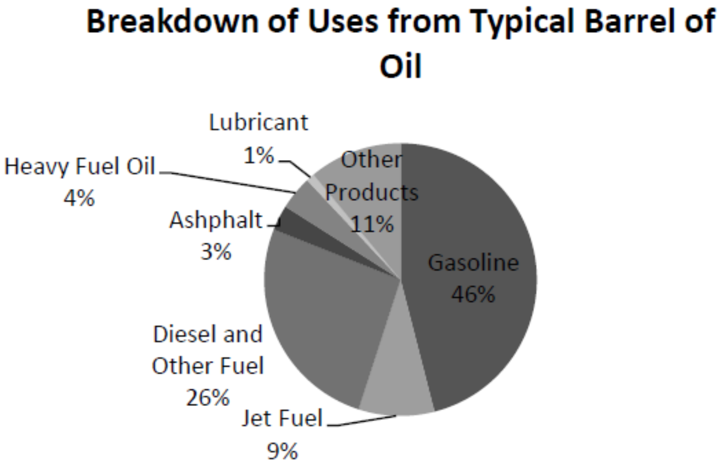
All fuels are not created equal - Why Oil is different?

"Surveying the available alternative energy sources for criteria such as energy density, environmental impacts, reliance on depleting raw materials, intermittency versus constancy of supply, and the percentage of energy returned on the energy invested in energy production, none currently appears capable of perpetuating this kind of society."

Richard Heinberg



Source: U.S. Energy Information Administration

Breakdown of Uses from Typical Barrel of Oil

More often than not we hear commentators discussing oil in terms of barrels. A barrel of crude oil is 42 U.S. gallons or 158.9873 litres. A barrel of oil contains about six gigajoules of energy. This is equivalent to six billion joules or approximately 1667 kilowatt-hours. This equates to 5.8 million Btu, or British thermal units. By definition, one Btu of energy will raise 1 pound of water by 1 degree Fahrenheit, so about 75 Btu are needed to boil a cup of water to make your morning coffee or tea.[226] This one barrel of oil with its astronomical 6.1gigajoules of energy has the ability to do the work of approximately 2000 horse power hours. One horse power equates to approximately 745 watts. A healthy strong person doing physical work for eight hours generates around 75 watts of energy or one tenth of the energy a horse can deliver.[227] Therefore as a rough guide one barrel of crude oil has the ability to do around 10 years of human labour based on a 40 hour work week. Oil is a dense energy source which has multiple uses. Yet it seems many of us take this precious substance for granted, not thinking about how this liquid gold has changed our lives.

Nate Hagens, an ex-Wall Street investment advisor, turned activist, spoke at the Association for the Study of ‘peak oil’ (ASPO), conference in Vienna in 2012. He sums up the importance of oil. “To put it into context, one barrel of oil that currently sells for between $100 to $120 U.S produces approximately 1700 kilowatt hours of energy. The average human produces around six tenths of a kilowatt hour, on a normal working year it would take around eleven years to produce the same amount of energy as one barrel of oil. The average salary in America is $45,000 per year, eleven years that’s $500,000 of labour displaced by one barrel of oil. That is the story of industrialisation, the swapping of manual labour for machine and fossil labour."

Due to its high energy density, ability to be easy transported and relative abundance, oil has been the world's most important source of energy since the mid-1950s. The density of energy v's cost, weight and storability have enabled petroleum to remain the dominate fuel for transportation for the last several decades. While most associate petroleum as a with fuel source, there are over 6,000 items that we use each day made from petroleum waste by-products. Some of the more familiar ones include: fertiliser, linoleum, perfume, insecticide, soap, vitamin capsules, computers, mobile phones, CD's, clothes, tires, dyes, food preservatives, paint, shoes, lubricants, food packaging, lounges, antiseptics and pharmaceuticals.

One of the most influential uses oil has had since the 1940's is on agricultural productivity through the use of energy-intensive mechanisation, fertilisers and pesticides. These have dramatically changed the nature of farming, resulting in an increased reliance on fossil fuel based inputs needed to broad scale farming. As Lester Brown from the Earth Policy Institute points out, "the growth in the world fertiliser industry after World War II was spectacular. Between 1950 and 1988, fertiliser use climbed from 14 million to 144 million tons. As the world economy evolved from being largely rural to being highly urbanised, the natural nutrient cycle was disrupted. In traditional rural societies, food is consumed locally, and human and animal waste is returned to the land, completing the nutrient cycle. But in highly urbanised societies, where food is consumed far from where it is produced, using fertiliser to replace the lost nutrients is the only practical way to maintain land productivity. It comes as no surprise the growth in fertiliser use closely tracks the growth in urbanisation, with much of it concentrated in the last 60 years."[229] While some countries are using less fertiliser inputs, the average growth rate for global fertilisers demand according to a United Nations report, suggests demand between 2011 to 2015 will to grow by around 2%.

Oil Formation and Constraints

We take for granted the energy crude oil produces each day. It is therefore important to understand what constitutes crude oil and its properties. Crude oil is a naturally occurring hydrocarbon found within geological formations in the earth. Oil is a product of millions of years of organic matter such as plants, usually zooplankton and algae as well as animals and insects. As the organic matter fell to the bottom of these oceans it mixed with sand, mud and clay, forming an organically rich mixture. Under immense pressure and high temperatures over millions of years, these sediments formed all the ingredients to transform this organic matter into oil.

Certain areas such as the Gulf of Mexico and the Tethys Sea had an organically rich sedimentary profile, making the perfect conditions for oil to form. As land masses moved and shifted throughout millennia sea levels eventually fell hundreds of metres. During the Cenzoic period (around 66 million years ago), the sea levels fell dramatically between the Atlantic and the Tethys Sea, better known today as the Middle East. This resulted in large masses of organic material being buried under subsequent deposits such as shale formed from mud.231 Crude oil is essentially stored solar energy from millions of years of ancient sunlight which humans stumbled upon.

There are certain conditions which must be present for oil reservoirs to form. A source rock, rich in hydrocarbon material buried deep enough for subterranean heat to cook it into oil, a porous and permeable reservoir rock, for it to accumulate in, and a cap rock (seal) or other mechanism that prevents it from escaping to the surface. Within these reservoirs, fluids will typically organize themselves like a three-layer cake. Typically a layer of water is found below the oil layer and a layer of gas above it. As most hydrocarbons are less dense than rock or water, they often migrate upward through adjacent rock layers until either reaching the surface or becoming trapped within porous rocks (known as reservoirs) by impermeable rocks above. The process is influenced by underground water flows, causing oil to migrate hundreds of kilometres horizontally or even short distances downward before becoming trapped in a reservoir. When enough hydrocarbons are concentrated in a trap an oil field forms.

An oil deposit consists of drops of oil in porous rock stored at high pressure. When an oil well is drilled, the pressure differential forces oil up the well to the surface. This causes the pressure in the reservoir to fall. The oil reservoir is comparable to a shaken can of fizzy drink. Punch several holes in the top of the can and the internal pressure will force the contents out at a maximum rate. As soon the internal pressure falls, this causes the flow to slow until it eventually stops with much of the contents remaining in the can. Oil companies can return the pressure in oil reservoirs by pumping down other materials such as water, to replace the oil which has been extracted. This however becomes an expensive exercise and is only a partial solution. A majority of the oil always remains in the ground as the extraction rate tails off at a predictable rate. This is known as the depletion rate. The economics of resource extraction ensures energy companies pursue the easiest and most accessible resources in the first instances.