The Importance of oil for the Transportation Sector

Global trade is not a new concept as people have traded goods and services for many thousands of years. While wide scale transportation is not entirely essential for humanity to survive it does provide societal interaction for people. It also facilitates the movement of goods and services across borders and promotes economic development. Cities have grown and developed off the back of fossil fuels which has dominated as a fuel source for the last few hundred years. Today virtually all (95%), of transport energy comes from oil-based fuels, largely diesel (about 31% of total energy), and gasoline (47%).306 Transportation accounted for almost 70% of total petroleum consumption in 2012, in the U.S. This illustrates how dominant the use of light vehicles, trucks and cars is within the U.S. economy. As crude oil and its derivatives are the number one feedstock for our current industrialised way of life and economy, it is worth understanding how and for what oil is currently used.

According to the 'Vehicle Ownership and Income Growth, Worldwide: 1960-2030', research by Joyce Dargay (University of Leeds), Dermot Gately (New York University), and Martin Sommer (International Monetary Fund), there were approximately 122 million vehicles in the world in 1960. By 2002 this number grew significantly to 812 million vehicles with an annual growth rate of 4.6%. Further research by Ward Auto, on vehicle-population trends, indicates global vehicle registrations jumped from 980 million units in 2009 to 1.015 billion in 2010. The world vehicle population in 1986 was 500 million. Just 24 years later, the number of private vehicles doubled surpassing the one billion-unit mark in 2010. The BRIC countries, Brazil, Russia, India, and China added about 14 million new cars to their circulation in 2010 alone.

The 27 European Union (EU-27) member countries had a fleet of over 256 million vehicles in 2008, with passenger vehicles accounting for 87% of the union's fleet.[308] According to Ward's, the United States has the largest fleet of motor vehicles in the world with 239.8 million as of 2010. Vehicle ownership per capita in the U.S. is also the highest in the world, with 769 vehicles in operation per 1000 inhabitants. The People's Republic of China has the second largest fleet in the world, with slightly more than 78 million vehicles, overtaking Japan in 2010. The dependence on land transport for petroleum combined with these staggering growth rates in vehicle ownership, clearly illustrate the potential challenges countries and economies face moving forward.

Air Transport

According to The International Air Transport Association (IATA), which is the trade association for the world's airlines, the global airline industry's fuel bill was $210 billion in 2013 (accounting for 30% of operating expenses at $108.8/barrel Brent of oil). This is an increase of $2 billion over 2012 and is almost 5 times 2003's fuel bill of $44 billion. In 2014, the airline fuel bill was estimated to be $212 billion (accounting for 30% of operating expenses). This is a dramatic shift from 2003 when fuel was costing the airlines just $28.80 per barrel. The price has ratcheted up significantly reaching a high of $111.80 per barrel in 2012 contributing to 31% of operating costs. Scheduled passenger numbers have risen from just over 2 billion in 2004 to around 3.1 billion in 2013. It is interesting to note, while passenger numbers are at an all-time high, revenue per kilometre has declined sharply from 14.9% in 2005 to 1.2% in 2009 before recovering to stabilise to around 6% in 2013. Obviously the spike in world oil prices in 2008 impacted these margins.

Demand from China is partly the reason growth has continued in the aviation sector. The UN World Tourism Organisation, reported in 2013 the Chinese were now the world's leading spenders on international tourism. With an aggregate spend of $102 billion in 2012. This was a 40% increase on 2011, making the Chinese bigger spenders than both the Germans and Americans. Interestingly, the UN report detailed the average household income of the Chinese traveler was under $18,000 a year.[312] With the rapid growth in the Chinese middle class who are willing to travel, many tourism operators have become optimistic about this growing pool of potential international travellers. In 2013, the number of outbound tourists totalled 98.19 million, up 18% compared with 2012.[313] IATA estimates the global airline industry will generate $18 billion in profits for 2014. The problem for the industry is that from its revenues of $746 billion the net margin is will only average 2.4% which equates to around $6 per passenger.

Kjell Aleklett is Professor of Physics at Uppsala University in Sweden, he heads up the Uppsala Global Energy Systems Group. He is also President for the 'Association for Study of Peak Oil' (ASPO). Aleklett advocates, "the airline industry has put ambitious goals on increases in fuel efficiency for the aviation fleet. Traffic is predicted to grow by 5% per year to 2026, fuel demand by about 3% per year. At the same time aviation fuel production is predicted to decrease by several percent each year after the crude oil production peak is reached, resulting in a substantial shortage of jet fuel by 2026. The aviation industry will have a hard time replacing this with fuel from other sources, even if air traffic remains at current levels. Airbus and Boeing assume air traffic will grow by 5% per year. If they continue to increase efficiency as they have done in recent years then this will mean an increased fuel need of 3% per year. It is not easy to significantly increase the proportion of aviation fuel produced from crude oil by the refineries. If the proportion of aviation fuel continues at 6.3% of crude oil then none of today's scenarios can satisfy aviation's thirst not even the IEA's most optimistic prognosis."

While the airline industry faces serious challenges, it is hard to find any information suggesting they are acknowledging and addressing these issues. In the IATA 2050 vision paper, which was established to 'identify long-term challenges and possible outcomes for the air transport industry' there is not a word on 'peak oil' and the likely implications of resource depletion.[316] While other land transport industries have some ability to use alternative forms of energy, the airline industry is limited in what it can do apart from increasing efficiency. While some bio fuels are being trialed and used in some aircraft, these are generally more expensive than conventional fuels. Currently the infrastructure is not in place and the investment risk for any large scale bio fuels projects is limited in the current environment.

Like many other industries highly dependent upon fossil fuels, there seems to be a collective ignorance and lack of understanding around the challenges ahead. Many of the biases mentioned in the first section of this book seem to be present when it comes to business. With pro-innovation bias, willful blindness, blind spot bias and optimism bias, rampant across business sectors, it seems many are choosing to carry on with a business as usual approach in the hope things will just work out.

Shipping

The international shipping industry is responsible for the transport of about 90% of world trade and is vital to the functioning of the global economy. Intercontinental trade which facilitates the transport of bulk raw materials and the import/export of affordable food and consumer goods would simply not be

possible without shipping. The relatively low cost and efficiency of maritime transport has enabled the shift towards industrial production in Asia and other emerging economies. This shift has been largely responsible, for the offshoring of manufacturing and the production of low cost consumer goods which have flooded world markets. Some would argue this has contributed to dramatic improvements in global living standards.

In the merchant fleet there are 16,664 bulk carriers, 10,026, general cargo ships, 6,619 crude oil tankers, 5,091 container ships, 4,798 chemical tankers, 3,956 passenger ships and 1,588 liquefied natural gas tankers which contribute to the global commercial maritime fleet.[318] These figures don't account for global military vessels and medium to small pleasure craft. The fuel used in ships is waste oil. This is basically what is left over after the crude oil refining process. It is the same as asphalt, so thick that when cold it can be walked upon. It's the cheapest and most polluting fuel available. The world's 90,000 odd large commercial ships chew through an astonishing 7.29 million barrels of it each day. This is equivalent of more than 84% of all exported oil production from Saudi Arabia, the world's largest oil exporter.

Cost of Infrastructure

There is no doubting the global transport infrastructure network is immense. The development, resourcing and maintenance of this infrastructure have taken decades to develop. This infrastructure has cost hundreds of trillions of dollars to implement and maintain. It should be of some concern that much of the global transport network is predominantly reliant on a single fossil fuel resource. Petroleum supplies around 95% of the total energy used by world transport. According to the *Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (IPCC), transport was responsible for 23% of world energy-related GHG emissions with about three quarters of this coming from road vehicles. Over the past decade, transport's GHG emissions have increased at a faster rate than any other energy using sector.[320] The IPCC report also outlined how transport activity is expected to grow robustly over the next several decades. Unless there is a major shift away from current patterns of energy use, world transport energy use is projected to increase at the rate of about 2% per year. The highest rates of growth will occur in the emerging economies with total transport energy use and carbon emissions projected to be about 80% higher than current levels by 2030.

The Infrastructure enabling us to move around the planet with such ease and speed is mind boggling. There are vast networks of pipelines stretching hundreds of thousands of kilometres which aggregate resources from central hubs, enabling so distribution to the necessary locations. There are also thousands of processing and storage facilities.

These are necessary for providing a variety of services to the industry, from treating, separation to managing and distribution of finished products. The network of roads, rail and port facilities which help facilitate and move hydrocarbons and other resources to market stretch for millions of miles across the globe. Recent developments in the U.S. natural gas, natural gas liquids, and crude oil markets, have seen a rapid growth in direct capital investment toward oil and gas infrastructure assets. A report for the 'American Petroleum Institute,' estimates that capital spending in oil and gas midstream and downstream infrastructure has increased by 60 percent, from $56.3 billion in 2010 to $89.6 billion in 2013. This increase in capital spending has provided both an economic stimulus and an incisive data point showing how shale driven oil and gas production is reshaping the U.S. oil and gas infrastructure landscape. An IHS report for the American Petroleum Institute, forecast for oil and

gas infrastructure investment over the next 12 years (2014 – 2025), there would be a cumulative spending of $890 billion (in 2012 Dollars). Crude oil and natural gas gathering systems, and direct production support facilities, would receive the largest share of the investment at 60% of total.

The current gasoline and diesel fuel infrastructure comprises of numerous refineries, pipelines, terminals, and service stations. There are approximately 160,000 service stations and 5,000 truck stops in the United States. These supply 380 million gallons of gasoline per day (blended with ethanol) and 140 million gallons of diesel per day (blended with biodiesel). Capital investments for gasoline and diesel production and dispensing facilities have occurred over several decades. With the average cost well over $1 million to develop a service station site, including real estate, it would cost over $50 billion in the U.S alone to replace 50,000 + service stations. To completely reproduce the petroleum infrastructure would be significantly more. While the current global transport infrastructure in place is huge, the potential for growth over the following decades adds a new dimension to the challenges ahead.

The International Energy Agency (IEA) has modelled various scenarios based on potential requirements to support projected road and rail travel through to 2050. Their modelling suggests "over the next four decades, global passenger and freight travel is expected to double over 2010 levels; with non-OECD regions accounting for 90% of global travel increases. The consequences of this potential surge in global mobility are significant. Under 'The Energy Technology Perspectives' (ETP) *2012 scenario,* it estimates transport sector energy consumption under a current policies scenario (*ETP 2012* 6oC Scenario [6DS]), will grow by nearly 80%. Under this scenario, which is the current global transport trajectory, this would see global temperatures rise by 6 degrees celsius.

In a new policies scenario (*ETP 2012* 4oC Scenario [4DS]), in which fuel economy standards are tightened and there is a small uptake of advanced vehicle technologies, transport energy consumption and emissions are projected to increase by nearly 40% by 2050. Neither scenario will achieve emissions targets of keeping within a 2oC increase in average global atmospheric temperatures. The report suggests any growth in the transport sector will have serious consequences for energy requirements and will radically change the planet. If unabated and growth in the transport sector continues "under the Energy Technology Perspective of 2012 of 4 degrees scenario (ETP 2012 4DS), it is expected the world will need to add nearly 25 million paved road lane-kilometres (km) and 335,000 rail track kilometres (track-km), or a 60% increase over 2010 combined road and rail network length by 2050. In addition, it is expected between 45,000 square kilometres (km2) and 77, 000 km2 of new parking spaces will need to be added to accommodate passenger vehicle stock growth. In total, road, rail and parking infrastructure by 2050 is expected to account for between 250 000 km2 and 350 000 km2 of built surface area. This is roughly equivalent to the size of the United Kingdom and Germany (in land area), respectively.

If these scenarios do eventuate and humanity is still around, then the infrastructure additions estimated in this analysis will carry significant costs, not just environmental. Cumulative expenditures on transport infrastructure investments (capital construction) where fuel efficiency is adopted, there is some uptake in alternative fuels and advanced technology such as fuels cells, are expected to reach USD 45 trillion of capital investment by 2050. This accounts for roughly 0.7% of global GDP. This is consistent with present land transport infrastructure investment levels. When combined with reconstruction and upgrade costs, and annual operation and maintenance spending, global transport spending on roads, rail, Bus, rapid transit (BRT), High Speed Rail (HSR) and parking is expected to

reach nearly USD 120 trillion by 2050. This is roughly equivalent to an average of USD $3 trillion per year over the next 40 years. This equates to 2% of projected global GDP to 2050."[323] If these projections aren't astounding enough! The surge in growth from China and India in travel growth has already added approximately 50% of the 12 million lane-km since 2000. There has also been a tripling of annual passenger and freight travel between 2000 and 2010 as well as an increase in total road and rail kilometres by nearly 290% during the same period. [324]

The IEA report goes onto outline how rail track-km development has not progressed at the same rate as road expansion. Over 66,000 rail track-km has either been removed or retired in the past decade. Only China, India and ASEAN nations have added additional rail capacity of 11,000 km. Road maintenance costs are anticipated to increase as the world's roadway infrastructure continues to grow and age. The current global expenditure on reconstruction of roads is roughly USD $400 billion a year. By 2050, as capital costs begin to increase, annual reconstruction and upgrade costs are expected to rise to as much as USD $700 billion a year. This means the world will spend as much on fixing and rebuilding existing infrastructure as it does building new roadway. Cumulatively, reconstruction costs to 2050 represent nearly USD $22 trillion, or 0.4% of global GDP. Again, these values, combined with capital costs (or roughly 1% of GDP), appear to fall in line with current global spending on road investments.

The scope and size of the global transport and distribution networks is truly astounding. These transport systems involve vast amounts of capital and incredible amounts of resources to bring together a seamless and interconnected system. These systems have shaped economies and the global community over recent decades, enabling us to live in a globalised world. It is clear the global economy is principally driven by liquid fuels in the form of petroleum and petroleum derived products. These fuels drive the global network of land based transport, as well as shipping and aviation. Crude oil and its derivatives have provided humanity with the opportunities the pharaohs would have never dreamed. This once in a lifetime gift of stored ancient sunlight has not only transformed the way we move, it has changed the face of how we engage and interact with nature.