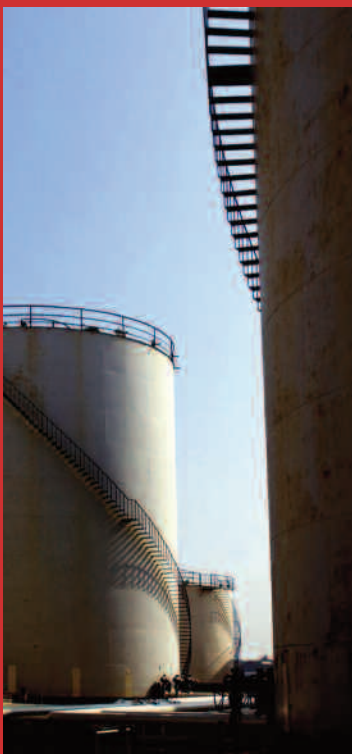




Meeting future demand for oil -  
considering alternatives to  
biofuels -  
A Greenergy perspective

This Perspective suggests that, from a carbon perspective, rather than comparing biofuel with petrol or diesel derived from conventional oil reserves, it may be more accurate instead to compare biofuels against the marginal world oil production, being the new and more energy intensive sources of crude oil such as Canadian oil sands that are now being developed.



## Summary

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Greenergy is a significant producer and supplier of petroleum and biofuels into the UK transport fuels market, supplying over 15% of the UK's overall petrol and diesel market and approximately one third of the biofuels market. The company has extensive worldwide sourcing experience, with manufacturing operations in the UK and a blending facility in Rotterdam from which we supply customers across Europe.

In this Perspective, Greenergy presents the following:

- The overall aim of biofuels is to reduce whole of life CO<sub>2</sub> emissions compared to their petroleum alternative.
- In calculating their carbon benefit, biofuels are usually compared with petrol or diesel made from conventional sources of crude oil.
- However, world demand for crude oil is set to increase further over the next twenty years and those crude oil reserves which are easiest to find, extract and refine are already heavily explored.
- As resources are further depleted, new crude oil reserves are increasingly heavy with higher sulphur content and are therefore more energy intensive to extract from the earth and then refine.
- Much of the investment in new crude oil reserves is in oil sands. These generate high levels of CO<sub>2</sub> emissions due to the energy intensive production processes required to extract the oil. Petrol and diesel derived from oil sands is around three times more carbon intensive than petrol and diesel derived from crude oil.
- In Canada, one of the world's largest producers of oil sands, there has been a steady increase in CO<sub>2</sub> emissions over the last ten years. The single largest contributor to this growth is oil sands.
- Rather than comparing biofuel with petrol or diesel derived from conventional oil reserves, it may be more accurate instead to compare biofuels against marginal world oil production, being the new sources of crude oil such as oil sands that are now being developed and which biofuels would displace at the margin.

# 1 Background

## Perspective

When comparing the carbon benefits of biofuels with those of petroleum fuels, biofuels are usually benchmarked against diesel or petrol produced in typical oil refineries from the most common forms of crude oil. But at the margin biofuels will replace other, newer sources of crude oil such as oil sands which are more energy intensive to exploit.

The main rationale of biofuels is to reduce whole of life CO<sub>2</sub> emissions compared to the petroleum alternative. Therefore the most effective biofuels are those that rank most highly relative to their petroleum equivalent.

There are several ways of calculating carbon savings, with varying degrees of detail. The UK's Renewable Transport Fuels Obligation gives default figures as a simple way of comparing various common biofuels. These give the following values:

**Table 1:** RTFO default factors for biofuel feedstocks.

Product	Carbon intensity (gCO <sub>2</sub> e/MJ)	% saving relative to petroleum diesel or petrol equivalent (conventional basis)
Sugar cane bioethanol	25	71
Sugar beet bioethanol	50	41
Rapeseed biodiesel (UK)	55	36
Soy biodiesel (US origin)	58	33
Conventional petrol	84.8	n/a
Conventional diesel	86.4	n/a

Source: Renewable Fuels Agency, Carbon and Sustainability Reporting with the RTFO, Technical Guidance, August 2008<sup>1</sup>

These comparisons tend to be against the average diesel or petrol production channel in the market that the fuels are being incentivised or consumed in (typically a modern oil refinery running on a commonly available base load crude oil).

Although this being the generally accepted methodology, Greenergy does not believe it gives a fair assessment of the true value of biofuels. This Perspective explains why it would be more appropriate to compare biofuels against marginal world oil production, being the new sources of crude oil that are now being explored and developed and which biofuels would displace at the margin.

<sup>1</sup> [http://www.renewablefuelsagency.org/\\_db/\\_documents/RFA\\_C&S\\_Technical\\_Guidance\\_Part\\_1\\_v1.2.pdf](http://www.renewablefuelsagency.org/_db/_documents/RFA_C&S_Technical_Guidance_Part_1_v1.2.pdf)

## 2 World product supply demand balance

### Perspective

High demand for crude oil has meant that those crude oil reserves which are easiest to find, extract from the earth and refine into products have or are already being heavily exploited. As demand for transport fuel continues to increase, so will the demand for crude oil and this surplus will need to be met by alternative sources of crude oil.

According to OPEC fossil fuels including oil, coal and gas will continue to provide more than 85% of the world's total energy needs to 2030.

**Table 2:** World oil demand outlook

Year	2006	2012	2015	2020	2025	2030
Million barrels per day	84.7	92.3	96.1	102.2	107.7	113.3

It is unlikely that rising demand for oil can be met by traditional crude oil sources alone. OPEC expects supply from non-conventional oil supplies to increase, with supply from biofuels production rising from 0.9 mb/d in 2006 to 2.7 mb/d by 2020<sup>2</sup>.

As time passes the type of crude oil being exploited is getting heavier and higher in sulphur and is increasingly coming from more sources which are more difficult to extract, such as oil sands and shale oils.

**Table 3:** Projected Canadian oil sands supply 2006 – 2025

Year	2006	2015	2020	2030
Million barrels per day	1.1	2.9	3.8	5.0

Source: OPEC World Oil Demand Outlook 2008<sup>3</sup>

<sup>2</sup> OPEC World Oil Outlook 2008 <http://www.opec.org/library/World%20Oil%20Outlook/pdf/Section%20One2008.pdf>

<sup>3</sup> <http://www.opec.org/library/World%20Oil%20Outlook/pdf/WOO2008.pdf>

### 3 Oil sands and oil shale

#### Perspective

The carbon emissions generated through processing oil sands is high because of the amount of energy required to extract, refine and convert the oil into petrol and diesel.

#### Oil Sands

Oil sands are a combination of clay, sand, water and bitumen, heavy black oil. They are mined and processed to extract the oil-rich bitumen which is then refined into oil. Unlike crude oil, bitumen oil cannot be pumped up to ground so has to be extracted by underground heating and recovery processes including steam injection to melt the bitumen followed by mechanical extraction and separation.

They are the heaviest and hardest to extract because they are solid tars mixed with rock and require substantial energy for melting and mechanical handling to be extracted as oil. Once the oil is extracted it is particularly heavy and requires even more energy in order to refine and convert it to lighter clean products such as diesel and petrol.

Oil sands are found in many places worldwide, but the largest deposits are found in Alberta in Canada, Venezuela and various countries in the Middle East<sup>4</sup>. Supply from Canadian oil sands is expected to grow from 1.1 million barrels a day in 2006 to almost 3.8 mb/d by 2020<sup>5</sup>.



The preceding photographs illustrate the scale of the extraction required for oil sands and give an initial impression of how much energy is required to extract the oil from these sands.

4 <http://ostseis.anl.gov/guide/tarsands/index.cfm>

5 <http://www.opec.org/library/World%20Oil%20Outlook/pdf/Section%20One2008.pdf>

## Oil Shale

Oil shale is sedimentary rock that contains solid bituminous materials that can be released as liquids when the rock is heated. These oil substances cannot be pumped directly out of the ground and therefore need to be mined, heated to extract the oil, and then refined. This process is more complex and expensive than conventional crude oil extraction and this has limited the development of the oil shale industry<sup>6</sup>.

Oil shale is found in China, Brazil, the USA and Estonia, but is not exploited on a large scale because of the high costs associated with extraction and refining. The largest known oil shale deposits are in the United States where there are an estimated 1.5 trillion barrels of reserves<sup>7</sup>.

The continuing depletion of crude oil supplies and increasing oil prices means that shale oils along with oil sands, could meet the demand for supplying some of the fossil energy needs of the world in the years ahead<sup>8</sup>.



Oil Shale - Image by US DOE

6 <http://ostseis.anl.gov/guide/oilshale/index.cfm>

7 "Unconventional Oil: Scraping the Bottom of the Barrel?" WWF, 29th July 2008

8 [http://emd.aapg.org/technical\\_areas/oil\\_shale.cfm](http://emd.aapg.org/technical_areas/oil_shale.cfm)

## 4 Extraction and refining costs

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### Perspective

As demand for fuel goes up across the world and as the easier crude oil to extract from the earth and refine into products is used up, oil prices have necessarily risen. This is because additional demand then has to be met by the heavier crude oils, oil sands and shale oils which are harder to extract and more expensive and energy intensive to process and which can only be produced in a higher price environment.

These kinds of oil sources are only economic when long term crude oil prices are over 60\$/bbl. This is because they require large amounts of energy to be used in their processing, to “melt” the heavy oils prior to separation from the sands.

In Canada, one of the world’s largest oil sands producers, there has been a significant increase in capital spent on oil sands over the last eight years:

**Table 3:** Canadian capital spent on oil sands (\$ billions)

2000	2001	2002	2003	2004	2005	2006	2007
4.2	5.9	6.8	5.0	6.2	10.4	14.3	18.1

Source: Canadian Association of Petroleum Producers<sup>9</sup>

If this increase in investment continues it will continue to adversely impact on Canada’s CO2 emissions and reduction targets.

9 <http://www.capp.ca/raw.asp?x=1&dt=NTV&e=PDF&dn=112820>

## 5 Marginal effect

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### Perspective

When compared to the marginal fuel production that they actually displace in the world, namely high cost fuels such as Canadian oil sands, biofuels are more effective in cutting greenhouse gas emissions than is normally claimed.

Oil sands are only economic when supplies of petroleum products are tight and crude oil prices are high. Thus as demand goes up, oil sands are the marginal source of additional product supply to meet demand. In this respect every tonne of oil biofuel produced reduces demand for petroleum products and results in less of a requirement to produce expensive oils sands to make up the deficit.

Therefore, biofuels should be benchmarked against high cost, high environmental impact oil sands rather than conventional fuels.

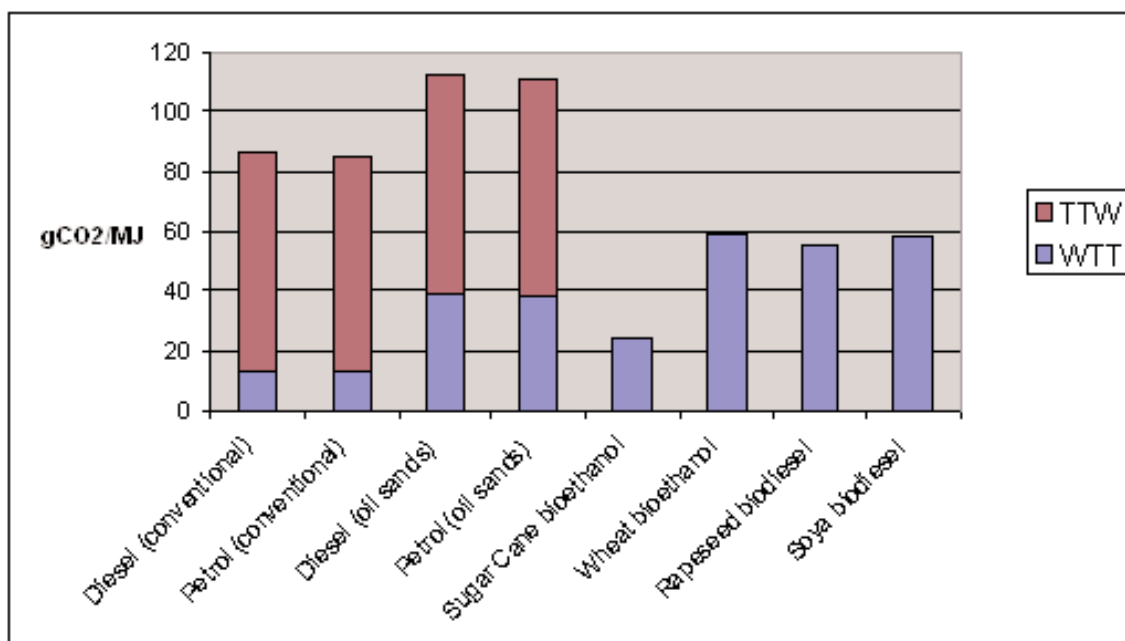
The amount of energy required to extract and refine crude oil from oil sands is higher than conventional crude oil - the carbon emissions from conventional crude oil is 28.6kg per barrel of oil, but this increases to 85.5 kg per barrel for oil sand production<sup>10</sup>.

The resulting petrol and diesel is therefore more carbon intensive as petrol and diesel derived from conventional crude oil.

The following graph and table shows the reduction in CO2 emissions of various biofuels compared to conventional petrol and diesel and petrol and diesel derived from oil sands, all measured on a whole of life basis.

<sup>10</sup> Woynillowicz D. Seversin-Baker C. & Raynolds M. Oil Sands Fever, Nov 2005 <http://pubs.pembina.org/reports/OilSands72.pdf>

**Figure 1:** Whole of life emissions



**Table 4:** Reduction in CO2 emissions

Product	Whole of life CO2 emissions (gCO2/MJ)	% saving to mineral petrol or diesel equivalent	
		(conventional basis)	(oil sand basis)
<b>Oil sands petrol</b>	110.5		
<b>Conventional petrol</b>	84.8		
<b>Sugar cane bioethanol</b>	25	- 71%	- 78%
<b>Sugar beet bioethanol</b>	61	- 41%	- 45%
<b>Oil sands diesel</b>	112.5		
<b>Conventional diesel</b>	86.4		
<b>Rapeseed biodiesel (UK origin)</b>	55	- 36%	- 52%
<b>Soya biodiesel (US origin)</b>	58	- 33%	- 49%

Source: Renewable Fuels Agency, Carbon and Sustainability Reporting with the RTFO, Technical Guidance, August 2008<sup>11</sup>

<sup>11</sup> [http://www.renewablefuelsagency.org/\\_db/\\_documents/RFA\\_C&S\\_Technical\\_Guidance\\_Part\\_1\\_v1.2.pdf](http://www.renewablefuelsagency.org/_db/_documents/RFA_C&S_Technical_Guidance_Part_1_v1.2.pdf)

## 6 Conclusion

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Rather than comparing biofuel with petrol or diesel derived from conventional oil reserves, it may be more accurate to instead compare biofuels against marginal world oil production, being the new sources of crude oil such as oil sands that are now being developed and which biofuels would displace at the margin.