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Coal-To-Liquids Technology - A Platts.com news feature

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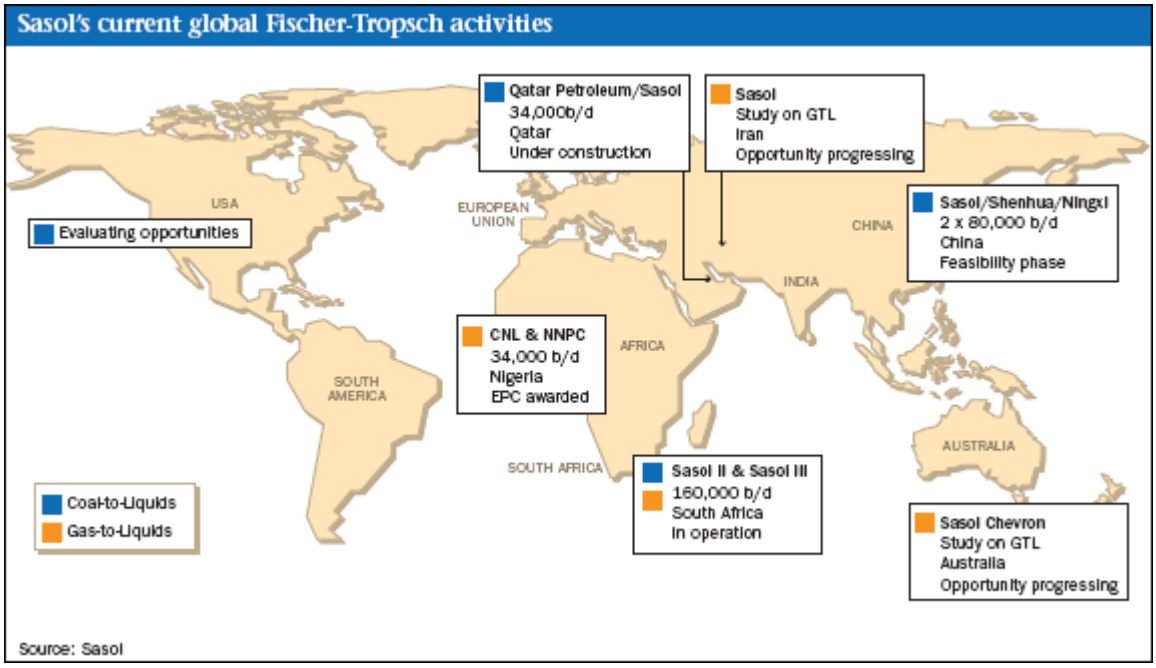

China's alchemists turn coal into black gold

Coal-rich and keen to curb its rising dependence on imported oil, China is playing a leading role in promoting decades-old coal liquefaction technology. Three large-scale projects have been sanctioned and dozens more are in the offing.

China's **National Development and Reform Commission**, the country's top economic planning body, expects alternative-energy projects like coal liquefaction to save 38 million tons of annual oil consumption during the Eleventh Five-Year Plan period, which runs from 2006-2010. This is equal to around 10% of China's total projected oil demand in 2010. The aim is to find a use for the country's abundant reserves of high sulfur coal, which are unsuitable for burning in power stations, while at the same time reducing the country's growing dependence on imported crude oil.

Just ten years after becoming a net oil importer, China's reliance on imported oil reached 40% in 2004, and held there for 2005. Moreover, China's domestic oil production is forecast to plateau, while demand for crude is expected to grow. Oil currently provides around 20% of China's total primary energy consumption.

By contrast, China has the world's third largest recoverable coal reserves after the US and Russia, up to half of which are high in sulfur. Coal is already the country's number one source of energy by a large margin, meeting about 70% of energy demand. The other 10% of the country's energy needs are met mostly by hydroelectricity and natural gas.

Coal liquefaction converts low-quality coal into synthetic oil products, such as methanol and dimethyl ether removing much of the polluting sulfur in the process. Methanol can be used directly as a fuel or further converted into gasoline, while DME, currently used as a propellant in aerosol spray cans, can be

handled like liquefied petroleum gas for power generation, as a substitute for diesel and LPG or as a synthetic gasoline.

Top ten countries by recoverable coal reserves (million short tons)		
1	United States	267,312
2	Russia	173,074
3	China	126,215
4	India	101,903
5	Australia	86,531
6	South Africa	53,738
7	Ukraine	37,647
8	Kazakhstan	34,479
9	Serbia and Montenegro	18,288
10	Poland	15,432

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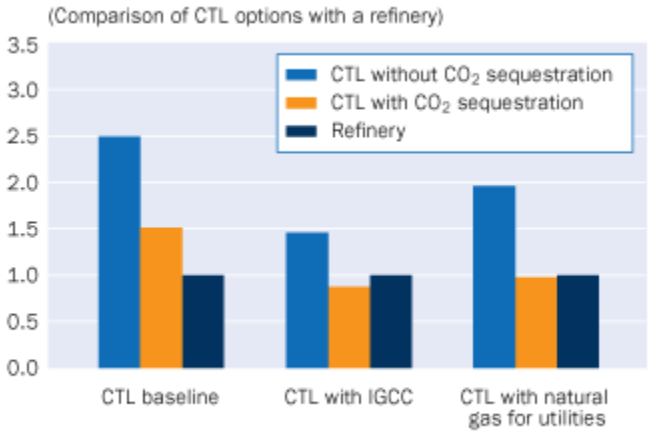


Source: Sasol

China's path to commerciality

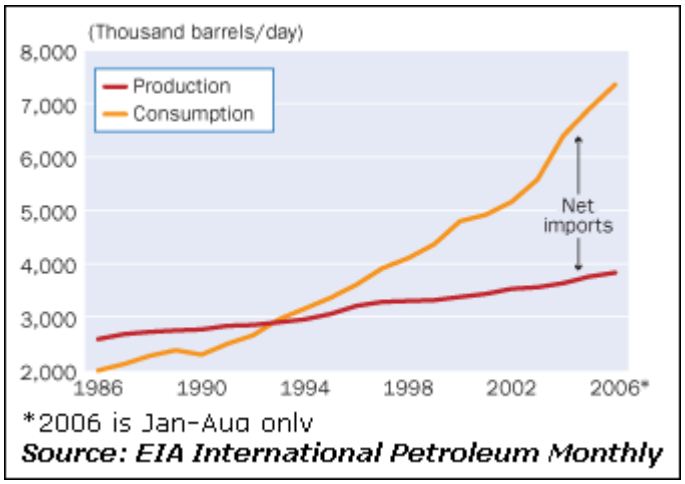
China began to turn its attention to upgrading coal liquefaction technology in the early 1980s, when it first began to import oil and the government realized that its days of self-sufficiency were numbered. One of China's early research efforts on coal liquefaction was the development of methanol-to-olefin technology, which was taken up in 1981 by the **Dalian Institute of Chemical Physics**, a division of the Beijing-based **Chinese Academy of Sciences**. Around the same time, in northern China's coal-rich Shanxi province, the country started to look to methanol in combination with gasoline as a transportation fuel. China became a net oil importer in 1993, and two years later, the government announced that its methanol-to-olefin technology had successfully passed the experimental stage, and industrial trials followed.

However, while experiments in the downstream conversion of coal liquids into usable products have proven successful, China's first primary coal liquefaction plants did not work as smoothly as expected. In Pingdingshan, in central China's Henan province, a 500,000 metric tons liquefaction plant launched in 1999 failed when local coal proved to have too much sulfur and ash content to be suitable for liquefaction.

Nevertheless, in 2001, under a project code named the '863 program,' the government increased its involvement in funding high-tech coal liquefaction research projects. In 2003, China overtook Japan as the world's second largest oil consumer behind the US. In addition, oil prices started to rise, adding even greater impetus to the development of upstream coal liquefaction projects.

The NDRC established in 2004 an Energy Bureau to focus on national energy security issues and to plan and manage the country's energy supply and related industrial development. A year later, the NDRC issued China's medium-and-long-term energy development strategy, which highlighted ten key projects to complete in the country's eleventh Five-Year-Plan period. Among them is the development

of alternatives to oil, through specific measures such as speeding up coal liquefaction projects.



The NDRC kicked off a new generation of CTL projects in China when in 2004 it assigned Shenhua Group, the country's largest coal producer, a project to build a coal liquefaction plant in northern China's Inner Mongolia Autonomous Region. The project has a designed annual production capacity of 5 million tons (100,000 barrels/day) of oil equivalent output. The first phase is intended to bring on stream annual production capacity of 1 million tons of oil equivalent output by 2007. The second phase, raising the project to its full design capacity, is tentatively scheduled for completion by 2010. Shenhua-I, when completed, will be the first 'direct liquefaction' plant in the world.

In 2005, Shaanxi province also pushed the country's methanol-to olefin technology forward when it signed a contract with one of Sinopec's local subsidiaries and the Chinese Academy of Sciences to build a dimethyl ether/methanol-to-olefin demonstration plant in the province. The plant started trial operations at end-2005. With a designed annual capacity of 15,000 tons of methanol the plant is believed to be the world's largest scale DMTO project to date. In August, based on "satisfactory" trial operation performance, China announced that its MTO technology was ready for large-scale industrial application.

In early 2006, the NDRC gave approval for two other domestic coal producers to embark on coal liquefaction projects. The Lu'an Group's demonstration plant in northern China's Shanxi province has a designed annual production capacity of 160,000 tons of oil equivalent to be completed by 2008. The company has also announced a plan to build up its coal liquefaction capacity to 5.2 million tons of oil equivalent by 2016. The third coal liquefaction plant is Yankuang Group's ambitious project in Northwest China's Shaanxi province, with a designed annual capacity of 10 million tons of oil equivalent to be completed by 2020. Yankuang's plant will produce the equivalent of 200,000 barrels per day of oil products, in line with the daily crude oil throughput of a good-sized oil refinery and bigger than most of China's existing refineries.

With the Chinese government willing to commit large resources to coal liquefaction research and development, CTL technology and processes are expected to develop quickly. Currently, there are two ways to liquefy coal. The first, direct coal liquefaction, involves combining a solvent with pulverized coal under high pressures and temperatures to create a heavy liquid called 'syncrude'. Most of the coal's hydrocarbon structure is broken down in a first-stage reactor. Liquefaction is completed in a second reactor, in which intermediate coal liquids can be upgraded using conventional refining techniques to

produce gasoline, jet and diesel fuels.

The Lu'an and Yankuang projects are based on indirect coal liquefaction. This process involves the gasification of coal to produce 'syngas', a mixture of carbon mono-oxide and hydrogen. The syngas is then subjected to a catalyzed chemical reaction to produce liquid hydrocarbons and methanol. It is expected that the processes employed have scope for substantial improvement through the use of new catalysts and as experience is gained on such large scale projects.

While only three coal liquefaction projects have been officially approved by the NDRC, at least one report this year by state-run newspaper China Daily said that about 30 other **projects** were either in detailed planning stages or undergoing feasibility studies. Together these projects represent an estimated investment of Yuan 120 billion ($15 billion), and a combined annual production capacity of 16 million tons (320,000 barrels/day) of oil equivalent.

Shenhua alone has announced a plan to develop annual capacity of 1 million tons by end-2007, rising to 5 million tons in 2010 and 15 million tons in 2015, before reaching 30 million tons in 2020. Zhang Yuzhuo, deputy general manager of Shenhua, has been quoted in local Chinese media saying that the company will spend Yuan 200 billion on coal liquefaction projects over the next 15 years.

Speaking to state-run news agency Xinhua, Zhang estimated that construction costs in China would be around 65% of those in the US. One factor that may fuel a CTL boom in China is cheap labor. A project with 1,000 workers would pay an average annual salary of Yuan 80,000 ($10,000), compared with typical average salaries of $80,000 for such a project in the US. China's coal prices are cheap too, Zhang said, pegging typical mine head prices at around Yuan 100/mt ($12.50/mt), close to a benchmark value of Yuan 90/mt that many companies in China are thought to use when conducting feasibility studies for coal liquefaction projects. Domestic coal prices have doubled over the last three years, but Zhang argues that this is mostly a product of rapid growth in transportation fees, while the price at the mine head has remained steady.

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Challenges lie ahead for CTL in China

CTL projects face big challenges, even in China where they have strong government backing and are seen as being at least as much a strategic investment as an economic one. The key issue over feasibility of coal liquefaction in China remains the intensive capital cost involved. According to Shenhua, for instance, building a coal liquefaction plant with an annual capacity of 10,000 mt would require at least seven times the investment of an oil refinery or other petrochemical plants.

In an era when oil prices are highly volatile, building such a facility runs a big risk of becoming a stranded investment. Typically CTL projects take three to five years to complete, and are thought to turn a profit with oil valued at $30/barrel or higher. Other outstanding issues include reducing the environmental impacts of such projects, and some fairly big geographical restrictions on where such projects can currently be built.

Coal liquefaction plants use a lot of water, while most of China's coal-rich provinces are short of water, with the exception of Yunnan and Guizhou. One expert in the field, Yan Kefeng with **Cambridge Energy Research Associates**, said that coal producers often fail to take environmental limitations into account when doing their economic calculations on CTL projects, an oversight that might ultimately change the profitability of many projects.

The unpredictability of winning permits and approvals for all projects is also an important obstacle to getting these projects off the ground. Shenhua, for instance, is reported to have signed a Yuan 7.5 billion insurance policy to cover some of its CTL investments in case they don't win final clearances as they prepare to move into production.

With so many issues to solve and so many projects under planning, the NDRC has positioned itself at the center of the CTL debate in China. In July, it issued a circular to require local governments to tighten controls over new coal liquefaction projects before a national blueprint for the coal liquefaction industry is completed. In particular, the NDRC will not approve any projects with an annual capacity under 3 million metric tons.

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South Africa's Sasol sees CTL potential in China

South Africa's synthetic fuel producer **Sasol** is preparing to conduct second-stage feasibility studies of two coal-to-liquids plants in China, after findings of the first-stage feasibility study pointed to economic viability of the projects, a company official said in November. President of Sasol's China ventures Andre de Ruyter told participants of the Hart World Refining and Fuels conference in Beijing that the two plants, each with a nominal capacity of delivering 80,000 b/d (about 3.6 million mt/year) of liquid fuels, are proposed to be built in northern Shaanxi province and the Ningxia Hui Autonomous Region, both key coal producing areas in China. Each plant is expected to cost more than $5 billion.

He said the two plants would use Sasol's propriety low-temperature **Fischer-Tropsch** chemical conversion technology which yields only diesel. The technology is especially apt in the mainland market which relies heavily on diesel. According to the Sasol official, China's gasoline-to-diesel yield ratio is 1:2.29, yet conventional crude refining generally gets a ratio of 1:1. Two-thirds of the output slate of the two China plants will be diesel, with the remainder make up of naphtha and liquefied petroleum gas, Ruyter noted. That would mean the plants could produce about 4.8 million mt of diesel a year, equivalent to 4.34% of China's total diesel production of 110.62 million mt in 2005.

Should these projects obtain final approval from the Chinese central government and go ahead, they could be brought into operation in 2013. On the sidelines of the conference, the Sasol official said the second stage feasibility studies would be completed in 2007. The second stage feasibility studies will go into detail in determining capital cost, feedstock cost, water supply and market conditions and will also determine most of the major commercial and funding issues. The Chinese government has appointed the country's major coal producers, Shenhua Group and Ningxia Coal Industry Group to cooperate with Sasol in the two coal-to-liquids plants.

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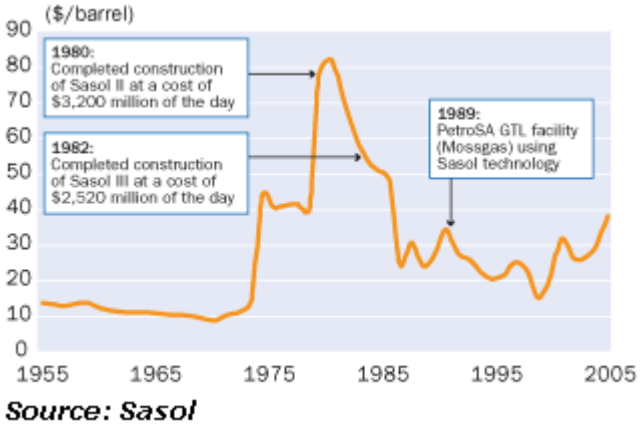
Sasol cashes in on coal-to-liquids technology

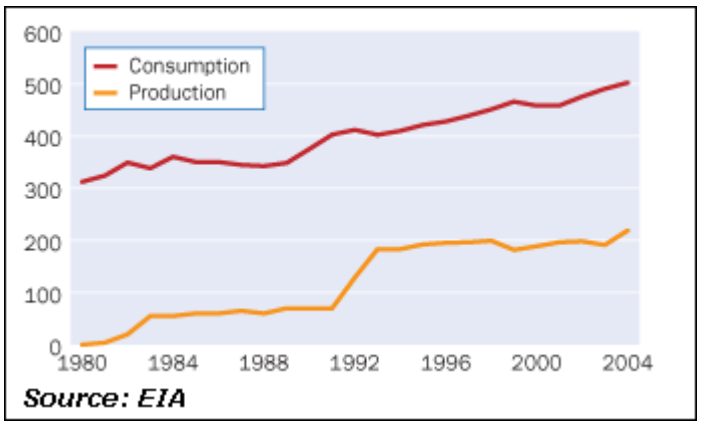


The world's scientists are beating a path to South Africa to discover more about coal-to-liquids producer **Sasol**. But Sasol faces challenges on the domestic front and South Africa is already feeling the impact on its coal industry of the competing claims of power and fuel. Moreover, CTL is another carbon emitting industry, that is ultimately reliant on the dubious promise of carbon capture and storage.

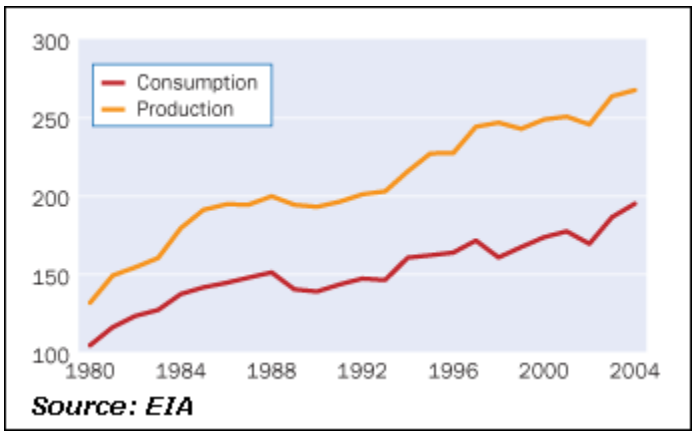
The coal-to-liquids industry is dominated by the entrenched power of South Africa's Sasol, the world's only commercial producer, which turns out about 150,000 b/d of crude at its Secunda plant, using 41.8 million tons a year of coal from its own mines. This provides a ratio of just over one ton of coal to make one barrel of oil product. SASOL Mining also produces enough coal to export 3.6 mt/yr from its nine coal mining operations across the country. It estimates that a CTL plant needs to secure between two to four billion tonnes of low cost coal reserves to sustain it.

High oil **prices** and security of supply have historically been the twin drivers of CTL technology. Two German scientists, Franz Fischer and Hans Tropsch, pioneered CTL in the 1920s, creating the **Fischer-Tropsch** synthesis process. Faced with a lack of access to oil during the Second World War, Nazi Germany developed 25 CTL plants to fuel its war machine. With the end of WWII again allowing the unhindered distribution of oil across war torn Europe, the technology migrated to a new home in South Africa.

Quick to recognize the country's lack of oil resources, politicians in Cape Town had tabled a white paper in parliament arguing the case for CTL as early as 1927, but it was only in 1950 that the Fisher-Tropsch process took root with the foundation of the state-run South African Coal and Gas Corporation, later renamed Sasol. South Africa was encouraged to pioneer CTL by the combination of threat and promise. The threat sprang from the establishment of apartheid by the nationalists in the late 1940s. The government rightly feared international sanctions and needed a secure supply of fuel to power both an expanding economy and the mechanized armed forces needed to prop up the apartheid regime.



The promise was the bountiful supply of cheap coal. South African coal is among the lowest priced internationally and the country boasts the world's sixth largest recoverable coal reserves at just under 54 billion short tons. In addition, Sasol Lurgi gasification technology means lower quality coal can be used in the CTL process, including lignite. Steep international oil prices and security of supply concerns have again stimulated huge interest in alternative energy sources, not just in South Africa but globally, and scientists from all over the world are now queuing up to share in Sasol's CTL technology.



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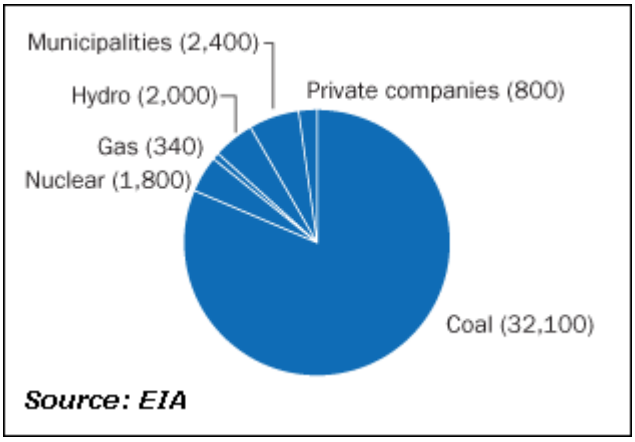
Domestic tribulations for Sasol

Sasol is a big player in the South African economy and claims to contribute R35 billion ($4.9 billion) to GDP and R16 billion to state coffers in company taxes and levies. Since 2002, the company has spent R40 billion on domestic capital projects. Sasol produces both gasoline and diesel and says it has turned out an estimated 700 million barrels since the early 1980s. The company has a market capitalization of $15 billion dollars and employs 31,000 workers in facilities in Africa, the Middle East, Malaysia, the US, Germany, Italy and the Netherlands. It has ambitious international expansion plans, but at the same time faces critical scrutiny from the state in its domestic market.



The government has two faces when it comes to dealing with Sasol. In November, the Minerals and Energy Minister Bulelwa Sonjica smiled on Sasol's plans for a new plant that would double CTL output, increasing production from 150,000 b/d to 300,000 b/d, saying that it was an important step in developing the country's energy security. Sasol already satisfies at least 28% of South Africa's energy needs with its synthetic fuel.

However, at the same time, the South African Treasury is threatening this very kind of investment by announcing that in February it will unveil plans for new taxes on the CTL industry. The idea is to claw back for the state some of the large profits made by Sasol, accompanied by a vague intention of using the funds to keep down domestic fuel prices. Once a land of cheap energy, fuel prices have become a highly contentious issue in South Africa as pump costs have soared. Some economists predict that rising fuel prices could derail the government's 2006 target of 6% GDP growth.

The windfall profits that the government hopes to harvest are a result of high international oil prices. Sasol gets the same price for its CTL fuel as for oil based fuel. This year, Sasol reported a massive 45% increase in annual pre-tax profits to R20 billion, nearly three billion dollars. A tempting target, and the South African government would hardly be the first to plunder the coffers of a rich state-owned company.

The breakeven price for a barrel of Sasol CTL fuel depends upon whom you ask. Some analysts put it at $20-22/barrel. John Sichinga, manager of CTL development at Sasol Synfuels International, is more conservative and puts the breakeven figure at $40/barrel in a low capital cost environment with good quality coal, or $50/barrel where there are high capital costs and poor quality coal. Whether at $20 or $40/barrel for the Secunda plant, Sasol's financial returns indicate it is making good money.

The Treasury argues that the windfall tax would be beneficial for the country and would not hurt the industry, but most analysts disagree and Sasol is fighting the proposals with submissions to parliament, arguing that such a tax will not solve the problem of high fuel prices. Several tax formulas have been discussed, but neither Sasol nor the government is sure how the tax would be levied. What is clear is that the Treasury will announce its decision in its budget statement in February.

Sasol CEO Pat Davies says, "Sasol has presented its case to the task team, stating the undesirability of a windfall tax for the company and the country as a whole, as this would create investor uncertainty and not support the government's stated fiscal and energy policy objectives to reward beneficiation. We also conveyed the message that we believe the time is right for a dialogue between government, Sasol,

and other stakeholders to map a way forward to secure additional local liquid fuels production for South Africa."

Tony Twine, an economist with consultants Econometrix in Johannesburg sees a risk to inward investment and Sasol's plans for investment in South Africa. "I think the tax is a very poor signal to foreign investors. What it says to companies is that if you come here and make too much profit we are going to take it away from you. I think the government will impose the windfall tax, the severity of it is still very much up in the clouds. If it is very high, no one can blame Sasol if it decides not to invest in South Africa."

Terence Creamer, deputy editor of South Africa's Engineering News, also sees the windfall tax as being at odds with other stated government priorities: "There is a serious and very solid argument that security of supply is more important than a tax. It is a compelling case, this country is importing more and more refined product to keep up with the growing demands of industry. In most countries energy operations are given incentives instead of taxes. Sasol is saying that it is being wooed by countries like China to go and partner them in CTL projects, while at home they are facing new taxes. It is very ironic."

In the past, the South African government has offered tariff protection and a fuel levy to help protect the growing synfuels operation, but the free market philosophy of the present government now makes any such interventions highly unlikely.

Black empowerment

Sasol is also in danger of falling foul of the government as it struggles towards black empowerment. The empowerment drive is a main plank of government policy and is aimed at redressing the imbalances caused by apartheid by transferring a large slice of ownership of business into the hands of the bereft black majority. What it amounts to is handing over a chunk of white-owned businesses at a discount to black owners. However, it is proving a tricky policy to implement, plagued by a shortage of suitable empowerment partners, deals that fall through and conflict before and after deals are struck.

Reg Rumney, an independent black empowerment consultant in Johannesburg, said, "There is little love lost between Sasol and the government on this one, it has always been seen as a white-run leftover from apartheid. Now, because it is so big and powerful, there is increasing pressure on the company to transform." This pressure is being taken seriously by Sasol, which knows the goodwill of the government is the key to expansion in South Africa. The company understands that it has a lot of expensive changes to make.

Sasol spokesperson Marina Bidoli admits that so far the main company has no black ownership, but says that new equity transactions are expected. She says that subsidiaries of Sasol have black empowerment stakes, but it is not clear whether these count. Sasol is waiting for a new set of Black Economic Empowerment codes, due to be published shortly, to see if it has improved its position. The stakes include a holding by the PIC government pension fund and 25% in Sasol Oil held by empowerment company Tshwarino, run by former justice minister Penuell Maduna.

Peter Leopeng, an independent coal analyst with Palenque Energy Services, says, "Having someone like Maduna involved will help Sasol. He is still on the ruling ANC's national executive where policies and decisions are discussed before they even go to parliament." Bidoli said that Sasol has also increased both procurement from black empowerment companies and the promotion of black managers. Both score points in the assessment of black empowerment. The company also claims that 60% of its executive board members are black.

International investors consider CTL schemes

Concerned with security of oil supplies, both in terms of price and availability -- whether as a result of energy demand growth or supply-side disruptions -- many countries are clamoring for South African technology to start up their own CTL operations.

With coal as its main energy resource, China is the latest country to buy in Sasol technology. China has the world's third largest recoverable coal reserves and plans a $6 billion investment in two CTL plants, each of which is expected to produce around 80,000 b/d by 2012, helping to reduce the country's ballooning crude oil imports by at least 55 million barrels a year. One will be in Shaanxi province and the other in the Ningxia Hui autonomous region. India has the world's fourth largest coal reserves, and like China is relatively poor in oil and gas, while the United States has the world's largest coal reserves and is heavily dependent on imported oil. Both are interested in South African CTL technology.

"We foresee a rebirth in coal utilization in some of the world's coal-rich regions. This case is particularly strong in those countries that have insufficient or no oil reserves, such as Australia, India, China and the US, as well as South Africa," Davies wrote in Sasol's 2006 annual report. However, surprisingly, CTL production is relatively underdeveloped in the United States. The US Department of Energy says it has put up $4.3 million towards the creation of two CTL plants. The department has also allocated $62.4 million to help set up 32 clean coal research projects.

The thirst for experience and technology among US scientists has lead many of them to South Africa. One is Professor Harold Schobert, a visiting academic at North West University, who has been studying coal chemistry for more than 30 years and is on an advisory board for Sasol. He says that Pennsylvania is looking into a CTL plant, but has yet to break ground on the project, while Montana is also looking at building a plant using South African technology. Plans, however, are still at the talking stage. "I don't think coal to liquids will attract serious investors who will put up big money until they are confident that oil prices will be high for a very long time to come," Schobert said. "Investors need to be sure, because it takes years to build one of these plants and they are a big investment. I think there is going to have to be an intervention by government to invest in the first major plant."

Nevertheless, elsewhere investors are considering CTL schemes. In November, mining giant Anglo American, with its new chief executive designate and former Alcan boss Cynthia Carrol, announced that it will pursue fuel from coal. Anglo is looking into a Sasol-type CTL plant in a joint venture with international oil major Shell. The company is studying the $4 billion dollar Monash project in Australia, which envisages mining brown coal to supply a 60,000 b/d CTL plant with CO2 capture and storage in depleted oil reservoirs in the Bass Strait.

Clean fuels, dirty air

Schobert also said there were increasing concerns in the United States about carbon dioxide emissions from the CTL process and said scientists were working on cleaner ways to dispose of the CO2. The Fischer-Tropsch process passes steam and oxygen over coke at high pressures and temperatures; the resultant hydrogen and carbon monoxide are then reassembled into the liquid fuel. In the process, sulfur and other pollutants such as ash and mercury are removed. The sulfur can be sold as a by-product, but the process releases carbon dioxide. As with coal in power generation, CTL's environmental credentials are ultimately dependent on the uncertain promise of carbon capture and storage. Advocates promote its creation of clean burning fuels, but are much less vocal about the CO2 emissions that result from the synthesis process.

Schobert says that one possibility is to inject CO2 into oil well reservoirs, as a means of enhanced oil recovery, while a second possibility would be to inject CO2 into coal seams to displace methane that

can cause explosions. So far, Sasol admits that all of the CO2 produced from its Secunda plant is vented into the atmosphere. However, the company pledges that no new plants will be built without carbon capture. South Africa is classed as a developing country under the Kyoto Protocol and is therefore largely exempt from emissions reduction targets.

Fuel versus power

However, experts question whether every country that desires a CTL industry has the ability to create one. Coal availability is the first issue. Regarding the import of coal for CTL processing, Sichinga said, "The cost of importing the coal would probably make it prohibitive." In addition, Econometrix's Twine points out that "if you are worried about the shortage of fuel you could import coal for CTL, but all you are doing is moving the fate of your country from the hands of the oil producers to the hands of the coal producers."

Of equal importance is the quality of coal. Sichinga says, "if good quality coal was available, it would require about 0.5 tonnes of coal for a barrel of product. Therefore, a world scale plant of around 80,000 b/d using good quality coal would require around 15 to 18 million tonnes of such coal per year and a reserve of around a billion tonnes. A sizeable 500,000 b/d industry would require in the order of 100 million tonnes of coal per year and coal reserves of around six billion tonnes. Sasol, for its Secunda facilities, mines less than half of this amount."

Even in a coal-rich country like South Africa, competition between CTL and traditional coal use for **power** generation is creating potential conflicts. Sasol says that demand for CTL can be satisfied without disturbing the balance of the coal market. However, all of this activity around CTL, combined with the promise of more exports from the country's Richards Bay Coal Terminal, is likely to put strain on South Africa's finite coal resources and infrastructure. RBCT plans to increase its export capacity from 72 million tons per year to 91 mt/yr by 2008 to give black empowerment coal producers more opportunity to ship quality coal to lucrative export markets, mainly in Europe.

Professor Rosemary Falcon, a Johannesburg-based palynologist who has spent nearly 40 years studying the coal industry in Africa, says that there is a real danger that South Africa could soon find itself suffering from a dearth of quality coal. Falcon said the last load of top quality blended export coal, so called "sweet coal", with just 7% ash content, went through RBCT in 2000 and now poorer grades of 12% and 15% ash content are being exported. She believes that South Africa may have a mere 20 to 40 years worth of top to medium grade coal left.

"The best quality coals are fast being used up and what coals we have left are definitely being competed for. The biggest competition is going to be between Eskom [the state-run power generating company], Sasol and export, that leaves behind the little brothers in the industry. There are about 8,000 boilers running most of our industries in this country and I fear for them, financially the competition is going to make it very difficult for them," she said.

Leopeng agrees: "I think the competition for coal is really going to get tough. I think it will be a heavy competition between CTL and power generation. I think power generation is going to win. The government is under pressure to keep up power generation after embarrassing blackouts in the last year and it seems that coal-fired power stations are a big part of this, so I think that is where the coal is going to go. The government is likely to say that it can still import crude oil to make up for any shortfalls in CTL."

The future of CTL looks brighter now than at any time before, but just as South Africa has led in its technological development, it may also be the first to experience the clash for resources inherent in the

dual use of coal for power generation and fuel. In addition, while Sasol may seek to escape its domestic difficulties by exploiting its technological lead abroad, CTL for the moment offers an avenue towards energy security, but with uncertain environmental safeguards. It is not a clean coal process and carbon capture and storage's commercial viability is some way off, if it is ever to be realized at all.

CTL -- clean fuel, big emissions

Sasol says that it recognizes the impact its operations have on the environment and in 2005 agreed a group-wide target of a 10% reduction in greenhouse gas emissions per tonne of product by July 2015, using 2004 as a baseline. The emissions per tonne of product formula anticipates a large increase in GHG emissions as CTL production expands. It intends to achieve its target by using more carbon efficient feedstocks at some existing facilities and at new production facilities, such as the use of natural gas at the Oryx gas-to-liquids facility in Qatar. In addition, it is looking at improved carbon management in the design of new facilities and investigating opportunities for carbon capture and storage as part of its planned international expansion of CTL.

In its Sustainable Development report published on December 7, Sasol said that its total emissions of methane and carbon dioxide, including indirect emissions, increased from 74.6 million tonnes in 2005 to 75.4 mt in 2006. The company's carbon intensity -- the number of tonnes of CO2 equivalent per tonne of product -- fell from 3.09 in 2005 to 3.04 in 2006, primarily as a result of switching to natural gas use at its Sasolburg facility and improving plant stability at its Secunda CTL plant. The company admits that its proposed CTL ventures in China "could potentially have significant implications, in the long run, for our commitment to reduce carbon intensity."

Sasol has undertaken a study of the lifecycle emissions from CTL compared with gas-to-liquids and standard refinery technology. The results show, unsurprisingly, that CTL is "significantly more GHG intensive than the refinery or GTL options." In fact, the study shows that CTL creates more than double the emissions of a traditional refinery process. The study includes options which improve CTL's performance relative to a normal refinery. These are using the tail gas from the process to generate electricity, using Integrated Gasification Combined Cycle technology, and sourcing the power used in the CTL process from natural gas plants rather than coal.

In addition, CTL produces CO2 in a concentrated form that lends itself to CCS. However, even if CCS is assumed -- and it's a big assumption -- emissions are still larger than a traditional refinery based on Sasol's well-to-wheels analysis. According to the study, CTL's environmental performance can only be brought significantly below that of a traditional refinery if CCS, IGCC and gas-based power are all brought into the equation.