WORLD COAL ASSOCIATION

COAL MATTERS

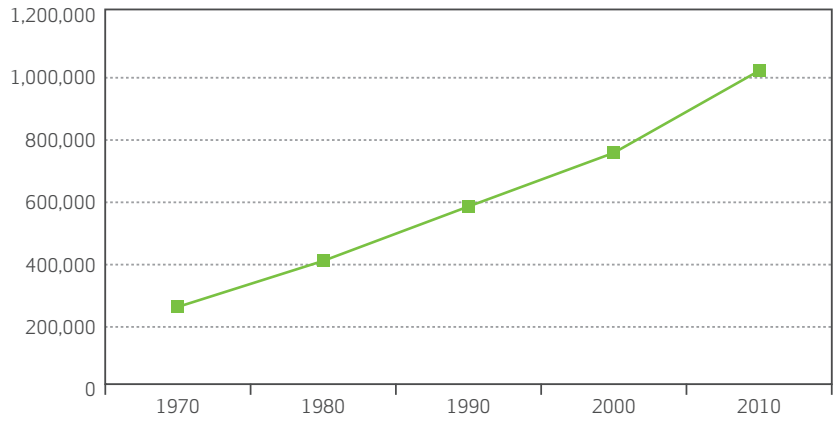
6/Coal and transport

Growing demand for transport fuels and infrastructure

The pressure to provide transport infrastructure and fuels is immense. Globally the ownership of motor vehicles has increased from around 250 million in 1970 to over one billion today.[1]

Coal-derived fuels and energy carriers, as well as coal-based electricity, can play a significant role in responding to the growing energy needs of the transport sector. Coal is also an important raw material and source of primary energy for the manufacturing of materials used to build transport infrastructure, such as steel, cement and aluminium.

World Motor Vehicle Registrations (thousands)



Source: US Department of Energy, 2012

In China, automobile ownership has increased more than seven times in the last ten years, from around 14 million in 2000 to over 100 million at the end of 2011. There could be as many as 219 million motor vehicles in total now in China if all types of vehicles, including motorcycles, tractors and trucks are counted.[2]

This growth trend is expected to continue over the coming decades in China and in the rest of the developing world as the global middle class continues to grow. In this context, there is a pressing need to explore new sources of fuel for the transport sector. If China had the same level of per capita car ownership as the USA has today it would use 99 million barrels of oil a day. Total worldwide production of oil is currently 89 million barrels a day.[3]

1. US Department of Energy, 2012
2. China Auto Web, 2014
3. U.S. Energy Information Administration, 2009-2013

Transport fuels - liquid coal fuels

Liquid fuels from coal provide a viable alternative to conventional oil products and can be used in the existing supply infrastructure. Several coal-to-liquids (CTL) demonstration plants are being developed in China. CTL currently provides 20% of South Africa's transport needs including 7.5% of jet fuel.

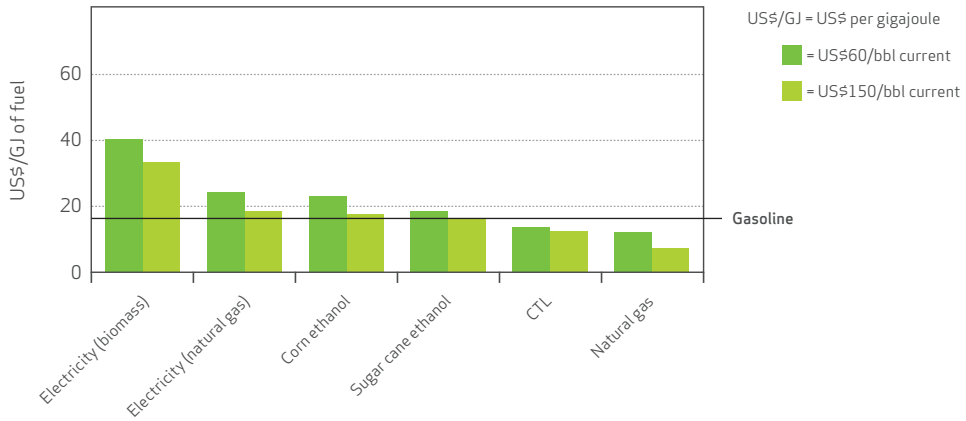
Converting coal to a liquid fuel – a process referred to as coal liquefaction – allows coal to be utilised as an alternative to oil. There are two different methods for converting coal into liquid fuels:

- Direct liquefaction works by dissolving the coal in a solvent at high temperature and pressure. This process is highly efficient, but the liquid products require further refining to achieve high grade fuel characteristics.
- Indirect liquefaction gasifies the coal to form a 'syngas' (a mixture of hydrogen and carbon monoxide). The syngas is then condensed over a catalyst – the 'Fischer-Tropsch' process – to produce high quality, ultra-clean products.

Coal-derived liquid fuels are also sulphur-free, low in particulates, with low levels of oxides of nitrogen, providing local and regional air quality benefits in comparison to oil. Over the full fuel cycle, CO_2 emissions of liquid fuels from coal can be reduced by up to 46%, compared to conventional oil products, if co-processing of coal and biomass is undertaken and combined with carbon capture and storage (CCS).

International Energy Agency (IEA) data shows that CTL can be produced at a much lower cost than gasoline and, together with natural gas, is the only alternative transport fuel able to compete with gasoline even at very low crude oil prices of around US$60 per barrel (bbl). At current crude oil prices of US$100/bbl to US$110/bbl (as of February 2014) CTL production costs are over 20% lower.

Production costs of alternative transport fuels



Source: IEA, 2013

Transport materials - coal in aeroplanes and cars

Coal is a key energy fuel in the production of aluminium – a non-ferrous metal known for its lightweight properties and widely used in cars, trains and airplanes to reduce the weight of these vehicles and their energy consumption. In fact, new cars in Europe use, on average, 132 kg of aluminium per car. Coal accounts for over 50% of the energy used to produce aluminium.

Carbon fibres are used in the production of advanced composite materials, such as reinforced plastics, which are increasingly used in the automotive and aerospace industries as a replacement of steel. Coal-tar pitch, a by-product of coal carbonisation or coal gasification, is used to produce carbon fibres via a series of processing steps, including refining, oxidation and carbonisation. Carbon fibres are a quarter of the weight of steel and ten times as strong. Carbon fibres can therefore reduce the weight of airplanes and cars, improving their energy efficiency and reducing the carbon footprint. The new Airbus A350 and Boeing Dreamliner have airframes comprising nearly half carbon fibre reinforced plastics and other composites. This approach offers weight savings on average of 20% compared to more conventional aluminium designs.

132kg

NEW CARS IN EUROPE USE, ON AVERAGE, 132KG OF ALUMINIUM PER CAR. COAL ACCOUNTS FOR OVER 50% OF THE ENERGY USED TO PRODUCE ALUMINIUM

Transport materials - coal in transport infrastructure

Energy intensive materials such as steel, cement and lime are used to build railroads, tunnels, bridges and roads. Coal, because of its relative affordability, is the most widely used source of energy in the manufacturing process of these materials.

Coal is not only an important energy source for steel production but is an essential raw material and energy fuel in the production process.

There are two main steel production routes; the integrated steel making route and the electric arc furnace route. The integrated steel making route on average uses 770kg of coal, 1400kg iron ore, 150kg of limestone, and 120kg of recycled steel to produce a tonne of crude steel. The electric arc furnace route uses primarily recycled steel and electricity. On average, it takes 880kg of recycled steel, 150kg of coal, and 43kg of limestone to produce a tonne of crude steel using the electric arc furnace process.

50%

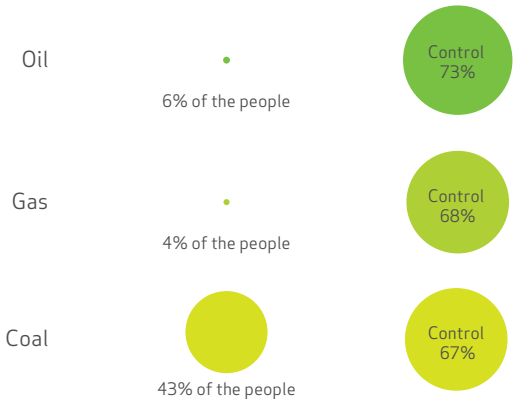
NEARLY HALF OF THE NEW AIRBUS A350 AND BOEING DREAMLINER AIRFRAMES ARE MADE OF CARBON FIBRE REINFORCED PLASTICS AND OTHER COMPOSITES

The development of the coal to liquids industry can serve to hedge against oil-related energy security risks. Coal prices have been historically lower and more stable than both oil and gas on an equivalent energy basis. Using domestic coal reserves, or accessing the relatively stable international coal market, can allow countries to minimise their exposure to oil price volatility while providing the liquid fuels needed for economic growth. Unlike the oil market, the coal market benefits from a very large number of suppliers.

20%

COAL DERIVED FUELS MEET 20% OF SOUTH AFRICA'S TRANSPORT NEEDS

Global distribution of the world's fossil fuel reserves



Source: Frank Clemente, Professor Emeritus at Penn State University , 2012

Transport fuels - coal-based electricity

The IEA envisions the widespread adoption and use of electric vehicles over coming decades. According to the IEA's Roadmap, plug-in hybrid electric vehicles (PHEV) should represent more than 50% of annual light duty vehicle sales worldwide by 2050. In fact, PHEVs are expected to be the most widespread form of sustainable vehicles over the coming decades, with estimated annual sales of 25 million vehicles in 2030.

Coal-based electricity has a role to play in supporting the electrification of the transport sector. With the use of carbon capture and storage, coal power plants could provide low-carbon electricity for the new generation of personal vehicles.

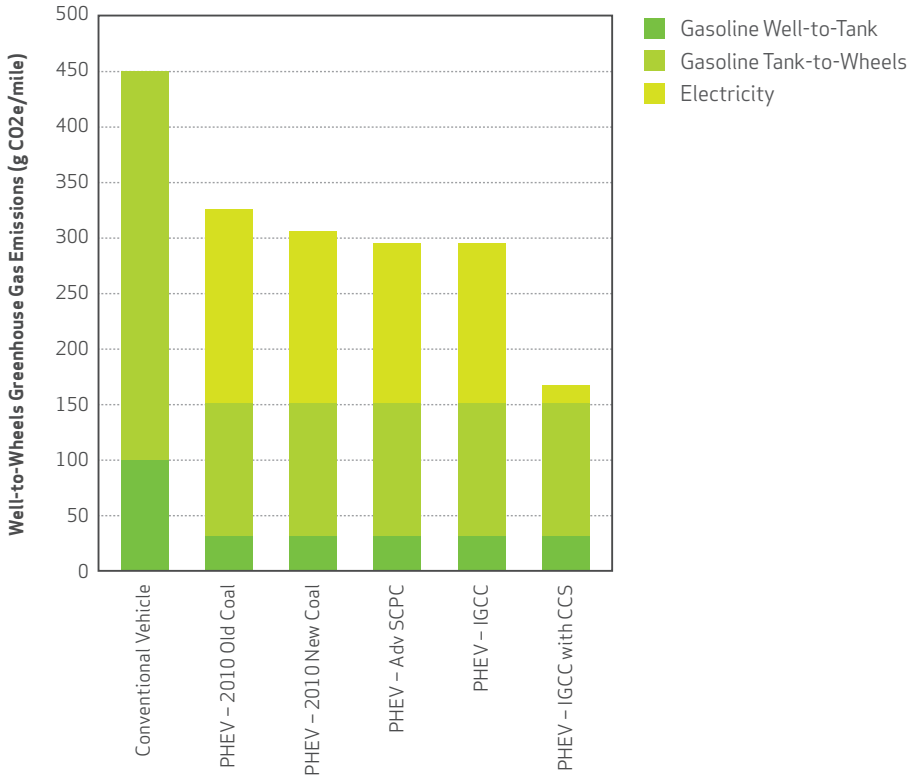
In comparison to conventional vehicles, PHEV charged with electricity from advanced supercritical coal power plants emit 33% less GHG emissions and 66% less if CCS is installed.

33%

PLUG-IN HYBRID ELECTRIC VEHICLES CHARGED WITH COAL-BASED ELECTRICITY EMIT 33% LESS GHG EMISSIONS THAN CONVENTIONAL VEHICLES

4. IEA, Technology Roadmap. Electric and plug-in hybrid electric vehicles, June 2011

GHG emissions from plug-in hybrid electric vehicles (PHEV) charged with electricity from specific power plant technologies



The above graph compares total GHG emissions from conventional vehicles and PHEV (with 20 miles of all-electric range) for a typical case of 12,000 miles driven per year.

Source: EPRI, 2007

Transport fuels - hydrogen from coal

Hydrogen could well become the major component of clean sustainable energy systems in the longer term, mainly in the transport sector. It can be used to power highly efficient fuel cell vehicles, without CO_2 or major air pollutant emissions at the point of end use. Coal, together with other fossil fuels, is one of the most economic energy sources for producing hydrogen. Today around 19% of the world's hydrogen production is based on coal.

19%

OF THE WORLD'S HYDROGEN PRODUCTION IS BASED ON COAL

Hydrogen is produced from coal by first gasifying the coal to form synthesis gas, or syngas, then processing the syngas further to increase the hydrogen content, and removing other components to produce a pure hydrogen stream. If CCS technology is used to capture the highly concentrated CO_2 from the coal gasification process, hydrogen from coal could be used as a zero-carbon fuel to power the transport sector.

The World Coal Association is a non-profit, non-governmental association

The World Coal Association is a global industry association formed of major international coal producers and stakeholders. WCA works to demonstrate and gain acceptance for the fundamental role coal plays in achieving a sustainable and lower carbon energy future. Membership is open to companies and not-for-profit organisations with a stake in the future of coal from anywhere in the world, with member companies represented at Chief Executive level or Chairman level.

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