



# COAL AND GAS TO LIQUIDS

(SYNTHETIC LIQUID FUELS)

TURNING COAL OR NATURAL GAS INTO LIQUID FUELS.

PROCESS WASTES A LOT OF ENERGY AND HAS  
SERIOUS CONSEQUENCES FOR WATER RESOURCES  
AND CLIMATE CHANGE.

## WHAT IS IT?

Converting coal to a liquid fuel is known as coal liquefaction and can be done in two ways; direct liquification, where the coal is dissolved at high temperature and pressure and then refined; and indirect liquification, where it is 'gasified' to form a 'syngas' (a mixture of hydrogen and carbon monoxide), which is then condensed to make a liquid fuel. Both processes require large amounts of energy.

Converting gas to liquids (GTL) can also be done using two methods, via direct conversion, or indirectly by converting first to syngas then using the Fisher-Tropsch process. The Fischer-Tropsch process was invented in the 1920s by two German chemists. The process was used to produce liquid fuel from coal during the Second World War as Germany lacked access to sufficient crude oil. The advent of cheap oil led to the technology being largely abandoned. Several direct conversion processes have been developed but have proven uneconomical. So far only indirect methods have been commercialised.<sup>1</sup>

Coal to liquids (CTL) technology was re-invigorated in the 1950s in South Africa when the country was isolated during apartheid, and it remains the only country with significant commercial CTL operations. However, as most transport infrastructure around the world is dependent on liquid fuels (particularly cars and planes), and with conventional oil reserves slowly running low, there is huge demand for alternative liquid fuels. Converting coal and gas to liquid fuels also means some countries can use their own resources for transportation fuel instead of being dependent on foreign imports. Another attractive feature of synthetic liquid fuels from coal and gas is that they can be used to create various chemicals traditionally made from crude oil.

Coal can also be converted to gas (coal gasification) using a process which is also very energy inefficient. This can be carried out underground, which results in serious greenhouse gas emissions, groundwater pollution, and other environmental problems (see Underground Coal Gasification factsheet for more information)

Note that GTL technologies are different from Liquefied Natural Gas (LNG). LNG is where natural gas is cooled and pressurised so it condenses into a liquid. It needs to be maintained at the correct temperatures and pressure in order to remain in liquid form. The processes for making and transporting LNG also use large amounts of energy.

## "TOTAL 'LIFECYCLE' GREENHOUSE GAS EMISSIONS FOR LIQUID FUEL FROM COAL IS ABOUT DOUBLE THAT OF FUEL FROM REFINING CONVENTIONAL CRUDE OIL"

The ORYX GTL plant, Qatar

### CLIMATE CHANGE

The energy used in converting coal and natural gas to liquid fuels means that they result in higher greenhouse gas emissions than fuel from conventional crude oil.

The total 'lifecycle' greenhouse gas emissions (which includes all emissions generated in extraction, processing, transportation etc.) for liquid fuel from coal is about double that of fuel from refining conventional crude oil.<sup>2,3</sup>

GTL fuels have been estimated to have about 30% higher lifecycle greenhouse gas emissions than fuel from refining conventional crude oil.<sup>4,5</sup>

The conversion process is usually powered by electricity, so greenhouse gas emissions from coal and gas to liquid technologies depend on how this electricity is generated. However, even if renewable sources are used, the process still wastes a lot of energy that could have been used for other purposes.

It has been estimated that using a quarter of the world's coal as CTL would increase atmospheric CO<sub>2</sub> concentrations by approximately 300 parts per million (ppm)<sup>9</sup> which equates to 636GtC.<sup>10</sup> This is a huge amount, far more than would result from burning all of the world's conventional petroleum,<sup>11</sup> and although there are disagreements about coal reserves and resources, with some claiming estimates are far too high, there is certainly enough conventional coal to go well beyond the carbon limit mentioned in the box above. The additional emissions that would result from developing coal and gas to liquid technologies only exacerbate the problem.

*If we are to reduce carbon emissions to anything like the levels required to maintain a reasonably habitable planet we must move away from all forms of fossil fuel as fast as possible. Measuring from the start of the industrial revolution (around 1750), a maximum of 500 Gigatonnes of carbon (GtC) can be emitted to the atmosphere while still avoiding most serious impacts and the risk of irreversible and uncontrollable changes to the climate.<sup>6</sup> Between 1750 and now (2014), we have already emitted about 370 GtC leaving a limit of 130 GtC that could be further added.<sup>7</sup>*

*In order to stay within this limit we have to leave the vast majority of the remaining conventional oil, coal and gas in the ground. Estimates vary significantly, but remaining conventional coal reserves alone are well over 500GT of carbon.<sup>8</sup>*

### Carbon Capture and Storage (CCS)

It has been estimated that CCS could only reduce CTL carbon emissions by a maximum of 50%, so they would still have high greenhouse gas emissions.<sup>12</sup>

There are also numerous critical problems with CCS itself, which remains a largely unproven technology, especially at the enormous scale that would be required (see CCS factsheet).

*Proponents of unconventional fossil fuels often argue that with CCS technologies, these new energy sources could be exploited at the same time as reducing GHG emissions. However, even if the huge problems with CCS technology are overcome (and this currently looking extremely unlikely), it would not change the fact that we need to move away from*

*all forms of fossil fuel, conventional and unconventional, as soon as possible.*

*In the most optimistic (and highly implausible) scenario, CCS could be used to reduce a small proportion of emissions from fossil fuels. In reality, the promise of CCS being implemented in the future is being used to allow the continued expansion of fossil fuel production, to prevent alternatives from being developed, and to deflect attention away from approaches which tackle the underlying systemic causes of climate change and other ecological crises. Ultimately CCS is a smokescreen, allowing the fossil fuel industry to continue profiting from the destruction of the environment. (see 'Carbon Capture Storage' factsheet for more information).*

## OTHER SOCIAL AND ENVIRONMENTAL ISSUES

Converting CTL fuel consumes large amounts of water and creates substantial amounts of contaminated waste water and solid waste.<sup>13</sup>

A Greenpeace investigation into a Coal to Liquids plant in Ordos, China run by the company Shenhua, revealed how the project required 10 tons of fresh water to produce just 1 ton of end-product, while at the same time producing 9 tons of carbon dioxide and 4.8 tons of waste water (1 ton = 0.9 tonnes).<sup>14</sup> The investigation also found a dramatic effect on local ground water levels, seriously impacting local farmers. Despite claims by the company of a “zero-discharge system” and that “the actual number of pollutants entering the water cycle is zero”, independent analysis of waste water leaking into the environment found high levels of harmful substances including carcinogens.<sup>15</sup>

A further problem with coal and gas to liquid technologies is that they require increased coal mining and natural gas extraction, with all the associated social and environmental problems.



The Sasol coal-to-liquids plant in Secunda

## WHERE, HOW MUCH AND WHO?

The South African energy and chemical company Sasol has a number of CTL and GTL projects around the world. As well as plants in South Africa (where CTL provides about 30% of the country’s gasoline and diesel),<sup>16</sup> there are coal or gas to liquid projects in the US, Qatar and Uzbekistan. China is rapidly developing its coal to liquids capacity,<sup>17</sup> and has the largest CTL plant in the world in Inner Mongolia, run by state coal company Shenhua.<sup>18</sup>

Other companies with significant interest in CTL/GTL technologies include Shell, Exxon, Statoil, Rentech and Syntroleum<sup>19</sup>. Shell is currently building the largest GTL plant in the world, in Ras Laffan, Qatar.<sup>20</sup>



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Ruins of a German synthetic petrol plant in Police, Poland

**For information on resistance see the Corporate Watch website ([corporatewatch.org/uff/resistance](http://corporatewatch.org/uff/resistance))**

## ENDNOTES

- 1 See here for examples: <<http://www.chemlink.com.au/gtl.htm>>
- 2 Jeff Logan and John Venezia. 'Coal to Liquids, Climate Change, and Energy Security'. *World Resource Institute*, May 2007. <[http://www.rand.org/content/dam/rand/pubs/monographs/2008/RAND\\_MG754.pdf](http://www.rand.org/content/dam/rand/pubs/monographs/2008/RAND_MG754.pdf)>
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- 5 Op cit (Farrell et al 2006)
- 6 Hansen, James, Pushker Kharecha, Makiko Sato, Valerie Masson-Delmotte, Frank Ackerman, David J. Beerling, Paul J. Hearty, et al. 'Assessing "Dangerous Climate Change": Required Reduction of Carbon Emissions to Protect Young People, Future Generations and Nature'. Edited by Juan A. Añel. *PLoS ONE* 8, no. 12 (3 December 2013): e81648. doi:10.1371/journal.pone.0081648. <<http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0081648>>
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- 8 Ibid
- 9 Op. Cit. (Farrell et al 2006)
- 10 1ppm is roughly equivalent to 2.12 Gt. Op. Cit. (Hansen et al 2013)
- 11 Op cit (Farrell et al 2006)
- 12 Ibid
- 13 Sonja Nowakowski 'Coal to Liquids Water Usage'. *November 8 ETIC meeting* (2007) <[http://leg.mt.gov/content/committees/interim/2007\\_2008/energy\\_telecom/assigned\\_studies/coal2liquidpage/Coal2liquidone.pdf](http://leg.mt.gov/content/committees/interim/2007_2008/energy_telecom/assigned_studies/coal2liquidpage/Coal2liquidone.pdf)>
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- 15 Ibid
- 16 'Coal to Liquid, Liquid Fuels'. *World Coal Association*. Accessed 8 March 2014. <<http://www.worldcoal.org/coal/uses-of-coal/coal-to-liquids>>
- 17 'Coal Emerges as Cinderella at China's Energy Ball'. *FT.com*. Accessed 8 March 2014. <<http://www.ft.com/cms/s/2/b3dff99a-b2a0-11e2-a388-00144feabdc0.html#axzz2kX8ZWWmy>>
- 18 'Institute for Energy Research' *China's Coal to Liquids Program Not Allowed in the United States*. Accessed 8 March 2014. <[http://www.instituteforenergyresearch.org/2011/06/28/china%E2%80%99s-coal-to-liquids-program-not-allowed-in-the-united-states/#\\_edn5](http://www.instituteforenergyresearch.org/2011/06/28/china%E2%80%99s-coal-to-liquids-program-not-allowed-in-the-united-states/#_edn5)>
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A GUIDE TO UNCONVENTIONAL FOSSIL FUELS

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