tonne-kilometres. More than a third of all freight activity is movement of oil and oil products.

Motorized transport provides enormous benefits. It facilitates and even stimulates just about everything now regarded as progress. It also produces major costs, notably fatalities and injuries from road traffic crashes, and the adverse effects of emissions from the burning of oil products in vehicles' internal combustion engines.

Modern societies require prodigious amounts of transport for their functioning, now almost wholly fuelled by oil products. During the next decade, as world oil production peaks and begins an inexorable decline, major shortfalls are likely to emerge between 'business-as-usual' projections of oil consumption and oil production (see Figure 1). The resulting scarcity and high oil prices will present what may be humankind's greatest challenge, more than climate change, at least for the short and medium terms. Prices are already rising as the peak approaches. When we completed *Transport Revolutions* in June 2007, a barrel of light, sweet crude oil cost US$67.50 on the New York Mercantile Exchange (for next month's delivery). At the end of March 2008 it is above $105.

Our assessment of numerous alternatives to oil as a transport fuel concludes that, as oil depletion progresses, only electricity could reasonably power acceptable levels of land transport. Oil products will be increasingly devoted to fuelling marine transport and aviation.

Movement over water can be highly fuel efficient if speeds are low; and oil use can be further reduced by exploiting wind energy. (*Transport Revolutions*' cover portrays a ship deploying a towing kite.) There are no feasible alternatives to oil products for aviation, which could undergo the most radical changes over next few decades. Aviation is additionally vulnerable because is the most oil-intensive transport mode and because aviation fuels attract little or no tax, making them especially sensitive to increases in the price of crude oil. If the crude oil price remains above $105 per barrel for the rest of 2008, the aviation industry could well shrink dramatically. (The shrinkage may have already begun with the demise of Hawaii's Aloha Airlines, chiefly on account of the rising price of jet kerosene.) During the next decade or so, aviation could become increasingly confined to large, fully occupied aircraft flying a small number of mostly intercontinental routes.

Electricity is an advantageous energy source for land transport in every respect except one: it cannot be stored on board vehicles in acceptable quantities. This disadvantage can be overcome by delivering electricity to vehicles while in motion. Grid-connected electric vehicles have provided transport for at least as long as vehicles powered by internal combustion engines. As electric trains, streetcars, and trolleybuses, they provide most public transit in most of the world's major cities. We anticipate substantial expansion in the use of this kind of vehicle, with development and some deployment of unfamiliar systems including trolley trucks and personal grid-connected vehicles.

Electric vehicles offer the important advantage of independence from how their fuel is produced. Electricity generation can transition among a variety of sources—from coal generation to solar thermal generation—without changes in the transport system. Electric traction is well suited to the necessary transition from non-renewable to renewable energy.

Increased use of electricity could bring greater reliance on coal generation. We demonstrate that such reliance can be avoided through ready reduction in electricity consumption for other purposes and development of numerous opportunities for renewable generation.

At the heart of planning for oil depletion is whether it will be anticipated in a timely manner. If anticipated, the result could be a 'soft landing' into oil depletion. If not, scarcity and price increases during oil depletion could produce a 'hard landing' involving economic and social disruption and dysfunctional panic responses.

A central feature of *Transport Revolutions* is analysis of how two countries, the US and China, could begin redesign of their transport systems for oil depletion. These are the most

challenging cases among richer and poorer countries. The year 2025 is the focus for this scenario-building, recognizing that it will be an early point in a long era of oil depletion; 2025 is far enough ahead to allow substantial change in transport systems, but near enough to impel early action.

The overall target—based on what we believe to be the most realistic expectations of world oil production available in mid-2007— is to reduce world oil consumption for transport to 35% below a 'business-as-usual' projection for 2025, or about 17% below consumption in 2007. We argue that this reduction should be shared shared unevenly between richer and poorer countries so that the US would reduce consumption by 40% from its 2007 level and China would increase consumption by no more than 23% above its 2007 level (still much below projected consumption).

The objective for transport activity within, to, and from the US is to maintain the current overall level, which would amount to a reduction by about 15% per capita by 2025. The comparable objective for China is to grow movement of people and freight to no more than four times current levels, i.e., to about a fifth of current US per-capita movement of people and a half of current US per-capita movement of freight.

The key feature of the transport redesign proposed for both countries is massive expansion of electrically powered land transport. Movement of people in the US, for example, would be 30% electrically powered in 2025 compared with well under 1% today. Oil products would still fuel most motorised transport in the US and China in 2025, but the transition to electric traction would be well under way and would continue for decades beyond 2025. Table 1 shows elements of the scenario-building for the movement of people in the US and China. For comparison, it also provides UK data for 2007.

We outline how these changes could be achieved in each country if serious redesign were to begin in 2010. The basic strategy is reflected in this maxim: to get out of a hole, the first thing to do is stop digging. Thus, we propose stopping highway and airport expansion in the US, and diverting a third or more of the government funding of highways and airports to rail expansion and electrification. We suggest mechanisms for shared use of the already extensive rail system, which is now used almost entirely for freight movement. Other required changes would be funded through carefully calibrated increases in fuel taxes. A new federal body, the Transportation Redevelopment Agency, would guide and oversee the redesign of the transport system, much as the War Production Board refashioned US domestic transport in 1942-1945 to make way for massive output of military materiel.

We propose much the same thing for China, allowing for that country's vastly different circumstances. As well as different governmental arrangements, these include China's ongoing rapid rail electrification, the spectacular rate of internal migration from rural to urban areas, and the plans to house many of these migrants in massive 'ecocities'.

The period until 2010 is critical. We have qualified optimism that enough progress can be made. In the US, the 2008 election campaign continues to offer as-yet-unrealised opportunities for proposing, debating, and securing acceptance of appropriate strategies to accommodate oil depletion. In China, the political success of the 2008 Olympic and Paralympic Games could hinge on demonstration of serious intent to curtail consumption of oil and other fossil fuels. The Games are to be China's 'coming out' as a superpower. We note that China is relatively more dependent on Middle East oil than the US and suggest that leadership in addressing oil depletion—domestically and internationally—would be a good way for China to assume a superpower's geopolitical responsibilities.

During 1942, in an earlier era of transport revolutions, land transport in the US was radically transformed. In 1941, 3.8 million cars rolled off US assembly lines. Few were made in 1942 and essentially none at all in 1943 and 1944. Car plants were quickly retooled for military production. Car travel fell by half between 1941 and 1943; use of public transit tripled. From our Canadian perspectives, we believe that the US remains capable of the kind of decisive innovation that yielded the transport revolutions necessary for saving western democracies during the Second World War. We are similarly confident that China could take bold actions to move away from its oil-intensive transport trajectory. *Transport Revolutions* was written to help stimulate and facilitate such transformations.

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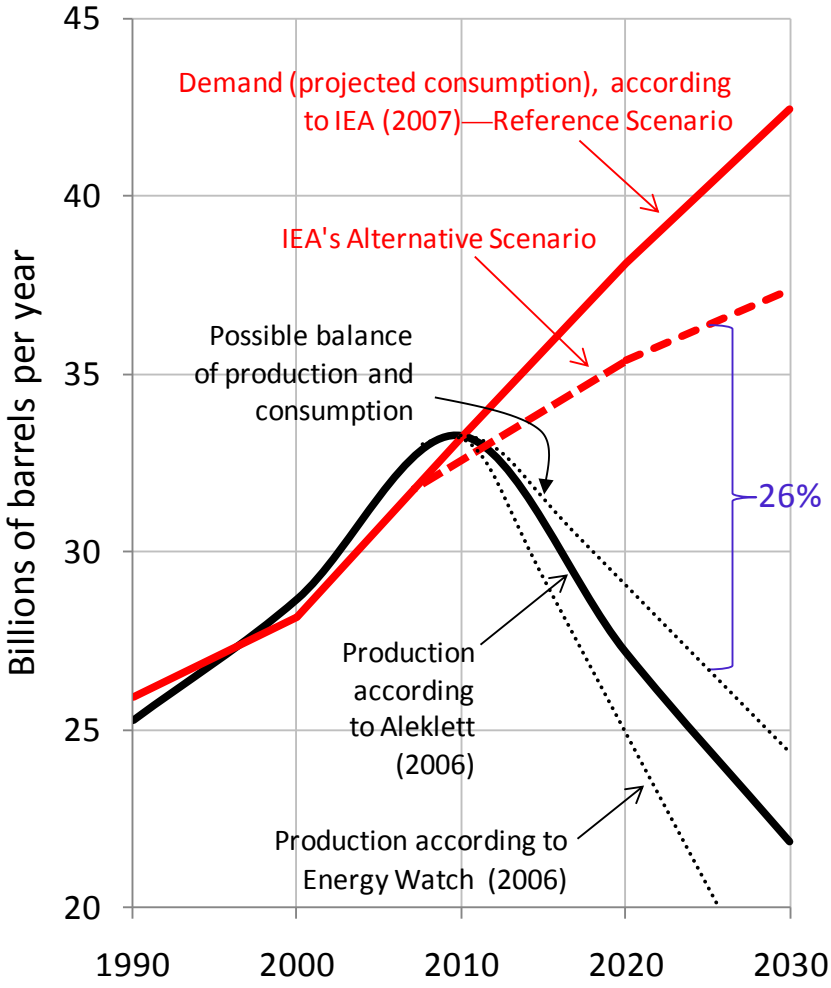
Figure 1. Actual and estimated world consumption and production of petroleum liquids, 1990-2030



Note to Figure 1: The upper thick solid line shows the International Energy Agency's Reference ('business-as-usual') Scenario of world oil consumption until 2030. The thick dashed line show's the IEA's Alternative Scenario, which assumes implementation of "all the policies that governments around the world are considering today". The lower thick solid line shows what the authors consider to be the most authoritative projection of world oil production. The upper dotted line is the authors' concession to arguments that massive production shortfalls are likely to raise production, an effect that has generally been found to be modest at best. Even then, in 2025 production would be 26% below the Alternative Scenario's projection of consumption. The lower dotted line is included to signal that there are credible projections of even more rapid oil depletion than the projection we favour. Sources: Aleklett, K (University of Uppsala, Sweden), presentation at the Energy and Environment Conference, Shijiazhuang, China, November 2006, http://www.peakoil.net/Aleklett/Aleklett_Shijiazhuang.pdf. Energy Watch, *Crude Oil, The Supply Outlook*, Ludwig-Bölkow-Stiftung, Ottobrunn, Germany (2007). IEA, *World Energy Outlook 2007*, International Energy Agency, Paris, France (2007).

Table 1. Movement of people in 2007 and 2025 in the US and China, and 2007 in the UK

units are billions of person-kilometres (pkm), except per capita pkm and megajoules per pkm

	US			China			UK
Mode	**2007**	**2025**	**Change**	**2007**	**2025**	**Change**	**2007**
Personal vehicle (ICE)	7,700	5,000	0.6	500	1,250	2.5	700
Personal vehicle (electric)		1,000		200	1,500	7.5	
Future transport (PRT, etc.)		200			500		
Local public transport (ICE)	50	100	2.0	300			25
Local public transport (electric)	40	400	10.0	30	1,000	33.3	10
Bus (inter-city, ICE)	200	500		500	500	1.0	25
Bus (inter-city, electric)		500			500		
Rail (inter-city, ICE)	6	100	16.7	300	100	0.3	20
Rail (inter-city, electric)	3	400	133.3	300	900	3.0	30
Aircraft (domestic)	950	600	0.6	150	150	1.0	10
Aircraft (international)	330	400	1.2	50	100	2.0	300
Airship (dom. and int.)		100			100		
Marine (dom. and int.)		100		5	100	20.0	
Totals	9,300	9,400	1.0	2,350	7,250	3.1	1,120
Per capita	30,500	26,500	0.9	1,750	5,000	2.9	19,000
Total electrically powered	45	2,500	55.6	730	4,400	6.0	30
Mean MJ/pkm for ICI movement	2.5	1.9	0.8	1.5	1.1	0.7	1.9

Note to Table 1. ICE refers to powering by internal combustion engines. More detail as to how the scenarios for the US and China were constructed is in *Transport Revolutions* together with detailed sources for 2007 estimates for these countries. The main sources for transport activity in 2007 are: US: *National Transportation Statistics*, US Department of Transportation, Bureau of Transportation Statistics, Washington DC (2007). China: *China Statistical Yearbook* 2006, National Bureau of Statistics of China, China Statistics Press, Beijing Info Press, Beijing, China (2007). UK: *Transport Statistics Great Britain*, Her Majesty's Stationery Office, London, UK (2007).