



Unconventional Oil

Scraping the bottom of the barrel?

The **co-operative** bank
insurance
investments

About WWF

WWF, one of the world's most experienced conservation organisations, addresses global threats to people and nature such as climate change, the peril to endangered species and habitats, and the unsustainable consumption of the world's natural resources. We do this by influencing how governments, businesses and people think, learn and act in relation to the world around us, and by working with local communities to improve their livelihoods and the environment upon which we all depend. WWF uses its practical experience, knowledge and credibility to create long-term solutions for the planet's environment.

If everyone in the world consumed natural resources and generated carbon dioxide at the rate we do in the UK, we would need three planets to support us. The impacts – which include climate change, deforestation and biodiversity loss – are starting to affect us all. WWF has a vision for a One Planet Future – a world in which people and nature thrive within their fair share of the Earth's natural resources.

That is why WWF is working to develop a One Planet Finance system, where the investments made by individuals and institutions contribute to this vision. This includes holding the owners and managers of capital to account on how funds are used – because it will be essential to direct flows of capital away from carbon-intensive activities and towards low-carbon opportunities.

Acknowledgements

The report was written by James Leaton of WWF-UK, with contributions from Colin Baines of The Co-operative Group, Niall O'Shea of The Co-operative Investments, and Anthony Footitt of the Tyndall Centre for Climate Change Research. The authors would also like to thank Gary Kendall, Rob Powell, Hadley Archer, Mark Eckstein, Francis Grant-Suttie, Arlin Hackman, Julia Langer, Louise Hotchkiss, Peter Denton and Alun Evans for their comments and contributions.

Photography: © Jiri Rezac / WWF-UK unless stated otherwise.

About The Co-operative Financial Services

The Co-operative Financial Services (CFS) is part of The Co-operative Group, the UK's largest consumer co-operative. CFS is the group of businesses that includes The Co-operative Bank, The Co-operative Insurance and The Co-operative Investments. CFS puts the social concerns of its 6.5 million customers at the heart of the way it does business.

In 1992, The Co-operative Bank became the first UK high street bank to launch a customer-led Ethical Policy. Through the policy, the bank sets out where it will and will not invest its customers' money.

In June 2005, The Co-operative Insurance became the world's first insurance company to launch a customer-led Ethical Engagement Policy. It directs how The Co-operative Insurance and The Co-operative Investments use their influence as shareholders to push for positive change within the companies in which they invest.

Foreword

It's one thing for society to be saddled with an existing energy strategy that could result in dangerous climate change; it's another thing when new technologies are exploited that push us closer to climate disaster - and that is what the commercialisation of unconventional fossil fuels would do.

One can provide good social, environmental and economic rationales for why the commercialisation of unconventional oils by rich developed countries is wrong-headed, but the long and short of it is that it is plain and simply 'wrong'. How can we expect the developing world to emerge along a low carbon path when (a) the vast bulk of CO₂ already in the atmosphere is from us and (b) we then go on to exploit even more climate hostile sources of energy.

The Co-operative Group, and particularly our financial services businesses, intends to devote a not insignificant amount of time, energy and money to this issue, and with the support of our customers and members we hope to help secure a safer, low-carbon future.

Paul Monaghan
Head of Social Goals and Sustainability
The Co-operative Group



Extraction as far as the eye can see in Alberta.

Contents

Executive Summary	5
Oil Sands	9
Climate Change	13
Boreal Forests	24
Water	27
Oil Company Involvement	33
Oil Shale	37
Climate Disaster	41
Investor Risk	43
Recommendations	45

***400 tonne trucks, the size of a house,
at the Shell Albian mine.***



Executive Summary

This report highlights perilous trends in the oil sector, where increased investment in unconventional fossil fuels, such as Canadian oil sands and US oil shales, may dangerously contribute to climate change and cause local ecological disaster. The report also demonstrates the significant investor risk associated with these unconventional oils.

The vast resources of oil shales and sands (unconventionals) could redraw the world oil map. Canada is already promoting itself as an energy superpower, touting its reserves of 174 billion barrels of oil, which places it only second to Saudi Arabia. Oil shale is less developed than oil sands, but the renewed interest shows the sector is heading in the wrong direction at present. Extracting these reserves would entail huge cost. Financially, operators have proposed more than C\$125 billion of projects by 2015, which will need the backing of investors. However the proposed activities also involve huge social and environmental costs that would be felt in terms of local and global impacts.

Climate Change

In order to avoid dangerous levels of climate change, it is likely that global emissions must peak by 2015 and fall by at least 80% compared with 1990 levels by 2050. This imperative makes it essential that we rapidly develop a low carbon economy. The cost of inaction on climate change in terms of lost GDP outweighs the costs of taking action to cut emissions.

The energy intensity of unconventional fossil fuels poses stark choices for oil companies, governments and investors. Oil sands extraction produces three times the carbon emissions of conventional oil production, whilst oil shale extraction produces up to eight times as much. In terms of the quantity of oil potentially available, ultimate Canadian oil sand reserves are thought to be in the region of 1.7 trillion barrels, with 315 billion probable barrels accessible using technology currently under development. US oil shale deposits are estimated at 1.5 trillion barrels of reserves there are currently only estimates as to what proportion may be recoverable, but the figure used by the US government is 800 billion barrels.

If all 1,115 billion barrels of these recoverable unconventional reserves in North America were exploited, it would result in estimated well to wheel emissions of 980 Gt CO₂, equating to an estimated increase in atmospheric CO₂ levels of between 49 and 65ppm. This could be catastrophic given that our atmospheric levels are already at 430ppm CO_{2e} and we risk a new global extinction event if we pass the 450ppm CO_{2e} stabilisation target and trigger global mean temperature increases above 2°C.

As Jim Hansen, Director of the NASA Goddard Institute and Adjunct Professor of Earth and Environmental Sciences at Columbia University's Earth Institute, has said, "squeezing oil from shale mountains is not an option that would allow our planet and its inhabitants to survive".

Canada's greenhouse gas emissions were already 26% above its 1990 levels by 2006, compared with its Kyoto target of a 6% reduction. If Canadian oil sands development continues to expand at the pace currently desired by the industry, the production and use of the fuel would account for 87% of the maximum emissions from OECD countries in 2050 under a 450ppm stabilisation pathway.

Operators have huge oil sands expansion plans, having announced over US\$125 billion of projects to be developed by 2015. The larger operators, including Shell, ExxonMobil, BP and ConocoPhillips, are looking to each produce several hundred thousand barrels per day from the oil sands by 2020. Companies are currently looking to build multi-billion dollar trans-continental pipelines to supply the gas to extract more tar from Canada's sands. Oil shale is still at a more developmental stage, but billions are going into research in order to make it viable. In the US, companies are pushing engineering boundaries to develop a freeze wall technology, which can provide a frozen retaining wall to surround a super-heated oil shale core. The human race is going to extreme lengths to 're-carbonise' its activities, at a time when rapid decarbonisation is needed.

Regulation is essential if a low carbon economy is to be achieved, California has already developed legislation that stipulates a Low Carbon Fuel Standard, which calls for a reduction of at least 10% in the lifecycle carbon intensity of state's transport fuels by 2020. This would effectively prohibit fuels with lifecycle CO₂ emissions greater than those derived from conventional sources. Other US states and Canadian provinces have indicated they are to follow suit. The US Energy Independence and Security Act 2007 could also restrict the market for unconventional oils and further measures can be expected from a new US President in 2009.

Most operators point to potential technological solutions such as carbon capture and storage (CCS) and the Canadian government has proposed a requirement for all oil sand projects from 2012 to be CCS-effective by 2018. However, CCS is still up to a decade away from being *tested* on a commercial scale and realistically will not be a viable solution for decades to come. Additionally, operators insist they require heavy subsidies to develop CCS and ensure profit margins remain worthwhile. They also do not want to be held responsible for legacy issues, such as what the stored carbon might do in the future. It is not acceptable to use a promise of CCS as a licence to significantly expand the exploitation of unconventional fossil fuels when its viability remains in the balance and its availability on a sufficient scale is decades from being achieved.

Boreal Forest

The oil sands cover 140,000 sq km in the primary boreal forest of Canada, an area larger than England. Due to oil sands operations, the Alberta landscape may never look the same again, with the primary boreal forest criss-crossed with seismic lines, huge open-cast mines and tailing ponds filled with toxic wastewater, and pipes and infrastructure spreading across the scenery. Canada is home to half the remaining boreal forest in the world, and (not including tundra and wetlands) contains 11% of the global terrestrial carbon sinks. Oil sand operations are leading to significant deforestation and damage to peatland and wetlands, eroding the carbon storage value of these areas. Deforestation has been identified by the IPCC as a major contributor to climate change. Due to its key role in carbon storage, Canada's boreal region has been described as a "life support system for the planet". In May 2007, 1,500 scientists from more than 50 countries called on the Canadian government to provide more protection for the boreal forest.

The boreal forest is also home to caribou, which avoid the fragmented forest created by oil sands activities. Unique wetlands such as the McClelland patterned fen – vital for migratory birds – are under threat. Oil sand licences are granted on the basis that operators will return areas to at least the same condition in which they were found. However, after decades of activity only 104 hectares have been certified as reclaimed by the Alberta government. Most companies admit it is impossible to artificially return boreal forest to the same condition as they found it; instead reclaimed land will have much lower levels of carbon density and biodiversity than previously existed.

Water Intensity and Toxic Waste

The production of oil sands is also water intensive, averaging three barrels of water to produce a single barrel of oil. The primary source of water is the Athabasca River, which is already down to critical levels as disturbance of the Athabasca wetland catchment reduces the amount of runoff and groundwater reaching the river and extraction from the river increases. The average summer flow of the river declined by 29% between 1970 and 2005, whilst current licences to extract 2.3 billion barrels per year are set to increase to 3.3 billion barrels, threatening its ecological functions.

It is possible to reuse more than 90% of the water extracted, but ultimately only 5-10% is returned to the river – the rest being too toxic. The huge volumes mean that enormous amounts of toxic wastewater are produced. Individual tailing ponds are up to 50 sq km in size and can be seen from space. The dam structures used are among the largest in the world. After decades of operations, there is no evidence that reclamation of tailing ponds is possible. Containing high levels of naphthenic acids from the bitumen, the water in the tailing ponds is acutely toxic to aquatic life and wildlife that comes into contact with the water. Concerns have been expressed that contaminated water may leach out over time, the ecological impacts of which would be serious and persistent.

Oil shale production would also be water intensive and ecologically damaging. Mining oil shale requires between two and five barrels of water for each barrel of oil produced. Extraction levels of three million barrels per day would therefore require six to 15 million barrels of water per day; this in an area where the US Department of the Interior has announced special measures to tackle a drought which has been occurring for the last eight years.

Airborne emissions from oil shale production are expected to include sulphur dioxides, nitrogen dioxides, particulates, ozone precursors and carbon monoxide. Research in China indicates that an oil shale waste site experienced contamination of soil and groundwater by heavy metals and carcinogenous hydrocarbons.

Communities

Canadian First Nations indigenous communities who live and fish downstream from the oil sands mines are also concerned about water quality, and the level of toxins in both the water and the fish. Further research is needed to establish the risk to local people and the sources of contamination. The Canadian health authorities are now investigating reports of unusual incidences of cancer in the Fort Chipewyan community. Indigenous groups are also starting to use legal routes to challenge oil sands leases where they feel their rights to consultation have been ignored. The Assembly of First Nations Treaty Chiefs have issued a call to implement a full moratorium on oil sands development.

INVESTOR RISK

The financial sustainability of unconventional oil is dependent on a scenario with limited regulation, a high oil price and a low carbon price. Policy makers, and energy and utility companies agree that limited regulation and a low carbon price will not last long.

- Oil sands are the most carbon intensive fuel currently being exploited and therefore the least efficient in a carbon constrained economy. Oil shales present an even more carbon intensive option.
- Government measures are in development, which could restrict access to primary markets by prohibiting fuels with lifecycle CO₂ emissions greater than those derived from conventional sources.
- Expanding oil sand capacity is already capital intensive, currently up to 20 times more so than conventional oil.
- When there are cheaper conventional resources available, which are sufficient for maximum possible exploitation in a carbon constrained economy, this lavish capital expenditure may produce stranded assets.
- Spiralling labour and infrastructure costs in the sector will further add to capital costs.
- If approved, future gas pipelines will add to expense and environmental liabilities. Non-approval would limit growth.

- Although far from commercial viability, the requirement for CCS will further add to capital costs and sequestered carbon will present a long-term environmental liability.
- Operational licences are increasingly being challenged in the courts on environmental grounds and have been suspended.
- Requirements to reclaim boreal forest to the same condition as found present a significant long-term environmental liability, and due to lack of success, a significant risk.
- As a result of unsustainable water usage, operators can expect access to water to be restricted or costs to rise, limiting growth or further increasing capital intensity.
- Management of tailing ponds presents a long-term environmental liability and significant risk due to size and toxicity.
- Damage to sensitive and globally important ecosystems, plus the loss of wildlife, present significant reputational risk.
- Concerns over health impacts on First Nation communities and potential litigation present a risk.

Oil companies have hardly begun to factor in the externalities that are currently imposed on the environment and local communities, yet are rapidly expanding unconventional oil developments in the hope of future technological solutions, subsidies, and favourable government intervention to reduce companies' exposure to environmental liabilities. This is a complacent attitude. Shareholders should challenge those oil companies that fail to steward investment responsibly.

RECOMMENDATIONS

GOVERNMENT

- Halt the licensing of new unconventional fossil fuel operations.
- Introduce low carbon fuel standards to prohibit fuels with lifecycle 'well to wheel' carbon emissions greater than those derived from conventional sources.
- Implement effective measures to reduce absolute carbon emissions from existing operations.
- Deliver on Kyoto commitments and agree strong targets post Kyoto.
- Hold companies accountable for environmental and social impacts, including carbon emissions, deforestation, water usage and toxic waste management.
- Protect sensitive and endangered biodiversity and carbon sinks.
- Investigate the relationship between oil sand operations, water contaminants and downstream water quality and health.
- Improve monitoring of tailings ponds and introduce mandatory independent assessment of operations.

OIL COMPANIES

- Report on all risks associated with the environmental and social liabilities of oil sands operations, including energy intensity and carbon emissions, deforestation and land reclamation, community health and safety, water intensity and long-term toxic waste management.
- Publicly disclose strategies for addressing and reducing these risks in the context of a low carbon economy, and report progress of implementation.
- Until these strategies are in place and their success proven, halt the expansion of oil sand operations.
- Justify the competitiveness of unconventional fossil fuels in a carbon-constrained economy.
- Evaluate future fuel technologies for development based on their potential to meet low carbon fuel obligations, and switch research and development expenditure away from carbon-intensive fuels such as shale oils to sustainable alternatives.

INVESTORS

- Consider the competitiveness of unconventional fossil fuel investment in a carbon-constrained economy.
- Question the strategy of oil companies.
- Include long-term environmental liabilities such as toxic waste management and community health and safety in investment decisions.
- Engage with oil companies to report on risks associated with the environmental and social liabilities of unconventional fossil fuel exploitation, and to introduce strategies to address.
- Evaluate fuel technologies for investment based on their potential to meet low carbon fuel obligations.



**Satellite view of
oil sands production.**

Oil sands

Background

What are they?

Oil sands (also known as tar sands) consist of oil trapped in a complex mixture of sand, water and clay. The most prominent theory of how this vast Canadian resource was formed suggests that light crude oil from southern Alberta migrated north and east with the same geological pressures that formed the Rocky Mountains. Over time, the actions of water and bacteria transformed the light crude into bitumen – a much heavier, carbon rich, and extremely viscous oil.¹ The proportion of bitumen in an oil sands mixture can range from 1-20%.

Where are they?

The oil sands cover 140,000 sq km in the boreal forest of Alberta – an area larger than the 130,000 sq km of England.² The deposits are in three main regions: Athabasca, Peace River and Cold Lake, as can be seen on the map below (Figure 1). Exploration leases are typically provided for five years. Areas that have been surveyed in the past, but not considered viable, are now being revisited and 75% of leases are still available. Venezuela's Orinoco Belt is the only other region with significant oil sands reserves and production, although smaller natural bitumen deposits are found in many other countries.³

The extraction process

Oil sands deposits can be divided into surface deposits (up to 75m in depth)⁴ that are extracted by “open pit” processes, and deeper underground deposits that are extracted “in situ”. Of the established reserves, 82% require in situ extraction rather than open mining.⁵ Mining has accounted for the majority of projects to date, but more expensive deeper deposits are economically viable at today's oil price.

Surface Mining

Surface deposits can be mined using more traditional methods similar to open pit mining. To produce one barrel of oil from surface mining, at least two tonnes of material is mined.⁶ The oil sands are moved by huge 400 tonne trucks to a cleaning facility where the material is mixed with warm water to remove the bitumen from the sand. Open pit mines are much more obviously destructive in terms of excavation, but the surface activities of in situ extraction can also have significant impacts on land cover. Some of the huge mines can be seen from space.

Figure 1:
Map of main oil sands regions
in Alberta, Canada



In situ Processing

For oil sands reservoirs too deep to support economic surface mining operations, some form of in situ recovery is required to produce bitumen. In situ oil sands production is similar to that of conventional oil production in that oil is recovered through wells. However, the heavy, viscous nature of the bitumen means that it will not flow under normal conditions. The large areas required for steam generation plants, well pads, roads, 3-D seismic lines and pipelines for these processes means they disturb significant areas of land. Even more water and energy is required for in situ than mined oil sands.

Upgrading

Upgrading is the energy-intensive process by which heavier oil fractions are converted into more useful/desirable petroleum derivatives. This is done either by removing carbon (coking) or adding hydrogen (hydrocracking).⁷ Hydrotreating is a secondary process to remove sulphur and nitrogen and metals using a catalyst. In the oil sands, bitumen is converted into a higher quality, lighter crude oil. This is known as synthetic crude oil or "syncrude". Increasingly, companies are seeking to integrate the upgrading and produce higher value products, rather than bitumen. The Premier of Alberta, Ed Stelmach, has expressed his desire to retain as much of the value-adding upgrading north of the border as possible.⁸ However, this will bring the associated emissions and increase pressure on infrastructure.

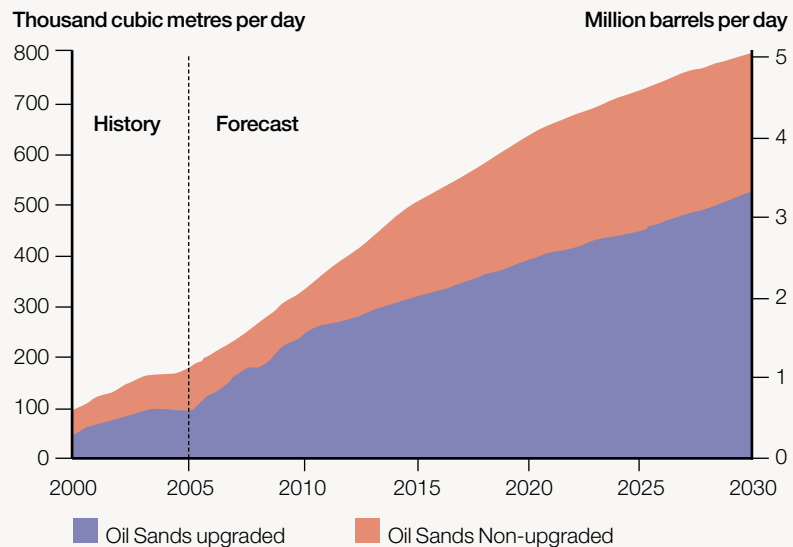
Refining

Oil companies in North America have to reconfigure their refineries if they want to accept large volumes of these synthetic heavy oils; indeed this was a precursor for BP's asset swap with Husky in December 2007, which provides vertical integration of Husky's extraction with BP's refineries. BP announced a US\$3bn investment in its Whiting refinery in 2006 and a US\$3.6bn upgrade of its Toledo refinery in 2007.^{9, 10} While BP has been slower to invest in upstream oil sands, the company is a significant player in United States downstream activities, (BP is the second largest refiner in the US at 1.5 million barrels per day (bpd)), and as a result has a big interest in which fuel stocks are used.¹¹ There has been local opposition to the expansion of refineries to receive oil sands production due to concerns over local air quality and health impacts. Community groups staged protests outside BP's Whiting refinery in Indiana.¹² Most expansion in oil sands production is destined for the US.

The scale of the industry

Canadian oil sands production has seen significant growth in recent years to 1 million bpd. Even more rapid growth is projected by the industry, with forecasts predicting 5 million bpd between 2020 and 2030. The graph below (Figure 2) is based on The Canadian National Energy Board base case expansion scenario to 2030, splitting the output by upgraded synthetic crude and non-upgraded bitumen.

Figure 2: *Oil production from Canada's oil sands*



Source: Canadian National Energy Board¹³

Estimates of capital expenditures to construct all announced projects over the period 2006 to 2015 total C\$125 billion.¹⁴ The Alberta oil sands region is set to become one of the largest oil developments in the world. Oil sands are a capital-intensive activity connecting with a revenue-rich oil industry, which is desperate to increase both production and reserves.

To illustrate this, conventional oil capacity can be added at \$5,000 per barrel of production capacity, compared with the oil sands, where the cost can be as high as \$100,000 per extra barrel of production.^{15,16,17} Integrated operations have seen lower expansion costs of \$30,000 per barrel, but these figures are rising all the time linked to the increase of materials, equipment and labour costs.¹⁸ In its 2008 annual report, Shell reported that operating costs had increased 50% in two years.¹⁹

The province of Alberta is set to become the “pollution capital of Canada”. It has proven reserves of 174 billion barrels of oil, and 315 billion probable barrels using technology currently under development.²⁰ Ultimate reserves are thought to be in the region of 1.7 trillion barrels.²¹ In terms of proven reserves, 174 billion barrels places Canada second only to Saudi Arabia.²² Saudi Arabia produced 10.9 million bpd in 2006, followed by Russia with 9.8 million and the US with 6.9 million.²³ The Prime Minister of Canada has talked of his country becoming an “energy superpower” in international forums as a result.²⁴

Energy Intensity

It takes energy to make energy – and in the case of oil sands, an unusually large amount, used in a highly inefficient manner. For oil sands this is the equivalent of up to 30% of the energy contained in the extracted oil,²⁵ which is around three times as much as typical oil extraction.²⁶ In order to meet the energy demand that would result from growth in oil sands, companies are looking to increase natural gas supply. The rapid projected growth of oil sands would need to be mirrored by increasing energy supply. In 2004, the oil sands used 0.6 billion cu ft of gas; this is projected to reach a demand of 2.3 billion cu ft by 2015.²⁷

The current gas usage is already equivalent to that required to heat three million of Canada’s 12 million dwellings.²⁸ If the predicted expansion occurred, the oil sands would use enough gas to heat them all.

Pipelines

As a means of supplying more gas, a 1,200 km gas pipeline through the Mackenzie Valley (see Figure 3 opposite) is currently being considered by a joint territorial and federal review process.²⁹ This \$16.2 billion project is proposed by a consortium including ExxonMobil (and its subsidiary Imperial Oil), Royal Dutch Shell and ConocoPhillips. This could provide gas to fuel oil sands expansion. WWF has intervened in the process, concerned that the huge infrastructure development in a globally significant wetland ecoregion would impact upon it irreversibly. WWF has proposed a Conservation First approach, which would establish a network of protected areas that function at an ecosystem level, prior to any exploitation of mineral resources.³⁰ There is still no plan proposed that would not cause significant degradation of this ecosystem.

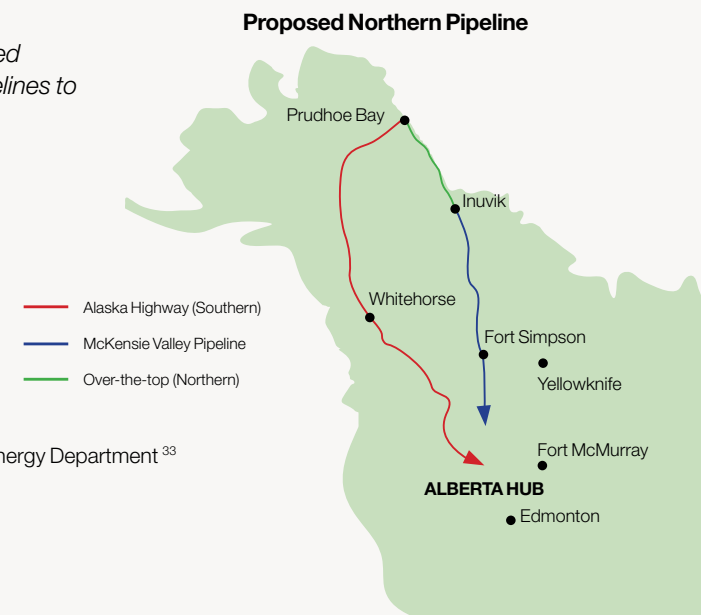
Another potential supply route is the \$42 billion Alaska natural gas pipeline which would bring gas from Alaska’s Arctic slope, across the Yukon to Alberta and on to Chicago.³¹ BP announced in April 2008 it would be joining forces with ConocoPhillips to deliver this project.³² At 5,600 km, this is an even longer pipeline that is likely to face significant challenges from native communities and environmental groups in Alaska. The Alaska Governor is not keen on the terms proposed, and land claims would have to be resolved; the project would also have to be climate change resilient, as permafrost melts in the decades to come.

The gas supply from either the Mackenzie or Alaska pipelines would be a key driver in oil sands expansion. The map below (Figure 3), from the Alberta Energy Department, shows the proposed gas links to the oil sands. Exploration is also taking place in British Columbia. A carbon and water intensive alternative would be to tap into coal bed methane in the south of Alberta.

Nuclear

There has been some talk of developing small-scale nuclear plants in the oil sands region. While this is not seen as a likely option, the fact it has been considered demonstrates that energy supply is a limiting factor the industry is concerned about, particularly if some greenhouse gas limits are imposed. Alberta Energy has launched an assessment of the viability of nuclear energy being developed in the oil sands, to come online in a decade’s time.

Figure 3:
Map of proposed gas supply pipelines to the oil sands



Source: Alberta Energy Department³³

Conclusions

- Unconventionals are far more energy intensive to extract and produce, and therefore more carbon intensive. Their increasing exploitation is a warning sign that the industry is “recarbonising” at a time when we need to urgently tackle climate change.
- The context of a high oil price and concerns about energy security has renewed interest in unconventionals. In terms of its reserves, Canada has risen dramatically up the ranks of oil nations as a result.
- Canada is in a position where it risks damaging its physical environment and international reputation, as well as contributing to global climate change, in order to supply the US with oil. Using a cleaner fuel such as natural gas to produce dirty transport fuels is irresponsible.
- As the largest consumer per capita of energy, North America needs to consider how it can reduce demand, not just increase supply.
- Expanding oil sand capacity is capital intensive – up to 20 times more so than conventional oil. When there are cheaper conventional resources available, which are sufficient for maximum possible exploitation in a carbon constrained economy, this lavish capital expenditure may produce stranded assets in the more carbon constrained world to come.

As we will see from looking at the impacts of these activities, the true costs of the lifecycle of oil sands have not even begun to be assessed properly. Oil companies and the long-term investor should see that unconventionals, in addition to being climate-hostile, start to look even less economic when their true cost (including relevant externalities such as properly mitigating ecological impacts) is considered.

A bear is forced to take to the road in Alberta.



Climate Change

In order to avoid dangerous levels of climate change, we need to limit global mean temperature increases to 2°C above pre-industrial levels by stabilising atmospheric CO₂-equivalent levels at around 450 parts per million.³⁴ In order to achieve this, it is likely that our emissions must peak by 2015 and fall by 80% compared with 1990 levels by 2050.^{35, 36}

The world has already consumed 1 trillion barrels of oil. We cannot afford to exploit this amount again, especially from unconventional oils, if we wish to remain within the safe threshold of global warming.³⁷ As outlined in the WWF Climate Solutions report,³⁸ it is both pragmatic and essential to shift to the least carbon intensive fuels available and use them in the most efficient way, to meet energy demand.

The oil sands represent a carbon intensive option:

- For a conventional barrel of oil, 28.6 kg of CO₂ is emitted in its production.
- For an average barrel from the oil sands, 85.5 kg CO₂ is released in its production.³⁹

These are average industry figures, which vary depending on the depth of the oil sands, the fuel used and the age and efficiency of the equipment and techniques used. They also do not include fugitive emissions such as those from forest carbon sinks destroyed or damaged during construction and operational phases, or from tailings ponds (large lakes of slurry). Therefore in reality we believe the total figures from oil sands are even higher. It has been calculated by the Tyndall Centre for Climate Change that total greenhouse gas (GHG) emissions from the planned expansion of oil sands will more than double between 2004 and 2015, even with efficiency improvements.⁴⁰

Government actions

Currently the only project approval conditions for reducing emissions relate to a requirement to apply the Best Available Technology Economically Achievable (BATEA). This is obviously open to interpretation, and provides little incentive for reducing emissions. Recent air emissions legislation, (Canadian Clean Air Act 2006),⁴¹ has focused more on reducing non-GHG emissions such as NO_x and SO_x to improve air quality. Some improvements have been made to improve efficiency and recover heat; but the growth in emissions from the proposed tripling of production by 2015 would dwarf any efficiency gains.

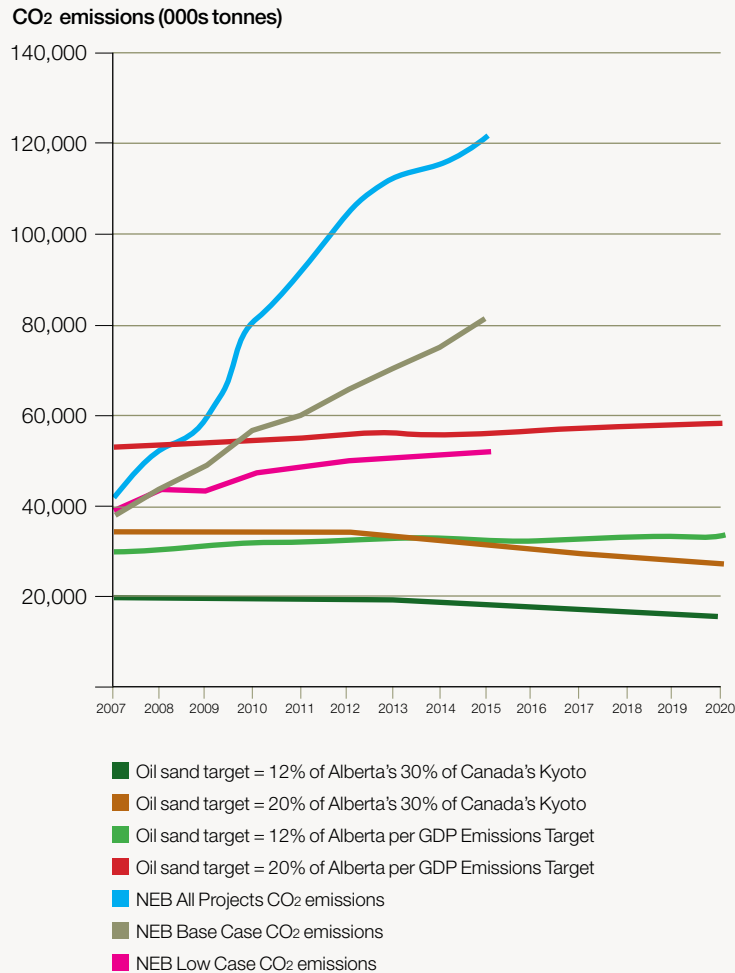
Imperial Oil's Kearn development has been delayed by a legal challenge from Ecojustice, which was upheld in March and May 2008. The successful claim exposed the failure of the government's joint assessment panel to consider how the intensity targets proposed by Imperial would tackle the problem of rising absolute greenhouse gas emissions, which it had too easily dismissed as insignificant.⁴²

Kyoto Protocol targets

Canada has a Kyoto target to achieve a 6% reduction in GHG emissions by 2012 from 1990 levels.⁴³ Since the Montreal climate change conference in 2005, a new Canadian conservative government has been appointed in January 2006 and has already announced that it will abandon Canada's Kyoto targets, with GHG emissions already 27% above 1990 levels in 2006.⁴⁴ As more and more oil sands expansion has been announced, so the projected GHG emissions levels have grown, resulting in an increasing "Kyoto gap" between emissions and targets.

The following graph (Figure 4) forecasts the emissions that would result from the oil sands expansion scenarios outlined by the National Energy Board (NEB) of Canada.⁴⁵ These range from the low (2m bpd in 2015), through the base case (3m bpd in 2015) to all projects (4.5m bpd in 2015). The province of Alberta produced 12% of Canada's GHG emissions in 1990, compared with 20% by 2006. The graph also plots the emissions that would be permitted if Alberta were to limit oil sands emissions according to these proportions of its share of the national Kyoto target. The difference between the two is the Alberta oil sands' Kyoto gap. If all projects were to progress, this Kyoto gap would be 90 million tonnes of CO₂ equivalent by 2015, based on Alberta's 2006 projections.

Figure 4:
The 'Kyoto gap' between projected emissions and Canada's commitments for the Alberta oil sands



Source: Tyndall Centre for Climate Change Research⁴⁶

A review of the Canadian government's attempts to regulate GHG emissions in relation to the oil sands was conducted by the Tyndall Centre for Climate Change in 2007. The government proposed plans setting intensity targets relative to GDP contribution, rather than absolute emissions caps. It claimed these targets would reduce emissions to 20% below 2006 levels by 2020. Canadian emissions were already 27% above 1990 levels in 2006, and 35% above the Kyoto target.⁴⁷

The Tyndall Centre review concluded that the intensity-based targets mooted by the federal government would not deliver any meaningful reductions, as they were no more ambitious than industry's existing efficiency plans, which fall way short of Canada's Kyoto commitment. Indeed, the scheme was so generous that if the oil sands delivered further cuts, they would be able to claim credits worth up to \$700 million.⁴⁸ So while oil sands production tripled, and CO₂ emissions more than doubled, the oil companies would pocket a credits windfall, and the gap to Canada's Kyoto commitments would grow.

The 2006 Report of the Commissioner of the Environment and Sustainable Development (Office of the Auditor General) concluded that:

*"Oil and gas production, particularly the rapid development of Canadian oil sands, is significantly increasing greenhouse gas emissions. Yet few federal efforts are under way to reduce these emissions, and those efforts have had minimal results to date. For its part, the federal government is counting on regulatory and long-term technological solutions to achieve future reductions in this sector. However, it is not leading the way by clearly stating how and to what degree Canada will reduce greenhouse gas emissions when oil and gas production is expected to increase."*⁴⁹

At present Canada is likely to be penalised for breaching its Kyoto commitments. And civil society groups are seeking to hold the government accountable for this failure. Clearly further regulation of GHG emissions in Canada is both necessary and likely, providing regulatory risk to oil sands operators. An investor with an eye to the future must consider that large-scale expansion of oil sands – at least without some magic bullet to solve the emissions problem – will provoke regulatory shocks down the line.

Carbon Intensity Fuel Standards

The majority of future unconventional production is presently destined for the US. California has already developed legislation that stipulates a Low Carbon Fuel Standard (LCFS), as well as having quotas for hybrid vehicles. The Californian LCFS calls for a reduction of at least 10% in the lifecycle carbon intensity of California's transport fuels by 2020.⁵⁰ Other US states and Canadian provinces have indicated they are to follow suit. The US Energy Independence and Security Act 2007 could also restrict the market for unconventional oils.⁵¹

Section 526 of the Act limits US government procurement of fuels to those from which the lifecycle GHG emissions are equal to or less than those from fuel from conventional petroleum sources. There is currently a debate over the scope of application of the Bill, with Canada lobbying for an exclusion for oil sands, while North American NGOs are calling for a strict application of the Bill.^{52,53} It would appear an unfair application of trade rules if GHG standards were imposed for biofuels that were not required for oil sands.

Figure 5:
Greenhouse gas emissions for fossil hydrocarbon fuels production

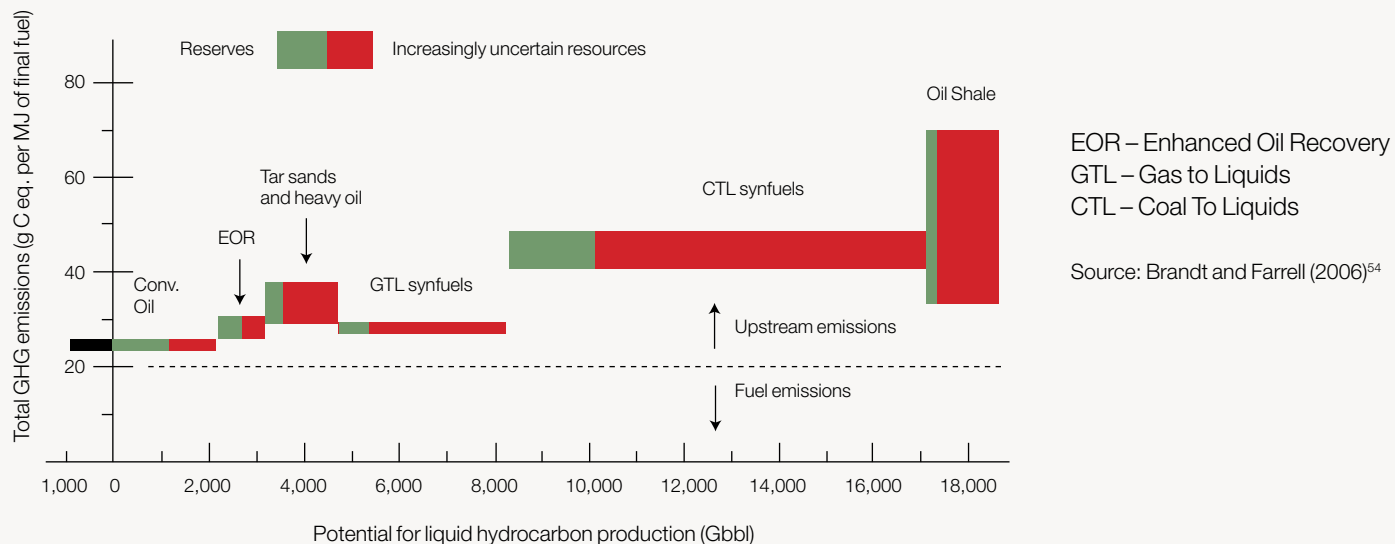


Figure 5 below indicates how (upstream) production emissions from unconventional such as oil sands and oil shale are significantly higher than for conventional oil. Regulation is essential if our fuels are to become less carbon intensive, rather than making the situation worse. These figures do not include fugitive emissions. Therefore in reality we believe the total figures from oil sands are even higher.

Figure 5 also brings in another dangerous threat to reducing emissions: Coal-To-Liquid (CTL) synthetic fuels. The option of converting coal to liquid fuels demonstrates how the world is 95% reliant on oil for its transport fuels. With high oil prices and energy security concerns, the world's largest oil consuming nations are looking to their coal reserves to meet growing demand. An alternative is obviously to better manage demand, and to seek more efficient alternative transport solutions. A more complete discussion of the consumption of oil, and the domination of the internal combustion engine, is contained in the WWF publication *Plugged In: the end of the oil age*.⁵⁵ Oil companies are also pursuing CTL technology: for example, Royal Dutch Shell is developing plants with partners in China and the US.⁵⁶

Supplying the US makes the oil sands lifecycle even less efficient because North American vehicle fleets are the least efficient in the world. A joint study by Natural Resources Defense Council, Pembina Institute and Western Resources Associates concluded that “unless we take swift action, US transportation emissions, which already contribute over one third of total US global warming pollution, will double by 2050”.⁵⁷

In 2006, Canadian oil production was around 2.4 million bpd, with around half of this coming from oil sands, and 1.6 million bpd of oil exported to the United States.⁵⁸ By 2015, exports are expected to nearly double to more than 3.1 million bpd – with the growth all coming from the oil sands while conventional production declines.⁵⁹ Canada supplied around 12% of total US oil demand in 2006. The current infrastructure and difficulties associated with alternative export routes means that the US is currently the only significant market for oil sands production. Both Chinese and Indian companies have shown interest in investing in the oil sands.

However, numerous new pipeline proposals and expansions of existing pipelines have been announced in recent years, with producers and shippers now assessing the alternatives to determine which projects will get market support. Proposals currently include pipelines to Vancouver and Puget Sound on Canada’s west coast, Portland on the US east coast, and numerous pipelines to the Gulf of Mexico.

In the short term, US demand would be seriously restricted if either federal or state low carbon fuel standards are implemented. The US petroleum industry is currently investing in heavy oil infrastructure, expanding and upgrading refineries to take oil sands production. There has been local opposition to refineries as well, with communities resistant to the air quality impacts and concerned about health risks. Consumers are baulking at the rising cost of filling up their cars, as high oil prices are passed on to them.

The expansion plans face further potential regulatory risk, especially with a new US President due in 2009. Moreover, unconventionals, because of their carbon intensity, are likely to become more and more unpalatable in markets where parallel efforts are being made to curtail carbon. The economic viability of oil sands would be uncertain in any carbon-constrained economy of the future.



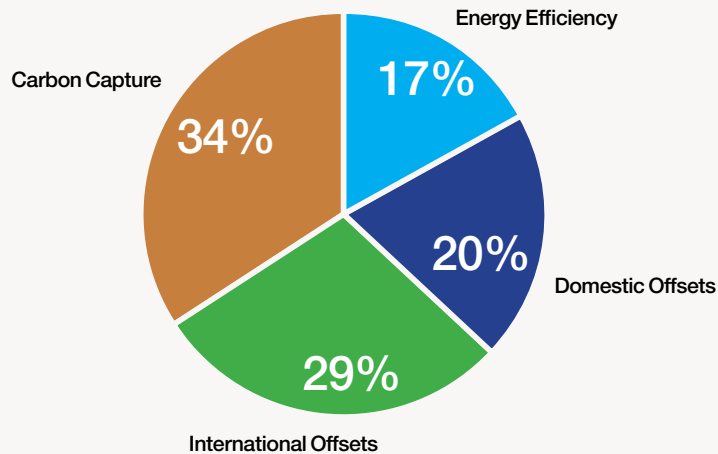


***The inefficient US vehicle fleet
is driving demand.***

Company efforts

There is very limited action by most oil companies to reduce their emissions in respect of oil sands, which reflects the vacuum of effective regulation. In 2007 the Ethical Funds Company of Canada review of climate change risks in the oil and gas sector in Canada concluded that most operators had failed to take action to reduce emissions.⁶⁰ Only a handful of companies had an action plan to reduce emissions or factored the costs of carbon into investment decisions.

The only oil sands producer that has set a GHG reduction target is Shell, which has introduced a voluntary target to reduce emissions by 50% from the original specification for its Athabasca Oil Sands Project (AOSP) by 2010.⁶¹ A presentation from Shell indicates the following breakdown of how the 50% will be achieved:



Source: Shell Climate Change & GHG Strategy Manager presentation⁶²

If Shell were able to achieve absolute emission reductions of 50%, which looking at its strategy, does not appear to be the case, it would still mean that the product's emissions are higher than those from conventional fossil fuel production. The lifecycle analysis applied for market standards (for example the California Low Carbon Fuel Standard) should not permit the inclusion of unrelated carbon offsets, as this would distort the comparison. As part of Shell's commitment to reduce emissions, it is considering a large-scale carbon capture project, which would store more than 1 million tonnes of CO₂ per year from Shell's Athabasca Scotford Upgrader. However, the likelihood of this being in place by 2010 is very slim.

I hope that I don't have the following conversation with my granddaughter twenty years from now:

"Grandpa, did you really do that?" "Do 'what', Masha?"
 "Did you take natural gas from the Arctic down to Alberta to boil water to make steam to melt tar out of the oil sands, then use more natural gas to produce hydrogen to make the tar molecules into gasoline so North Americans could drive four tonne vehicles five kilometres to sports clubs to spend fifteen minutes riding stationary bikes; did you really do that, Grandpa?" "Ahhhh..., yes, Masha, I am afraid we did."

Professor Robert Skinner of the Oxford Energy Institute

Carbon capture and storage (CCS)

Most operators point to potential technological solutions such as carbon sequestration and an industry group, the Integrated CO₂ Network, has been set up to call for a Canadian carbon capture and storage initiative.⁶³ The oil and gas reservoirs in the Western Canada Sedimentary Basin potentially suitable for CCS are around 500 km from the oil sands.⁶⁴ The Tyndall Centre has conducted an analysis showing that the costs of recovering carbon emissions are marginal per barrel of oil, even at today's least optimistic estimated costs.⁶⁵ However, oil companies are still seeking a subsidy for carbon capture rather than taking responsibility for their own emissions. The industry has acknowledged that CCS will not come on stream for another decade.⁶⁶

In a speech in April 2008, Nobuo Tanaka, the Executive Director of the International Energy Agency gave an indication of the timescales required for CCS when he said: "In carbon capture and storage, we would need to build at least 20 demonstration plants by 2020, at a cost of US\$1.5bn each. Such a construction program should be viewed as a litmus test of our seriousness towards combating climate change."⁶⁷ This indicates CCS is still far from being a viable commercial scale solution and realistically will not be viable for decades to come. In 2007, the World Energy Council predicted CCS could reach its full potential within the next 30 to 40 years,⁶⁸ the IPCC believes full potential to be 20-40% of global fossil fuel emissions, and due to technical limitations does not believe it to be achievable until 2050.⁶⁹ According to the United Nations Development Programme, "CCS technology is projected to come on-stream very slowly in the years ahead...At this rate, one of the key technologies in the battle against global warming will arrive on the battlefield far too late to help the world avoid dangerous climate change".⁷⁰

The re-elected Alberta government is placing a major emphasis on investment in this technology in order to limit the growth of greenhouse gas emissions.⁷¹ Although CCS technology has the potential to play an important role in mitigating climate change, it is still at the research and development stage and the required infrastructure does not exist in Alberta. Given the timescales required for development, it is not a viable solution for cutting emissions by 2015, as is required. It is not acceptable to use a promise of CCS as a licence to significantly expand the exploitation of unconventional fossil fuels when its availability on a sufficient scale is decades from being achieved, and so many contingencies leave its viability hanging in the balance.

For instance, the companies insist they require heavy subsidies to ensure that profit margins remain worthwhile and they do not want to be held responsible for legacy issues such as what the stored carbon might do in the future. Should and will government accept liability? A global carbon trading regime needs to be in force to create the right price for carbon to turn CCS and cleaner technologies into commercial opportunity, not just costs to be borne. A 'correct' price for carbon, which does include its true cost, is indeed desirable but the global regime envisaged is some years away, at best. In the meantime, investors should be questioning the judgement of oil companies' whose strategies are dependent on indefinite financial support from government, through subsidy and bail-out.

The federal government has proposed a requirement for all projects initiated from 2012 to have CCS effective by 2018; and Natural Resources Canada has announced a C\$125 million R&D fund.^{72, 73} Given it is unlikely that CCS will be viable by then, this could restrict growth at this time. Canada was criticised for misrepresenting this proposal future in its latest submission to the UN Climate Change Conference in Bangkok in April 2008, claiming it as a contribution to the current Kyoto period, despite not coming onstream until post-2012.

The other impacts of oil sands should not be forgotten. The potential for CCS helping to mitigate climate change impacts should not be seen as a green light for unfettered expansion of the oil sands. The GHG picture cannot be seen in isolation from the ecosystem effects: not from an ethical point of view, nor from a financial point of view. Limits for greenhouse gases, water use, forest degradation and species loss should be considered as part of a package that cannot be unbundled.

How much carbon emissions would result?

If all the oil sands were exploited and consumed, the greenhouse gas emissions would be significant. The level of emissions would depend on the rate and method of extraction and the availability of any technological efficiency and mitigation improvements which may be applied over time. These calculations are based on a well-to-wheel emissions rate of 638.5 kgCO₂ per barrel of transport fuel used in central North America.⁷⁴ The table below shows that the exploitation and use of just the proven reserves would result in more than 100 Gt CO₂. Global anthropogenic greenhouse gas emissions were 49 Gt CO₂ equivalent in 2004.⁷⁵

Total emission Well to Wheel (WTW)	(Gt CO₂eq)
Proven reserves (174 billion barrels)	105
Probable reserves (315 billion barrels)	183

The current oil sands production level of more than 1 million bpd is around 2% of global production. If the oil sands industry achieves the higher rates of production planned by 2020 of around 5 million bpd, or nearly 1.825 billion barrels a year, this would represent around 10% of current global annual consumption of oil. By 2050, around half of the proven reserves could have been exploited if development proceeds at a rapid pace. This would mean that the oil sands would be responsible for more than 50 Gt CO₂ by 2050.

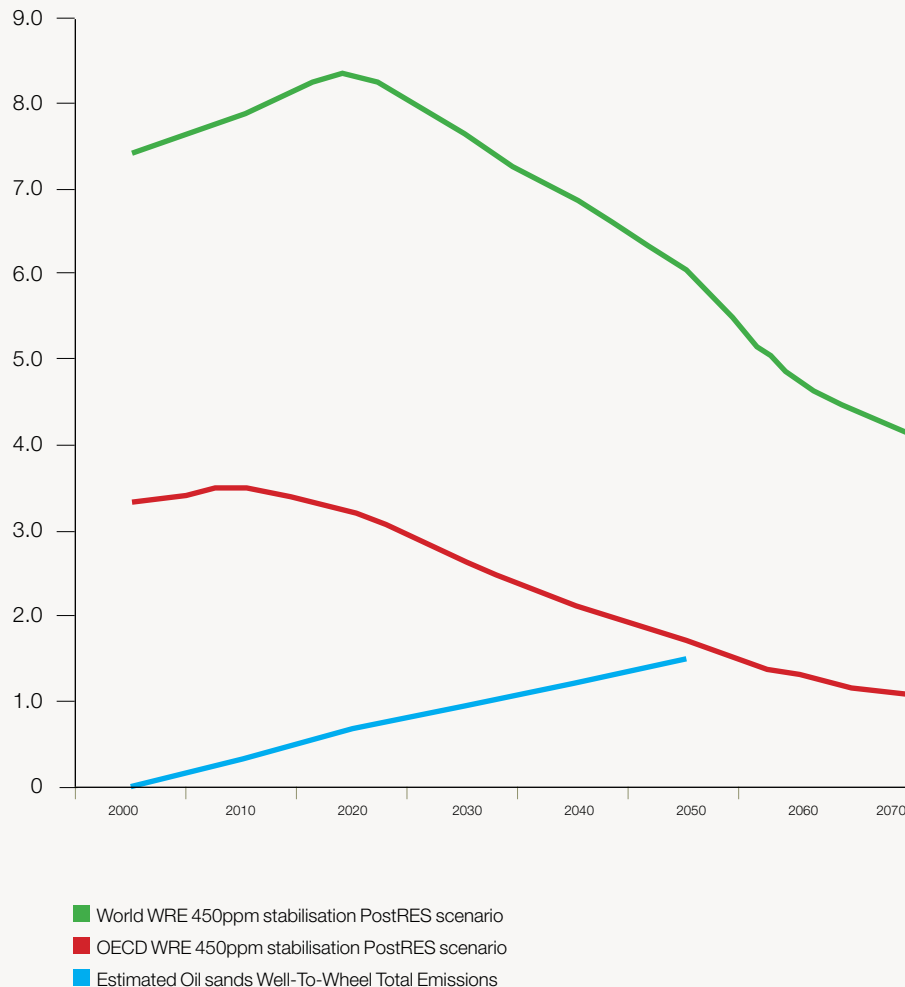
The larger the proportion of oil production from unconventional with a higher carbon footprint, the further the world will get from the emissions pathways needed. Companies are putting a large amount of effort into trying to make unconventional oils no worse than conventional oil, when in fact solutions are needed to rapidly produce a lower emissions trajectory.

Figure 6 below shows how the development of oil sands as a resource for transport fuels in North America is heading in the wrong direction. By 2050, this activity alone could account for the majority (87%) of emissions that can be produced from OECD countries in order to have a chance of stabilising at 450ppm. The diagram shows overall Well to Wheel (WTW) emissions for the rising oil sands production based on the Alberta Energy and Utilities Board forecast.⁷⁶ This is compared to the Intergovernmental Panel on Climate Change (IPCC) stabilisation pathways for the world and for OECD countries.

If oil companies are to be part of the solution rather than exacerbating the problem, they will need to decarbonise their energy portfolios. Investors will need to start valuing companies in a different way, which takes into account the reduced value of fossil fuels in a carbon-constrained world. Governments also need to take greater action to ensure strong emissions reduction targets are set and met. In the absence of the required government intervention, and as the scale of oil sand exploitation increases unchecked, the scenario could get even worse.

If all 315 billion barrels of probable reserves were fully exploited within the next century, it would result in emissions of 183 GtCO₂. It is estimated that this would lead to an increase in atmospheric CO₂ levels of between 9 and 12 parts per million.⁷⁷

Figure 6:
Annual emissions of oil sands expansion compared to those under a 450ppm stabilisation scenario for the world and OECD



Based on calculations by the Tyndall Centre for Climate Change Research

Conclusions

- Humans have discovered adequate conventional fossil fuel reserves to cause dangerous climate change by 2050. Putting more effort into perpetuating this model is detracting from finding alternative solutions.
- The world can only afford to use the least carbon-intensive fuels available. Oil sands are the most carbon-intensive fuel sources currently being exploited, and therefore the least efficient in a carbon constrained economy.
- Producing oil from oil sands creates on average three times as much GHG emissions as conventional oil.
- Canada has a target to reduce GHG emissions by 6% between 1990 and 2012, but in 2006 emissions were 27% above 1990 levels. The oil sands developments are the fastest growing contributor to Canada's GHG emissions and current plans guarantee Canada will continue to fail its Kyoto targets.
- If the oil sands continue to expand at the pace desired by the industry, the production and use of the fuel would account for 87% of the maximum allowable emissions from OECD countries in 2050 under a 450ppm stabilisation pathway.
- There is currently inadequate regulation of GHG emissions in Canada. If expansion goes unchecked, the result would be catastrophic for climate change.
- Internationally, low carbon fuel standards are required to prohibit fuels with lifecycle 'well to wheel' CO₂ emissions greater than those derived from conventional sources.
- Oil companies and investors should note the development of government measures to reduce CO₂ emissions, including those in the US to prohibit fuels with lifecycle CO₂ emissions greater than those derived from conventional sources. There are leading indicators that these regulations may restrict access to the primary markets for Canadian oil sand derived fuels.
- This capital intensive industry will see already high costs further increase by the need to reduce emissions.

***Intact boreal forest
– home to the caribou.***





***Exploration and infrastructure
is fragmenting the forest.***

Boreal forests

The forest and peat covering the oil sands act as a huge carbon reservoir, and the deforestation and removal/drying of the peat is releasing this carbon. The scale of Canada's function in this regard is globally significant. The boreal forest is the single largest terrestrial carbon storehouse in the world, and deforestation has been identified by the IPCC as a major contributor to climate change.

The scale of the clearance for oil sands can only be appreciated from the air. A closer look in Alberta reveals a criss-cross of cleared lines, where seismic exploration for oil sands has fragmented the habitat. In places these lines are six metres wide and just 40 metres apart. Drilling pads, access roads and pipelines also require clearance of forest. In addition, the processing plants cover a large area of land. So while in situ projects do not involve a large hole in the ground, they are capable of degrading the useful ground cover from an ecological perspective.

The forest is home to many species such as caribou, which require connected areas of intact forest that have sufficient buffers from such disturbance. At present there is no maximum density of activity that is applied to prevent cumulative impacts that destroy habitat. Studies have shown that forests within 1 km of roads and well sites tend to be avoided by caribou and that roads further fragment caribou habitat by acting as barriers to movement.^{78,79} Up to 80% of the surface area of current in situ developments provides less than a 250 metre buffer distance from industry disturbance.⁸⁰ Studies by the Canadian Parks and Wilderness Society and other studies indicate caribou populations have declined in recent decades due to a range of anthropogenic factors, including unsustainable logging and oil sands exploration.⁸¹

Some of the boreal forest is fen (peatland) which provides important ecosystem functions. More research is needed to better understand these subsurface processes which are critical for the ongoing functioning of the wetlands. For example, Petro-Canada has so far resisted entering McClelland Fen, half of which overlaps with one of its oil sands licences. McClelland Fen is one of the world's best examples of an ancient patterned fen, which provides a crucial habitat for migrating wildfowl such as the endangered whooping crane, as well as being home to some species that are unique to the region.⁸²

Government actions

In May 2007, 1,500 scientists from more than 50 countries called on the Canadian government to provide more protection for the boreal forest. This initiative was supported by the Canadian Boreal Initiative, which includes oil companies, First Nations (aboriginal) groups and conservation organisations among its members. Canada is home to half the remaining boreal forest in the world, and (not including tundra and wetlands) contains 11% of the global terrestrial carbon sinks. The boreal forest has an ecosystem carbon density of 164.8 t/ha.⁸³

The oil sands licences have been granted on the basis that operators will return areas to at least the same condition in which they were found – described as “equivalent land capability” by the Alberta government.⁸⁴ Companies have been conducting research into how best to recreate the boreal forest, with limited success. While some small areas have seen some tree growth, the harsh conditions and scale of the task mean that limited activity has taken place so far to reclaim a significant area. Almost 42,000 hectares are currently active for oil sands mining and almost 6,500 hectares were being reclaimed by the end of 2006.

After decades of activity, only 104 hectares have been certified as reclaimed by the Alberta government. Suncor Energy collected the topsoil from its mining in the 1980s and has managed to use this material as the basis for forest cultivation. No company has mastered the challenge of reclaiming a tailings pond. Most companies admit it is impossible to artificially return the land to the same condition as they found it; instead boreal land will have much lower levels of carbon density and biodiversity than previously existed.

The Cumulative Environmental Management Association (CEMA), a multi-stakeholder group charged with producing a framework for the oil sands a decade ago, has even called for a halt to oil sands licensing.⁸⁵ CEMA's membership includes First Nations representatives as well as oil companies (Petro-Canada, Imperial Oil and Suncor Energy), forestry companies and government departments. The proposal also recommends the protection of three boreal forest areas around Fort McMurray. The Assembly of First Nations Treaty Chiefs issued a call to go even further and implement a full moratorium on oil sands development.⁸⁶

Company activities

Some companies have developed less destructive seismic methods which require much less felling of trees and allow for deviations from a straight line, meaning that sight lines are broken along the seismic survey lines. However, there is no requirement to apply these methods, or to restore the affected areas.

The limited success in achieving reclamation should prompt questions about the wisdom of granting further licences to operate and expand. Shell has produced an advertisement on reclamation, stating that it will “do it right”.⁸⁷ Thresholds for disturbance would mean that companies could not open up more areas until they had satisfactorily restored previous areas, and thereby proved that wetland boreal forest could be adequately reclaimed. Some companies have started looking at offsetting the huge disturbance, both within Canada and overseas. This suggests that the operators are admitting failure on this issue, and trying to buy a quick fix through ‘biodiversity offsets’.

The oil sands licences are overlaid by a number of large forestry concessions. Coordination does occur between the oil companies and forestry companies regarding cutting areas that are about to be cleared for mining oil sands. Oil companies are required to compensate forestry companies for cleared areas, but not replant. WWF has worked with the forestry sector on Forest Stewardship Council (FSC) certification of its forestry areas. Some of these are subject to potential oil sands activity, and care must be taken not to compromise the achievement of FSC certification through forest destruction by oil sands activities, so as to maintain the ecological integrity of the certified lands and to protect the forest company interests.

Conclusions

- Deforestation has been identified by the IPCC as a major contributor to climate change; boreal forest is the world's largest terrestrial carbon reservoir and must be maintained.
- After decades of operation, there is no current evidence that reclamation of boreal forest is possible to the same levels of carbon density and biodiversity that previously existed.
- The use of “biodiversity offsetting” initiatives implies that companies have admitted that reclamation of some sites is impossible.
- Potential impacts on sensitive and endangered biodiversity and habitats represent reputational risk for oil companies. Sensitive areas such as McClelland Fen should not be exploited for oil sands as it will not be possible to recreate them.
- A maximum threshold of disturbance for each operator would limit the cumulative impact and compel reclamation.

Oil sands waste sites are supposed to be reclaimed to wetland.



Water

Huge amounts of water are used in extracting and processing oil sands. High levels of reuse have been achieved, with more than 90% being recycled in the process, but ultimately only 5-10% is returned to the river – the rest being too toxic.⁸⁸ The huge volumes involved mean that enormous amounts of wastewater are produced. There is widespread concern over whether there is sufficient water to meet both ecological needs and supply the existing oil sands developments, let alone the proposed expansions.

- Processing 1 m³ of bitumen produces 6 m³ of tailings.⁸⁹
- Between 2 and 4.5 barrels of water are used to produce a barrel of synthetic crude oil.⁹⁰ The average is 3 barrels of water.
- Oil sands water consumption is expected to more than double from 5 to 13 million m³ by 2015.⁹¹

Approved oil sands leases currently have licences to divert 370 million m³ (2.3 billion barrels) of freshwater a year from the Athabasca river. Planned expansions would increase this to 529 million m³ (3.3 billion barrels) a year, equivalent to 15.7% of current low flows.⁹²

The Athabasca river is a primary source of water for many of the Athabasca oil sands operations. The disturbance of the Athabasca wetland catchment by oil sands is also reducing the amount of runoff and groundwater reaching the river.⁹³ As a result there is less water in the river, while abstraction is increasing. The average summer flow in the Athabasca declined by 29% between 1970 and 2005.⁹⁴ In low flow seasons, there are concerns that the river is reaching levels below that needed to maintain its ecological functions. In particular the river suffers from low oxygenation in the winter and is at risk of temperatures lethal to fish during the summer, according to the University of Alberta.

Government actions

The absence of an effective management plan for the Athabasca has been highlighted for many years. Despite a Cumulative Environmental Management Association being set up to look at the issue, and the problem being raised during applications for specific oil sands projects, no agreement has been reached.

Given that the river is already reaching levels which indicate acute ecosystem stress in winter, allowing more extractions with flows declining cannot add up to a functioning Athabasca. Professor David Schindler, the leading expert on the Athabasca from the University of Alberta, states, “Current production levels may already be unsustainable due to poor water planning and climate change”.⁹⁵ Alberta Environment is refining the management plan to be implemented in 2010, and must come up with a stricter regime that prevents dangerously low levels and manages the cumulative impact on the river system.

In 2007, the Oil Sands Ministerial Strategy Committee – an advisory group to the Alberta government – concluded that the administration had failed to provide “timely advice and direction to industry relative to water use” and had “inadequate” capacity to enforce environmental laws.⁹⁶ It recognised that “the Athabasca river may not have sufficient flows to meet the needs of all the planned mining operations” and that the government had failed to determine if there was sufficient water available from the North Saskatchewan River to support the seven proposed upgraders.

Historically, licences for extracting water have been issued to operators without any consideration of the cumulative impacts on water bodies. Alberta Environment is now issuing shorter licences or considering non-renewal of licences. This provides an opportunity over the coming years to reduce extraction of water. There has already been a declaration that there will be no more licences on the Bow river, for example.

***McClelland patterned fen is vital
for birds but is under threat.***



Company activities

Some companies have achieved further improvements in water efficiency, reducing the need for new extraction licences to feed the expansion of production.

Operators are also considering alternative water sources for in situ projects such as saline aquifers. There are different concerns relating to this, in terms of leakage and salinisation of wetlands, and upsetting the balance of the aquifers. Producing steam from saline water produces a more concentrated waste which needs to be disposed of. The use of freshwater aquifers brings issues relating to drainage of the wetlands, which are essential for maintaining the boreal forest habitat.⁹⁷

Some companies are also researching “drier” technologies that heat oil sands using an element rather than steam. But such technologies are not expected to come online for 10-20 years.

Because of concerns that water availability will constrain production, some operators are investigating storage during higher flows to act as a reserve for low flow periods – for example, Petro-Canada has included storage for 45 days of water in the plans for its Fort Hills plant.⁹⁸ This storage option is still at a hypothetical stage, and it is not clear what the ecological effects of manipulating the flow regimes in this way would be. Experience of regulated flows downstream of dams suggests that disrupting the equilibrium in this way can have damaging effects and affect channel dynamics.

At present oil companies pay no charges relating to the volume of water they use. Payment is an option that could be explored, to ensure that sufficient water for ecosystem services and other essential uses is available. Oil companies may expect some kind of level playing field with other industries such as agriculture (irrigation) that also withdraw water in Alberta – but the fact remains that more than three-quarters of withdrawals from the Athabasca River are for the oil sands industry.⁹⁹

Toxic waste

The waste flows contain water, sands, silt, clay and residual bitumen, and are sent to tailings ponds (large lakes of slurry) to settle over decades. Individual tailings ponds are up to 50 sq km in size and can be seen from space. The dam structures are among the largest in the world. Contaminants include high levels of naphthenic acids from the bitumen. This water is acutely toxic to aquatic life and noise guns have to be used to prevent wildfowl landing on the water. Syncrude issued a public apology in May 2008, following an incident where several hundred migratory birds were killed because protective measures were not activated on a tailings pond.¹⁰⁰

The proximity of these huge toxic storage lakes to the Athabasca river – some are only metres from the bank – is particularly worrying. Any breach of these dams would lead to a catastrophic impact on the river – a major environmental risk for operators.

Limited information is available on how the toxic material is contained in the tailings ponds. Concern has been expressed that some of the contaminated water may leak out over time.¹⁰¹ Operators conduct their own monitoring of the situation. The extent of independent monitoring is not adequate to capture this information and needs to be improved. Investing in the Future, a review by the Alberta government, described the province’s capacity to enforce and monitor environmental standards as inadequate.¹⁰² Very limited data is available from the authorities, with only minimal data collected by the industry association.

Suncor expects the first major reclamation in 2010 from its original tailings pond that was started in 1967.¹⁰³ Over the decades of settling and evaporation, large quantities of volatile hydrocarbons will have been emitted from the water surface. Suncor has been required to provide security for reclamation liabilities to Alberta Environment for its Millennium and Steepbank mines, which totalled C\$163 million for the financial year 2006-07.¹⁰⁴ It is not clear whether insurance is available for environmental damage from dam failures.



Tailings ponds are vast lakes that store toxic sludge for decades.

Water quality and health issues

Representatives of the Mikisew Cree First Nations community live in the small town of Fort Chipewyan, on the shore of Lake Athabasca, downstream of the oil sands operations. Dr John O'Connor was the doctor for this community, and has raised the alarm over an unusual number of victims of a rare bile duct cancer in this town. The incidence is normally only one case in 100,000, yet he has seen five cases in the community of around 1,200 people.¹⁰⁵ The doctor has also observed an atypical number of thyroid problems and other immune system-related conditions. Local fishermen have also reported catching fish with lesions and boils in Lake Athabasca, downstream from the oil sands.¹⁰⁶

At present no direct causality has been proven with the oil sands activities. Dr O'Connor and his patients called for an investigation by Alberta Health Department into the unusually high numbers of cases in Fort Chipewyan. A recent study of the water and sediment revealed contaminants of concern including arsenic, mercury and polycyclic aromatic hydrocarbons (PAHs).¹⁰⁷ Mercury levels in fish used for human consumption present a serious concern. If US Environmental Protection Agency standards are applied, all walleye (pickereel), all female whitefish, and some 90% of male whitefish exceed subsistence fisher guidelines for mercury consumption.

The Chipewyan Prairie First Nation are suing the Alberta government, claiming that they were not consulted over the licensing of areas to MEG Energy, which they consider the "bread basket" of traditional lands that have supplied fish, game and other resources for generations of native groups.¹⁰⁸ The Canadian House of Commons Environment Committee is set to investigate water issues relating to the oil sands. Meanwhile the Alberta Cancer Board will conduct a joint investigation into the unusual level of health problems experienced in Fort Chipewyan.¹⁰⁹

Conclusions

- Availability of water could be a significant limiting factor to expansion and is a business and ecological sustainability issue. Government needs to set a regulatory framework and charge for water. Operators need to develop new water management plans to prevent impacts on operations and ecosystems.
- As water demand increases and river flows decrease to dangerous levels, companies can expect costs to rise or access to water to be restricted, limiting growth or increasing operating costs and capital intensity. The Athabasca river is already over-exploited and experiences low flows that impact the ecological functions of the aquatic ecosystem.
- Decades of legacy contamination are building up in tailings ponds. The management of these tailings, due to their size and toxicity, represents a long-term environmental liability and significant risk.
- After decades of operation, there is no current evidence that reclamation of tailing ponds is possible.
- Loss of wildlife which come into contact with tailings ponds presents a reputational risk.
- Concerns over health impacts on First Nations communities downstream from the oil sands need full investigation to establish the causes of abnormal rates of serious medical conditions.
- The independent monitoring system for water quality downstream from oil sands activities is inadequate and needs to be improved, to ensure the polluter pays.



Local fishermen on Lake Athabasca are concerned about water pollution.

Oil company involvement

In the last few years, high oil prices have led not only to a resurgence of interest in the oil sands, but also a raft of project announcements and proposals. This has been complemented by multinational oil companies acquiring smaller operators who held leases, causing a shift away from Canadian ownership of the operations and profits. Statoil bought North American Oil Sands, Total acquired Deer Creek, and BP partnered with Husky Oil. Royal Dutch Shell bought out the remaining shares in Shell Canada that it did not already own. Many operators are still planning or developing their projects, but the projection for production in 2020 indicates a different picture, with many of the bigger players aiming for more than 500,000 bpd.

Recent years have seen a flood of investment by major oil companies in the oil sands:

- In January 2008, Suncor outlined a C\$20 billion expansion plan for its Voyageur project.¹¹⁰
- In December 2007, BP announced a \$5.5 billion partnership with Husky Energy.
- Petro-Canada committed to the C\$26 billion Fort Hills project in June 2007.¹¹¹
- CNRL is completing the first C\$7 billion phase of its Horizon project, with up to C\$4 billion of further investment expected.
- In April 2007, Statoil paid \$2 billion to acquire North American Oil Sands, then spent a further \$2 billion acquiring leases from EnCana.
- In March 2007, Royal Dutch Shell completed the £3.8 billion acquisition of the 22% of Shell Canada that it did not already own.¹¹²
- In October 2006, ConocoPhillips and EnCana Corp announced a \$10.7 billion partnership to boost Canada's oil production and deepen its access to the US market.¹¹³
- ExxonMobil (through Imperial Oil) has applied for a \$6.8 billion development of its Kearl oil sands 4.4 billion barrel reserve.¹¹⁴
- Total paid \$1.7 billion in 2005 for Deer Creek Energy. In May 2007 it announced plans to spend \$15 billion over next decade in oil sands.¹¹⁵

Further investment is being directed to upgrading facilities in order to process the bitumen, as well as increasing refining capacity. The Syncrude Company is a joint venture between a number of the more established operators (Canadian Oil Sands Limited, ConocoPhillips, Imperial Oil Resources, Mocal Energy Limited, Murphy Oil Company Ltd, Nexen and Petro-Canada) and has both mines and upgrading

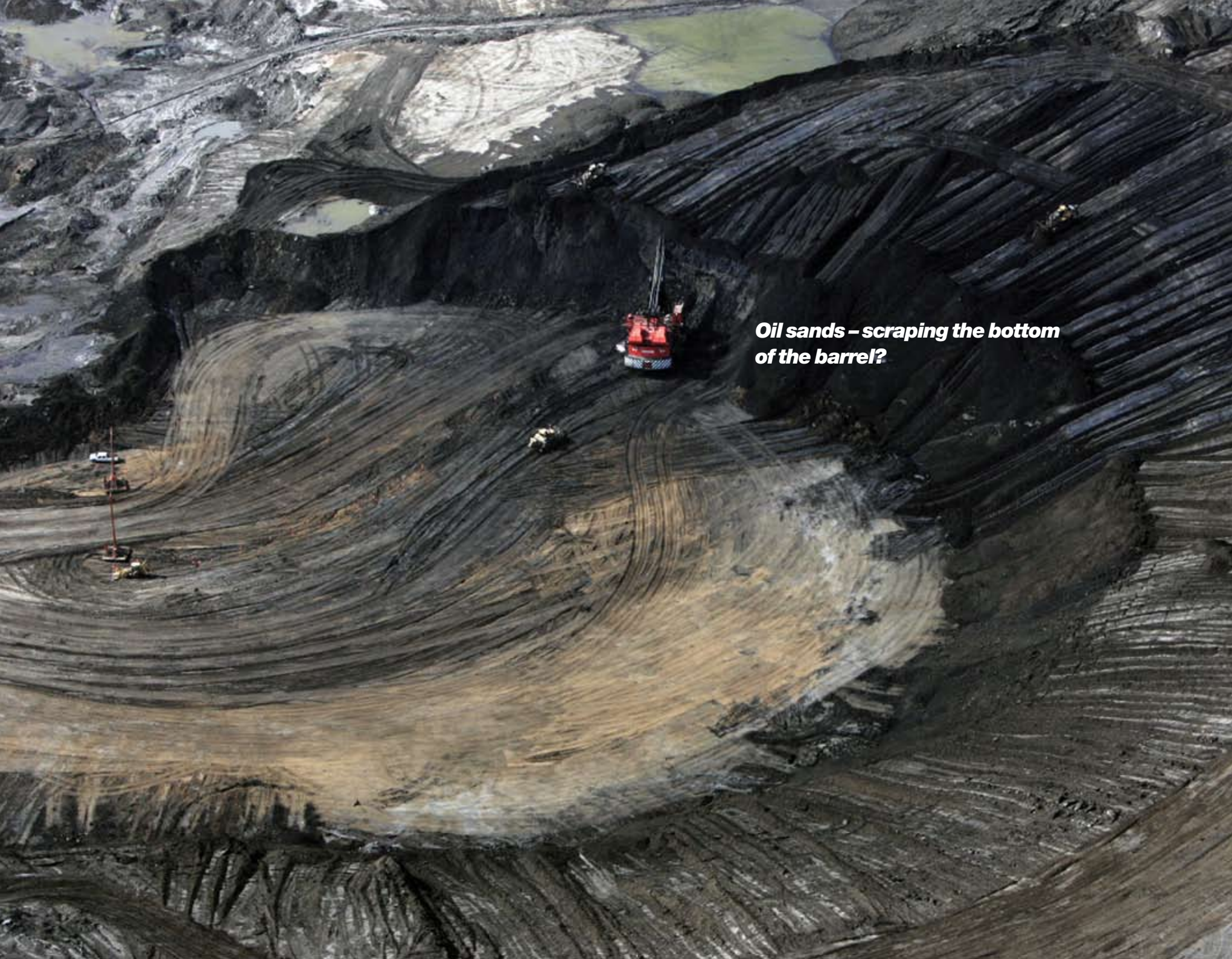
facilities. The collaborating oil companies utilise Syncrude's technology and facilities and have an interest in its expansion.¹¹⁶ Beyond this there is increasing vertical integration of extraction, upgrading and refining, as demonstrated by the Husky/BP and Conoco/EnCana tie-ups.

It is clear that a number of major oil companies are intending to have significant production of several hundred thousand barrels per day from oil sands in 2020. This reliance on unconventional production is a strategy which backs a high oil price and a low carbon price. Meanwhile, the companies do not appear to be backing sufficient alternatives to liquid hydrocarbons to provide energy for transport.

Table 1:
Summary of current and proposed output by company

Company	(Thousands of barrels per day)				Total
	Operating 2006	Planned 2020	Mining	In situ	
CNRL	0	577	50	240	817
Suncor	276	324	68	376	700
Shell	155	570	12	100	670
Syncrude	291	593			593
EnCana			50	500	500
ExxonMobil/Imperial		300	140	170	470
Petro-Canada		190	34.5	274.5	464.5
Total/Deer Creek		200	2	42	242
BP/Husky	0			230	230
OPTI/Nexen			2.5	218.5	218.5
Statoil/North American				160	160
Synenco		100			100
Conoco Phillips				100	100
Devon				70	70
JACOS			10	60	60
MEG				25	25
Black Rock			0.5	20.5	20.5
Connacher				10	10
Orion			2		0
TOTAL	722	2854	371.5	2596.5	5450.5

Source: Strategy West¹¹⁷



***Oil sands – scraping the bottom
of the barrel?***

Strategic direction: UK companies

Most operators in the Canadian oil sands claim to be investing in research and energy efficiency initiatives and technologies to reduce emissions from their operations. However, there is little evidence of progress actually being achieved. Shell is making more effort than most, in 2006 it introduced *Shell Enhance*, a froth treatment process, which, it claims, improved energy efficiency by 10%.¹¹⁸ Shell is one of only a handful of companies that have disclosed an action plan to reduce and offset emissions. However, as this report demonstrates, these measures are insufficient to mitigate the potential climate change impacts arising from oil sand exploitation, and rather than putting a large amount of effort into trying to make unconventional oils no worse than conventional oil, solutions should be sought that rapidly produce a lower emissions trajectory. Shell has stated in its annual report that it is aiming for up to 15% of its production from un conventionals by 2015, up from less than 5% now. Worryingly the proposed expansion projects, such as Shell's expansion of its Albion plant, have lower emissions performance than the existing plants due to relying on high carbon energy supplies.

Shell is a supporter of on-shore wind in the United States, with estimated installed capacity of over 400MW forecast for 2008-9, and has invested in R&D in third generation marine algae biofuels and new generation thin film solar technology.¹¹⁹ However, in recent months, as it has significantly increased investment in oil sands, it has also divested from renewable energy. The company sold its solar business off bit by bit during 2007¹²⁰ and has followed this in 2008 by pulling out of the London Array – the largest proposed wind farm in the world.¹²¹ The reason, Shell says, is to divert capital to better opportunities. Previously the company had publicly recognised that “offshore wind is vitally important to delivering the UK's renewables target” and that “wind energy has real potential for the UK as it has the best wind resource in Europe”¹²²

Shell has published its latest iteration of scenarios for energy futures. The “scramble” scenario in this document outlines an undesirable future. Investors should consider how companies are utilising capital to avoid this situation:

“How unconventional oil from oil sands, shale, and coal is developed provides a typical Scramble example of solutions being introduced with immediate benefits to energy security but some later negative consequences. Throughout the 2010s, investors pour more and more capital into unconventional oil projects that make an important contribution to addressing supply pressures. Nevertheless, these attract increasing opposition from powerful water and climate lobbies that oppose the environmental footprint of additional developments. This ultimately provokes a political backlash that challenges even the best-managed projects.”¹²³

In 2005, BP set up an Alternative Energy division, which pledged to invest \$8 billion by 2015, to deliver a business with a turnover of \$6 billion per annum. This compares to the \$20 billion per annum invested in the hydrocarbons business. The Alternative Energy unit includes not only wind, solar and hydrogen, but also natural gas. The inclusion of natural gas masks the precise extent of this activity that is not hydrocarbon based. BP's flagship hydrogen power and CCS project at Petershead, Scotland, was shelved in May 2007 after it failed to secure the subsidy it wanted from the UK government.

Both BP and Shell have also been researching the potential for biofuels, as countries attempt to meet their obligations in Europe to provide 5.75% of alternative fuels to petrol and diesel for transport by 2010. The complexity of issues relating to the sustainability of producing large quantities of biofuels which can deliver significant carbon emission benefits without compromising food production or biodiversity habitat mean that this is not a large scale solution in its current form.

The amount of green advertising from both Shell and BP is disproportionate to their efforts on actually delivering renewables. Shell has run a global advertising campaign talking about oil sands being “difficult yes, but impossible no”.¹²⁴ But all that has changed is the oil price, not the environmental cost of producing it from oil sands. The advert continues, “As long as we have innovation and ingenuity on our side, there's no energy challenge we can't overcome”. We therefore challenge Shell and other oil companies to develop an alternative to liquid hydrocarbon transport fuels, rather than perpetuate the status quo.

Conclusions

- The UN Framework Convention on Climate Change has outlined how investment needs to be withdrawn from fossil fuels and redirected to sustainable alternatives. This is not reflected in the investment strategies of the major oil companies.
- In view of these companies divesting from renewables whilst increasing investment in carbon intensive fuels, it is understandable that the public is sceptical and the companies accused of 'greenwash' when they persist with the message that they are responsible and seeking to be sustainable.

Emissions from oil sands processing.



Oil shale

Background

What is it?

The term oil shale generally refers to any sedimentary rock that contains solid bituminous materials (known as kerogen) that are released as petroleum-like liquids when the rock is heated.¹²⁵

How is it extracted?

To obtain oil, the shale must be heated to around 400°C and the resultant liquid captured. Processing has traditionally taken place once the rock is mined, but research is now focusing on ways to extract the liquid in situ underground.¹²⁶ The liquid that is produced needs to be upgraded to a light enough oil to be refined into petroleum products.

Shell has been developing advanced heating systems to use super-heated steam to heat the oil shale underground.¹²⁷ The major challenge is then how to prevent the liquefied hydrocarbons from flowing through the porous rock. Shell's answer to this is its "freezeway" technology. This involves the creation of frozen barriers around the edge of the extraction area. Shell is testing this on an area of land the size of a football field, which involves drilling 157 holes around the edge to a depth of 550 metres. An ammonia-based refrigeration system will be installed through these holes, to create a wall of frozen ground around the oil shale to be extracted.

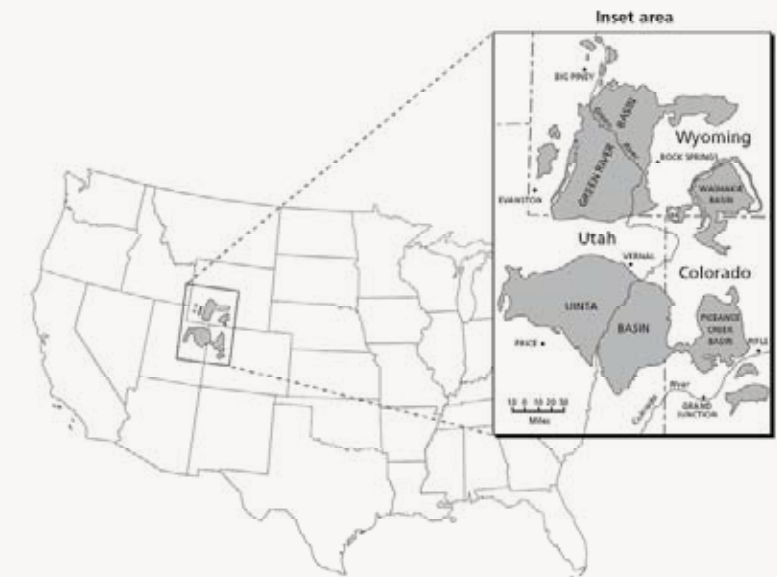
While this may be a feat of engineering, it is clearly a highly inefficient process if rock has to be frozen on the outside at the same time as the centre is being super-heated to 400°C. This is a prime example of how the technical expertise of the major oil companies is being misdirected to extracting inefficient liquid hydrocarbons, rather than developing alternatives. They are trying to make oil shale economically viable; given this is the charge levelled by oil companies at renewables – that the return on investment is not adequate – why can they not focus their efforts on clean solutions?

Where is it?

The largest known oil shale deposits are in the US, where there are an estimated 1.5 trillion barrels of reserves. There are only estimates as to what proportion may be recoverable, but the mid-point currently used by the US government is 800 billion barrels. This is equivalent to three times the reserves of Saudi Arabia.

Other countries with significant oil shale reserves (more than 15 billion barrels) include Australia, Brazil, Canada, China, Congo, Estonia, Italy, Jordan and Morocco.¹²⁸ Of these, only Brazil, China and Estonia are currently exploiting oil shale. Estonia mainly utilises its oil shale in a similar manner to lignite coal for electricity generation; however, it is scaling down this part of its energy production as part of its accession to the European Union, and due to the product's non-competitiveness compared with alternative fuels.¹²⁹

Figure 7:
Location of the Green River Formation oil shale and its main basins



Source: US Department of the Interior, Bureau of Land Management

Government actions

The US government has promoted oil shale development on many occasions and has expressed renewed interest, as laid out in the 2005 Energy Policy Act:¹³⁰

“Section 369 of the Energy Policy Act of 2005 (the Act), Public Law 109-58 (H.R. 6), enacted August 8, 2005, directs the Secretary of the Interior to make available for leasing such BLM-administered land in Colorado, Utah, and Wyoming as the Secretary considers to be necessary to conduct research and development activities to facilitate the recovery of liquid fuels from oil shale and tar sands on public lands. Furthermore, Section 369 directs the BLM to prepare a Programmatic Environmental Impact Statement (PEIS) for a commercial leasing program for oil shale and tar sands resources on public lands.”¹³¹

As a result of this legislation, the Federal Bureau of Land Management (BLM) issued a licensing round and accepted applications for leases from Shell, Chevron and EGL Resources.¹³² These leases grant rights to develop oil shale resources on tracts not exceeding 160 acres of public land for lease. These tracts were identified in proposals submitted by the companies in June 2005. The initial term of the leases is 10 years with the option of extending up to five years with proof of diligent pursuit of commercial production levels. The leases also contain a preferential right to convert the acreage, plus adjacent acreage up to 4,960 acres, to a 20-year commercial lease once commercial production levels have been achieved and all requirements have been met. The oil shale is found in Colorado, Utah and Wyoming, with the largest area being the Green River Foundation.

Climate change

Energy Intensity

A 2005 study by the RAND Corporation estimates it would require a 1,200-megawatt power plant to unlock just 100,000 barrels of shale oil a day. Large enough to serve half a million people, the power plant alone would burn five million tons of coal each year and release 10 million tons of GHG emissions.¹³³ A plant of 1,200 MW is enough to power 300,000 homes in the US – more than enough for the whole of Denver, the largest city in Colorado. Shell alone is looking for production five times this level. The plant would also place further stress on water resources to provide cooling water.

As Figure 5 indicates, production emissions from oil shale are significantly higher than for conventional oil – and even higher than oil sands.

What emissions would result?

The amount of emissions associated with oil shale would obviously depend on the exact technologies used, and the extent of any mitigation measures or carbon capture technologies. The Colorado Energy Institute, which works closely with the US government on oil shale issues, has estimated that the power plants and chemical reactions required would generate 350 million tonnes of carbon dioxide a year once production is established at three million barrels a day. This represents about 5% of current annual US GHG emissions of 7.26 Gt CO₂.¹³⁴

Figure 5 shows that the production of oil shale can easily produce the same emissions as the use of the fuel. If this is the case, the production and consumption of all 800 billion barrels could result in an estimated 797 Gt CO₂ from oil shale exploitation. It is estimated that this would result in an increase in atmospheric CO₂ levels of between 39 and 53ppm.¹³⁵

Water

Water quantity may also be an issue, as significant quantities in the order of several barrels for each barrel of oil produced are required for processing and cooling.¹³⁶ Mining oil shale requires between two and five barrels of water for each barrel of oil shale. Extraction levels of three million bpd would therefore require 6 to 15 million barrels of water per day. In situ processing requires the groundwater to be pumped out of the frozen extraction area. Water is used for steam and for cooling. Process waters are likely to have high concentrations of soluble organic materials, along with very high concentrations of ammonia nitrogen, alkalinity, chlorides and sulphates. The extraction of groundwater will also increase salinity concentrations and destroy habitat for native and endangered fish in the Lower Colorado and Green rivers.¹³⁷ In December 2007, the US Department of the Interior announced special measures to tackle the drought which has been occurring for the last eight years in Colorado.¹³⁸

Ecological impacts

The potential area for oil shale development in Colorado is home to several types of ecosystem which form habitats for a number of threatened or endangered species of flora and fauna, as identified by the US Fish and Wildlife Service. These are summarised in the programmatic environmental impact statement released by the US government in December 2007.¹³⁹ The exact impacts would depend on which sections of the known oil shale blocks were exploited, but potentially include long-eared owls, short-horned lizards and bald eagles. The waste material from mined oil shale would also need to be disposed of, and due to its greater volume than the shale extracted, would probably require some surface facilities on top of infilling mined areas.

Airborne emissions are expected to include sulphur dioxides, nitrogen dioxides, particulates, ozone precursors and carbon monoxide. Restrictions regarding the level of increases above ambient levels permitted in this region would need to be adhered to by any development.

The Colorado River Basin supplies a range of activities, and water quality is essential to municipal, industrial, agricultural and recreational users, as well as to aquatic wildlife. As with other mining, control of mine drainage and leachate from waste storage will be essential to prevent contamination of the water. Further work is needed to demonstrate that the infilling of waste material into mined areas could be adequately controlled from a toxic leaching point of view. Research in China indicates that an oil shale waste site experienced contamination of soil and groundwater by heavy metals and carcinogenous hydrocarbons which were traced back to the oil shale.¹⁴⁰

Oil company involvement

Royal Dutch Shell

Shell has acquired leases in the most recent round of licensing by the US government, and has released some initial information regarding its research and pilot project at Mahogany Ridge.^{141, 142} Shell reportedly expects to get 500,000 barrels of oil per day from the project, although analysts estimate it will take six to eight years before extraction methods are perfected.¹⁴³

Shell signed a joint venture with Jilin Energy, a Chinese company, in September 2005 to explore and develop oil shale resources in Jilin province.¹⁴⁴ Shell owns 61% of the company, and Jilin 39%. Up to US\$30 million will be invested in the exploration phase. Jilin province is estimated to hold 17 billion tonnes – more than half of China's oil shale.¹⁴⁵

Chevron

Chevron also acquired leases in the most recent round of licensing by the US government and has formed a strategic research alliance with the Los Alamos National Laboratory to improve the recovery of hydrocarbons from oil shale.¹⁴⁶ Chevron is investigating chemical conversion methods to convert shale, once it has physically shattered 60-metre thick layers underground.¹⁴⁷

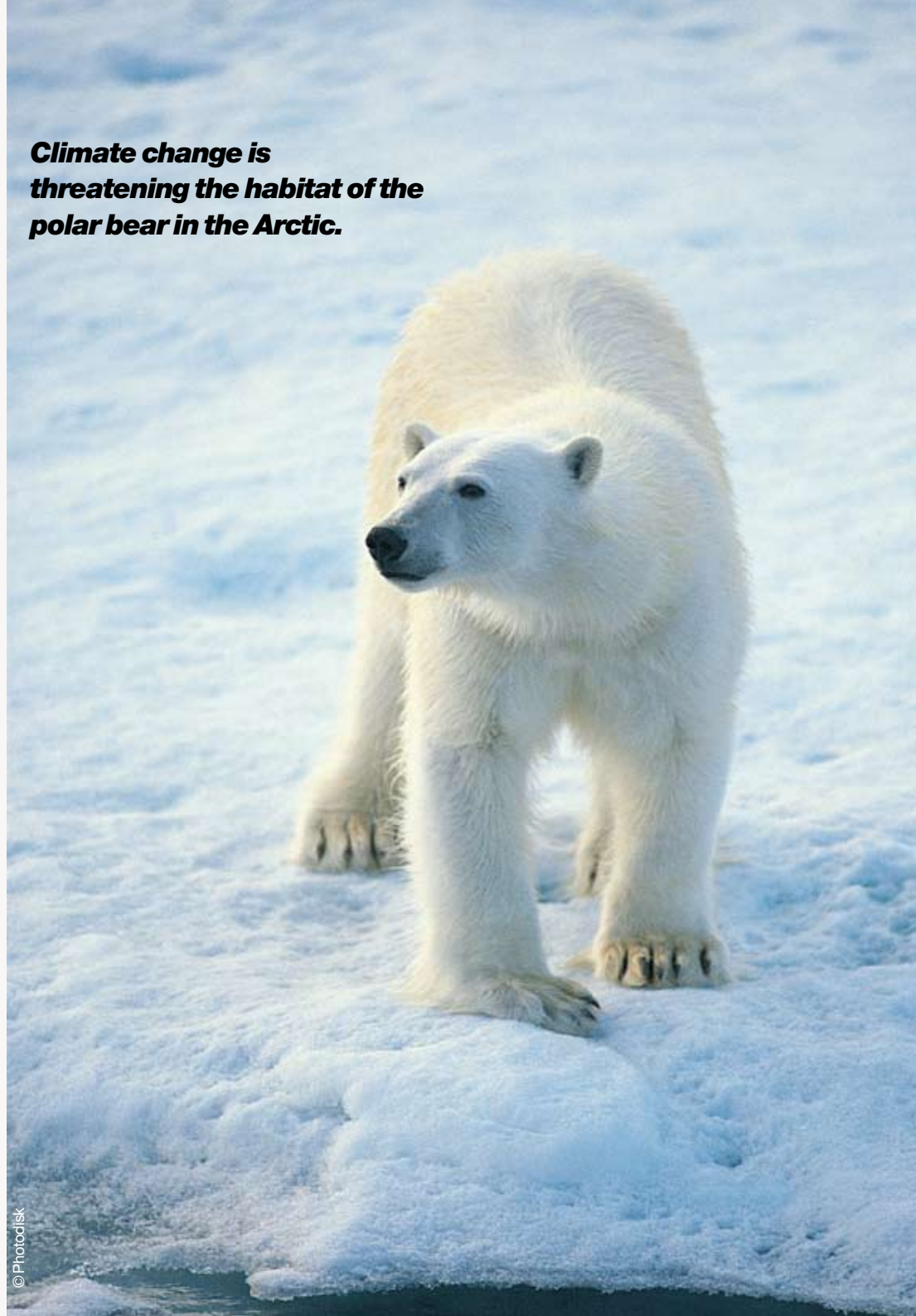
ExxonMobil

ExxonMobil publishes no details of its oil shale involvement, but its activities indicate its ongoing interest in the resource. The company did participate in the recent oil shale symposium held by the Colorado Energy Research Institute in October 2007.¹⁴⁸ ExxonMobil applied for leases in the recent Colorado licensing round, but were not shortlisted. ExxonMobil plans to shoot particles of petroleum coke, a by-product of oil refining, into cracks in the shale. The coke would be electrically charged to create a subterranean hotplate that would cook the bituminous material in the shale until it turns into crude.¹⁴⁹

Conclusions

- Oil shale is far more energy intensive to extract and produce than conventional oil or even oil sands, and is therefore more carbon intensive. Oil shale represents the extreme efforts the oil industry continues to pursue in spite of climate change concerns.
- Humans have discovered adequate conventional fossil fuel reserves to cause dangerous climate change by 2050. Putting more effort and capital into research and development of unconventional fossil fuel reserves is detracting from finding sustainable alternative solutions.
- Internationally, low carbon fuel standards are required to prohibit fuels with lifecycle 'well to wheel' CO₂ emissions greater than those derived from conventional sources.
- Oil companies and investors should note the development of government measures to reduce CO₂ emissions, including those in the US to prohibit fuels with lifecycle CO₂ emissions greater than those derived from conventional sources.
- The regions are experiencing drought and cannot support water intensive activities; this could be a significant limiting factor to commercialisation and is a business and ecological sustainability issue.

Climate change is threatening the habitat of the polar bear in the Arctic.



Climate disaster

The world's climate scientists agree that in order to avoid dangerous levels of climate change we need to limit global mean temperature increases to 2°C above pre-industrial levels. This will require stabilizing atmospheric CO₂-equivalent levels at around 450 parts per million (ppm).¹⁵⁰ In order to achieve this, it is likely that global emissions must peak by 2015¹⁵¹ and fall by 80% compared to 1990 levels by 2050.¹⁵² In the absence of significant intervention, the nightmare scenario could present itself where CO₂ emissions elsewhere in the global economy remained unaddressed whilst the exploitation of unconventional fossil fuels continued to accelerate, potentially releasing an additional 183 GtCO₂ from Canadian oil sands and 797 GtCO₂ from US shale oils. This would have devastating consequences.

The geological record gives us an indication of what these consequences could be. During the Palaeocene-Eocene period some 55 million years ago, the rapid decomposition of frozen methane gas hydrate deposits found in the deep ocean near continental margins and in the Arctic, led to accelerated global warming as the methane released during melting reacted with oxygen to produce huge amounts of CO₂. Both methane and carbon dioxide are potent greenhouse gases and caused temperatures to soar, with average global temperatures increasing by roughly 5 °C in less than 10,000 years.¹⁵³ This climate warming caused widespread changes including mass extinction in the world's oceans due to acidification, the shifting of climatic zones, with core extracted from the Arctic Ocean indicating sub-tropical temperatures, and rapidly changing ecosystems, with consequent species loss.¹⁵⁴

Many scientists now recognise the similarity between the event known as the Palaeocene-Eocene Thermal Maximum (PETM) and the world we are heading into this century. In May 2006, the Harvard University scientists John Higgins and Daniel Schrag stated, "The PETM represents one of the best natural analogues in the geologic record to the current rise in atmospheric CO₂ due to burning of fossil fuel."¹⁵⁵

It is estimated that the exploitation of US shale oil and Canadian oil sand deposits would result in well-to-wheel emissions of 980 GtCO₂, leading to an increase in atmospheric CO₂ levels of between 49 and 65ppm.¹⁵⁸ CO₂ levels in the atmosphere are currently 387ppm (430ppm CO_{2e}), up almost 40% since the industrial revolution and the highest for at least the last 650,000 years.¹⁵⁹

By emitting this 49 to 65ppm, in addition to emissions resulting from conventional oil, humanity would be knowingly risking a new global extinction event as we pass the 450 CO₂-equivalent ppm stabilisation target, most probably triggering positive feedbacks in the climate-carbon cycle and passing climate change tipping points, beyond which there is no return for thousands of years.

"If we follow business-as-usual then we will commit future generations to dangerous climate change, and if we exploit unconventional fossil fuels we could return the Earth to a hot state it hasn't seen since 55 million years ago."¹⁵⁶

Dr Tim Lenton, from the Tyndall Centre for Climate Change Research

"As conventional oil dwindles, squeezing oil from shale mountains is not an option that would allow our planet and its inhabitants to survive."¹⁵⁷

Jim Hansen, Director of the NASA Goddard Institute and Adjunct Professor of Earth and Environmental Sciences at Columbia University's Earth Institute

Passing 450 CO₂-equivalent ppm would result in temperature increases in excess of 2 °C,¹⁶⁰ this could push key geographical features which play a major role in regulating the planet's climate past their tipping points within the next 100 years. A recent study concluded that the tipping point for Arctic summer sea-ice may be reached within 10 years as global temperatures increase by 0.5-2 °C. Although it would take at least 300 years to reach a near ice-free state, the tipping point beyond which there is an ongoing net mass loss of the Greenland Ice Sheet resides at just 1-2 °C global warming. Arctic ice deflects solar radiation and helps stabilise the atmosphere, if the ice disappears its loss would amplify warming and disrupt weather patterns. The Earth's largest terrestrial carbon sinks could also be dramatically altered within the next 100 years and reach their tipping points within 50 years. Dieback of the Amazon rainforest has been predicted to occur at 3-4 °C warming due to a more persistent El Nino state that would lead to drought across much of the Amazon basin. The study also concludes that 3-5 °C of warming would result in large-scale dieback of the northern boreal forests to half their current global area. The loss of such carbon sinks and the emissions resulting from dieback would further accelerate climate change.¹⁶¹

Positive feedbacks in the climate-carbon cycle and accelerated man made emissions could eventually lead to temperature increases similar to that experienced during the PETM, but rather than millenia, this increase could occur over decades. This rapid global warming could prevent ecosystems from adapting to the changing climate, and flora and fauna from migrating with shifting climate zones.

Studies of more than one thousand species of plants, animals, and insects, found an average migration rate toward the North and South Poles of about four miles per decade in the second half of the twentieth century. That is not fast enough. During the past thirty years the lines marking the regions in which a given average temperature prevails ("isotherms") have been moving poleward at a rate of about thirty-five miles per decade. If emissions of greenhouse gases continue to increase at the current rate then the rate of isotherm movement will double in this century to at least seventy miles per decade.

If we continue on this path, a large proportion of the species on Earth may become extinct. The species most at risk are those in polar climates and the biologically diverse slopes of alpine regions. Polar animals, in effect, will be pushed off the planet. Alpine species will be pushed toward higher altitudes, and toward smaller, rockier areas with thinner air; thus, in effect, they will also be pushed off the planet.¹⁶²

According to a 2007 study, if global warming continues unabated, many of the world's climate zones may disappear altogether by 2100, leaving new ones in their place unlike any that exist today. Based on scenarios put forth in the Fourth Assessment report of the Intergovernmental Panel on Climate Change (IPCC), researchers found that the business-as-usual scenario would create entirely new patterns of temperature and precipitation for 12 to 39 percent of Earth's land area. An additional 10 to 48 percent of land would see its climate zones disappear, replaced by patterns of temperature and precipitation now occurring elsewhere, such as rain forest becoming savanna or evergreen forest becoming deciduous.¹⁶³

The IPCC, in its Fourth Assessment report, estimated in its worst case scenario that global average temperature increases could reach 6.4 °C by 2100. Such rapid warming could spell extinction for a significant proportion of life on Earth, with projections suggesting extinction rates of 40-70% around the world as temperature increases exceed 3.5 °C.¹⁶⁴

The world needs to be put on a very different path to ensure we avoid exceeding 450 CO₂-equivalent ppm and the very real chance of a new mass extinction event. Unless this fact is widely communicated, and decision-makers are responsive, it will soon be impossible to avoid climate change with far-ranging undesirable consequences. We have at most ten years – not to decide upon action – but ten years to alter fundamentally the trajectory of global greenhouse emissions. Government, companies and investors all need to ensure they are contributing to a positive outcome.

Investor risk

The Stern Review on the Economics of Climate Change commissioned by the UK Treasury concluded “climate change is the biggest market failure ever seen”.¹⁶⁵ Oil companies have taken advantage of the high oil price and the failure to create a market where the cost of carbon provides sufficient disincentive to invest in carbon-intensive activities. We infer that companies and governments promoting future unconventional oil production are either endorsing a future where carbon emissions are not going to be tackled by regulation or the market, or believe technology is going to solve unconventional side-effects in short order. This report has shown that if the latter assumption looks doubtful, the former is out of the question, unless climate disaster becomes acceptable.

Exploitation of unconventional fossil fuels is essentially an opportunistic response to market conditions. But even BP recognises that it and its competitors will have to become energy companies to survive, and that alternative cleaner energy sources can only become a bigger proportion of the pie, and will be here to stay. The wisdom of oil companies diverting time and money into making a highly polluting energy source somewhat less so, is therefore open to question. Rather they should accelerate the advancement of low-emission technologies and fuels while continuing to exploit conventional fossil fuels as a necessity for the time being. Energy companies frequently respond (meritoriously) that they are not charities and must obey the commercial imperative within the law. But is the commerce currently being undertaken sustainable?

At a time when investors want to know the carbon liabilities hidden in companies' books, it is legitimate for even the most conservative investor to question why companies are pursuing a path that, while profitable in the short term, could soon become unviable because of punitive carbon regulation and consumer concern. By this time, massive capital expenditure will have been injected into it, in a sector where costs elsewhere have been rising alarmingly. It is noteworthy that in the week of writing this report, Imperial Oil and ExxonMobil are engaged in a legal battle with the Canadian government to win back a permit to drain 200 square kilometres of the Muskeg, which was voided following a Federal Court ruling which challenged the companies' estimation of GHG emissions that formed part of its approval process. The decision threatens a project in which Imperial Oil has already spent C\$228 million.

And carbon liability is only one aspect of the real cost. We are living in a world where corporations can increasingly expect to be held to account and pay for these externalities. With unconventional fossil fuels, these costs will include the long-term management of toxic waste tailings ponds, large enough to be seen from space and to date unable to be reclaimed, and land reclamation of primary boreal forest, which has hardly begun to be addressed – and then with only limited success. Shareholders, bondholders and financiers who are making assumptions about returns in five years or more should not only be asking “what's the true cost here?” but also “what's the reputational risk?” In the week of writing and following significant public criticism, Syncrude has felt obliged to run full-page advertisements in newspapers apologising for the deaths of 500 migrating birds which landed on one of its tailings ponds.

The companies in the Integrated CO₂ Network, which include Shell and BP, have pressed for the adoption of large-scale CCS as the solution to the oil sand carbon problem. This has been granted in the form of regulation mandating all projects initiated from 2012 to have CCS effective by 2018. This should be an encouraging sign. However, success remains contingent on many unknowns. The commercial viability of CSS as a solution by 2018 looks doubtful and companies insist they require heavy subsidy to ensure profit margins remain worthwhile. The Canadian government may well balk at this. Companies are adamant that they must not be held responsible for legacy issues, such as what the stored carbon might do in the future. Should and will government accept liability? The companies also point out, rightly, that a global carbon trading regime needs to be in force to create the right price for carbon so that early adopters of CCS do not suffer from free riders, and can turn CCS and cleaner technologies into commercial opportunity, not just a cost to be borne. But given the divisiveness of international negotiations on any climate change regime, will CCS have to wait until a functional global market?

If oil sands and shale oil are to go ahead regardless, it is preferable that all available technologies are brought to bear immediately to minimise their negative impacts – but a survey of where the industry is at now suggests this is not likely to be the case for many years to come. Among the reasons are cost, lack of incentive and lack of an international, enforceable regime.

At a more general level, ultimately it is not in investors' interests to support industries that are exacerbating a problem with such far-reaching consequences as climate change, and they will increasingly be reluctant to have their names associated with these activities. So companies piling into unconventional fossil fuels have to persuade investors, communities and consumers not only that their calculations stack up, but also that they can demonstrate that their mitigation really works. This report demonstrates that we are still far from that stage. Companies are asking stakeholders to trust that they will make good their commitments in an industry where trust, for many, is a demeaned currency. The best way they can persuade us is a cautious, responsible approach to fossil fuels and renewed vigour to bring forward the clean energy of the future.

Niall O'Shea
Responsible shareholding analyst
The Co-operative Investments

Colin Baines
Ethics Adviser
The Co-operative Group

8 May 2008

Recommendations

GOVERNMENT

- Halt the licensing of new unconventional fossil fuel operations.
- Introduce low carbon fuel standards to prohibit fuels with lifecycle ‘well to wheel’ carbon emissions greater than those derived from conventional sources.
- Implement effective measures to reduce absolute carbon emissions from existing operations.
- Deliver on Kyoto commitments and agree strong targets post Kyoto.
- Hold companies accountable for environmental and social impacts, including carbon emissions, deforestation, water usage and toxic waste management.
- Protect sensitive and endangered biodiversity and carbon sinks.
- Investigate the relationship between oil sand operations, water contaminants and downstream water quality and health.
- Improve monitoring of tailings ponds and introduce mandatory independent assessment of operations.

OIL COMPANIES

- Report on all risks associated with the environmental and social liabilities of oil sands operations, including energy intensity and carbon emissions, deforestation and land reclamation, community health and safety, water intensity and long-term toxic waste management.
- Publicly disclose strategies for addressing and reducing these risks in the context of a low carbon economy, and report progress of implementation.
- Until these strategies are in place and their success proven, halt the expansion of oil sand operations.
- Justify the competitiveness of unconventional fossil fuels in a carbon-constrained economy.
- Evaluate future fuel technologies for development based on their potential to meet low carbon fuel obligations, and switch research and development expenditure away from carbon-intensive fuels such as shale oils to sustainable alternatives.

INVESTORS

- Consider the competitiveness of unconventional fossil fuel investment in a carbon-constrained economy.
- Question the strategy of oil companies.
- Include long-term environmental liabilities such as toxic waste management and community health and safety in investment decisions.
- Engage with oil companies to report on risks associated with the environmental and social liabilities of unconventional fossil fuel exploitation, and to introduce strategies to address.
- Evaluate fuel technologies for investment based on their potential to meet low carbon fuel obligations.

Endnotes

- 1 The Oil Sands Discovery Centre, available at http://www.oilsandsdiscovery.com/oil_sands_story/resource.html
- 2 Alberta Energy Department, available at <http://www.energy.gov.ab.ca/OilSands/pdfs/osgenbrf.pdf>
- 3 US Government Oil Shale & Tar Sands Guide, available at <http://ostseis.anl.gov/guide/tarsands/index.cfm>
- 4 Alberta Energy Department, available at <http://www.energy.gov.ab.ca/OilSands/793.asp>
- 5 Alberta Energy Department, available at <http://www.energy.gov.ab.ca/OilSands/pdfs/osgenbrf.pdf>
- 6 Alberta Energy Department, available at <http://www.energy.gov.ab.ca/OilSands/793.asp>
- 7 The Oil Sands Discovery Centre Factsheet, available at http://www.oilsandsdiscovery.com/oil_sands_story/upgrade.html
- 8 Premier Ed Stelmach (2007) Speech to Canadian Association of Petroleum Producers, available at <http://www.premier.alberta.ca/speeches/speeches-2007-june-19-CAPP.cfm>
- 9 BP News, available at <http://www.bpnews.com/go/doc/1550/165362>
- 10 BP News, available at <http://www.bp.com/sectiongenericarticle.do?categoryId=9019756&contentId=7035857>
- 11 BP News, available at <http://www.bp.com/sectiongenericarticle.do?categoryId=9004470&contentId=7008150>
- 12 More information on refinery expansion and community opposition is available from Rainforest Action Network, at <http://understory.ran.org/2008/04/21/toxic-tar-sands-exposed-at-earth-day-event/>
- 13 National Energy Board of Canada (2007) Canada's energy future: reference case and scenarios to 2030, available at: <http://www.neb.gc.ca/clf-nsi/rnrgynfmtn/nrgyrprt/nrgyfr/2007/nrgyfr2007chptr6-eng.html>
- 14 National Energy Board of Canada (2006) Canada's oil sands: Opportunities and challenges to 2015 – an update, available at <http://www.neb-one.gc.ca/clf-nsi/rnrgynfmtn/nrgyrprt/lsnd/pprntnsndchllngs20152006/pprntnsndchllngs20152006-eng.pdf>
- 15 The Canadian National Post (14 November 2007), "Oil supply problem, what supply problem?" available at <http://nationalpost.com/news/world/story.html?id=96076>
- 16 PetroCanada presentation (28 June 2007), Moving Forward in Oil Sands, available at: http://www.petro-canada.ca/pdfs/investors/FortHills_DBProject_Final_June-27-2007.pdf
- 17 Ernst & Young (2007), Canadian Oil Sands: A new frontier in global energy [http://www.ey.com/Global/assets.nsf/International/Industry_OG_CanadianOilSands/\\$file/Industry_OG_CanadianOilSands.pdf](http://www.ey.com/Global/assets.nsf/International/Industry_OG_CanadianOilSands/$file/Industry_OG_CanadianOilSands.pdf)
- 18 Shell Canada (28 July 2006), Oil sands update – investor presentation, available at http://www.shell.com/static/ca-en/downloads/investor/presentations/oilsands_strategy_pres_july28.pdf
- 19 Carl Mortishead, The Times (18 March 2008), Shell counts rising costs of squeezing oil from sand in Canada, available at http://business.timesonline.co.uk/tol/business/industry_sectors/natural_resources/article3572646.ece
- 20 National Energy Board of Canada (2006) Canada's oil sands: Opportunities and challenges to 2015 – an update, available at <http://www.neb-one.gc.ca/clf-nsi/rnrgynfmtn/nrgyrprt/lsnd/pprntnsndchllngs20152006/pprntnsndchllngs20152006-eng.pdf>
- 21 Energy Alberta (2006) Oil sands fact sheet, available at <http://www.energy.gov.ab.ca/OilSands/pdfs/osgenbrf.pdf>
- 22 Saudi Arabia has 260 billion barrels according to the US Energy Information Administration website, available at http://www.eia.doe.gov/emeu/cabs/Saudi_Arabia/Oil.html
- 23 BP (2007) BP Statistical Review of the Year 2007, available at <http://www.bp.com/sectiongenericarticle.do?categoryId=9017946&contentId=7033487>
- 24 Stephen Harper, Prime Minister of Canada (2006) Addressing the Canada-UK Chamber of Commerce, available at <http://pm.gc.ca/eng/media.asp?id=1247>
- 25 Jonathan Leake, The Sunday Times (20 May 2007). "Shell hit by 'dirty' Arctic oil furore", http://www.wwf.org.uk/news/n_0000003930.asp
- 26 National Energy Board of Canada (2006) Canada's oil sands: Opportunities and challenges to 2015 – an update, available at <http://www.neb-one.gc.ca/clf-nsi/rnrgynfmtn/nrgyrprt/lsnd/pprntnsndchllngs20152006/pprntnsndchllngs20152006-eng.pdf>
- 27 Pembina Institute (2005) Oil Sands Fever, available at <http://www.oilsandswatch.org/>
- 28 More information about the MacKenzie Gas Pipeline is available at <http://www.mackenziegasproject.com/>
- 29 More information on WWF's Conservation Initiative in the MacKenzie Valley is available at <http://www.wwf.ca/AboutWWF/WhatWeDo/Initiatives/Initiatives.asp?project=mackenzievalley>
- 30 More information on the Alaska pipeline is available at <http://ansnaturalgaspipeline.com/>
- 31 BP press release, available at <http://www.bp.com/genericarticle.do?categoryId=2012968&contentId=7043306>
- 32 Alberta Energy Department Northern Pipelines map, available at http://www.energy.gov.ab.ca/NaturalGas/Gas_Pdfs/Map_NorthernPipeline.pdf
- 33 www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf
- 34 [ibid](http://www.wwf.org.uk/news/n_0000003930.asp)
- 35 http://www.wwf.org.uk/filelibrary/pdf/science_ad.pdf
- 36 Cambridge Energy Associates, part of IHS Energy, estimate the total global production up to 2006 to be 1.08 trillion barrels of oil, available at <http://www.cera.com/aspx/cda/public1/news/pressReleases/pressReleaseDetails.aspx?CID=8444>
- 37 WWF (2007) Climate Solutions: WWF's Vision for 2050, available at <http://assets.panda.org/downloads/climatesolutionweb.pdf>
- 38 Pembina Institute (2005) Oil Sands Fever, available at <http://www.oilsandswatch.org/>
- 39 The Tyndall Centre for Climate Change Research (2007) Climate Change Policy and Canada's Oil Sands Resources, available at <http://www.wwf.org.uk/oilsands>
- 40 Canadian Clean Air Act 2006, available at http://www.ec.gc.ca/cleanair-airpur/Clean_Air_Act-WS1CA709C8-1_En.htm
- 41 <http://www.ecojustice.ca/media-centre/press-releases/environmentalists-win-landmark-tar-sands-lawsuit>
- 42 Government of Canada (2006) Canada's fourth national report on climate change, available at http://www.ec.gc.ca/climate/4th_Report_on_CC_e.pdf
- 43 CBC News Canada Kyoto Timeline, available at <http://www.cbc.ca/news/background/kyoto/timeline.html>
- 44 National Energy Board of Canada (2006) Canada's oil sands: Opportunities and challenges to 2015 – an update, available at <http://www.neb-one.gc.ca/clf-nsi/rnrgynfmtn/nrgyrprt/lsnd/pprntnsndchllngs20152006/pprntnsndchllngs20152006-eng.pdf>

- 46 The Tyndall Centre for Climate Change Research (2007) Climate Change Policy and Canada's Oil Sands Resources, available at <http://www.wwf.org.uk/oilsands>
- 47 The Office of the Auditor General, Canada (2006) Report of the Commissioner of the Environment and Sustainable Development, available at <http://www.oag-bvg.gc.ca/domino/reports.nsf/html/c20060903ce.html>
- 48 The Tyndall Centre for Climate Change Research (2007) Climate Change Policy and Canada's Oil Sands Resources, available at <http://www.wwf.org.uk/oilsands>
- 49 The Office of the Auditor General, Canada (2006) Report of the Commissioner of the Environment and Sustainable Development, available at <http://www.oag-bvg.gc.ca/domino/reports.nsf/html/c20060903ce.html>
- 50 More information on the California Low Carbon Fuel Standard is available at <http://www.arb.ca.gov/fuels/lcfs/lcfs.htm>
- 51 Financial Times, (10 March 2008), "Canada fears new law will undermine exports of tar sands", available at http://www.ft.com/cms/s/0/a40bb12a-ee43-11dc-a5c1-0000779fd2ac.html?ncklick_check=1
- 52 Leader Post (1 March 2008), Ottawa wants US to go easy, available at <http://www.canada.com/reginaleaderpost/news/story.html?id=1888ebe6-da41-4ca5-962e-d69a36e57a8d>
- 53 Letter from North American NGOs to members of the Senate (7 May 2008), available at http://docs.nrdc.org/globalwarming/glo_08050701B.pdf
- 54 Brandt, A. R. and A. E. Farrell, Environmental Research Letters (2006), "Risks of the oil transition". available at http://www.iop.org/Ej/article/1748-9326/1/1/014004/erl6_1_014004.pdf?request-id=4eca931b-03ef-496a-943d-08ea19d84785
- 55 WWF (2008) Plugged In: the end of the oil age, available at http://assets.panda.org/downloads/plugged_in_full_report_final.pdf
- 56 Royal Dutch Shell press release (2006), "Shenhua Ningxia Coal Industry Co Ltd and Shell sign Coal to Liquids joint study agreement", available at http://www.shell.com/home/content/china-en/news_and_library/press_releases/2006/cti_jsa_11072006.html
- 57 Natural Resources Defence Council, Pembina Institute & Western Resource Advocates (2007) Driving It Home, available at <http://www.nrdc.org/energy/drivingithome/drivingithome.pdf>
- 58 Ernst & Young (2007), Canadian Oil Sands: A new frontier in global energy [http://www.ey.com/Global/assets.nsf/International/Industry_OG_CanadianOilSands/\\$file/Industry_OG_CanadianOilSands.pdf](http://www.ey.com/Global/assets.nsf/International/Industry_OG_CanadianOilSands/$file/Industry_OG_CanadianOilSands.pdf)
- 59 Canadian Association of Petroleum Producers (2007), Crude Oil Forecast, Markets and Pipeline Expansions, available at <http://www.capp.ca/raw.asp?x=1&e=PDF&dt=NTV&dn=123361>
- 60 The Ethical Funds Company (2007) Head in the Oil Sands? Available at https://www.ethicalfunds.com/SiteCollectionDocuments/docs/Head_in_the_Oil_Sands_Final.pdf
- 61 Shell Canada website, available at http://www.shell.ca/home/content/ca-en/society_environment/environment/resources/climate/results_targets_plans.html#1
- 62 Shell Canada (2007) Oil sands and the GHG challenge, available at http://www.chem.queensu.ca/Conferences/CHEMRAWN/Makinen_21.pdf
- 63 <http://www.ico2n.com/index.php>
- 64 Pembina Institute (2006) Carbon Neutral 2020, available at http://pubs.pembina.org/reports/CarbonNeutral2020_Final.pdf
- 65 The Tyndall Centre for Climate Change Research (2007) Climate Change Policy and Canada's Oil Sands Resources, available at <http://www.wwf.org.uk/oilsands>
- 66 Interviews with Clive Mather, former Shell Canada CEO, and Alberta Energy in May 2007
- 67 The Independent (16 May 2008), "Shell's support for carbon capture plant raises hopes for emissions cuts", available at <http://www.independent.co.uk/news/business/news/shells-support-for-carbon-capture-plant-raises-hopes-for-emissions-cuts-829326.html>
- 68 World Energy Council (2007), "Carbon Capture and Storage: a WEC Interim Balance", available at <http://www.worldenergy.org/documents/ccsbrochurefinal.pdf> <http://www.worldenergy.org/documents/ccsbrochurefinal.pdf> IPCC (2005), Carbon dioxide capture and storage, available at http://www.ipcc.ch/pdf/special-reports/srccs/srccs_wholereport.pdf http://www.ipcc.ch/pdf/special-reports/srccs/srccs_wholereport.pdf
- 69 UNDP (2008) ,Human Development Report 2007/08 p145, available at http://hdr.undp.org/en/media/hdr_20072008_en_complete.pdf http://hdr.undp.org/en/media/hdr_20072008_en_complete.pdf
- 70 UNDP (2008) ,Human Development Report 2007/08 p145, available at http://hdr.undp.org/en/media/hdr_20072008_en_complete.pdf
- 71 Alberta Government press release, January 2008, Alberta plan to cut growth of GHG emissions, available at <http://alberta.ca/home/NewsFrame.cfm?ReleaseID=/acn/200801/22943ACC446ED-ED74-6A1E-6CF263E59920969B.html>
- 72 Environment Canada (2008), "Turning the Corner" Regulatory Framework, available at <http://www.ec.gc.ca/default.asp?lang=En&n=714D9AAE-1&news=B2B42466-B768-424C-9A5B-6D59C2AE1C36>
- 73 Press release from Natural Resources Canada (4 April 2008), available at <http://www.nrcan-rncan.gc.ca/media/newcom/2008/200822-eng.php>
- 74 Based on figures provided in Canada's oil sands and heavy oil (2000), Petroleum Communication Foundation
- 75 http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf
- 76 Alberta Energy and Utilities Board, (2007), Alberta's Energy Reserves 2006 and Supply/Demand Outlook, available at http://www.ercb.ca/docs/products/STs/st98_current.pdf
- 77 Based on Stern Review calculation: 15 – 20 GtCO₂ of emissions = atmospheric CO₂ increase of 1 ppm, available at www.hm-treasury.gov.uk/media/2/5/Part_III_Introduction_Group.pdf
- 78 Simon J. Dyer, Jack P. O'Neill, Shawn M. Wasel and Stan Boutin (2001), Avoidance of industrial development by woodland caribou, J. Wildl. Manage. 2001, 65: 531-542.
- 79 Simon J.Dyer, Jack P. O'Neill, Shawn M. Wasel and Stan Boutin (2001), Quantifying barrier effects of roads and seismic lines on movements of female woodland caribou in northeastern Alberta. Can. J. Zool. 2002, 80:839-845.
- 80 Pembina Institute & Canadian Parks and Wilderness Society (2006), Death by a thousand cuts, available at <http://www.oilsandswatch.org>
- 81 <http://www.cpaws-edmonton.org/CPAWS-NR-WoodCaribou.htm>
- 82 Canadian Parks and Wilderness Society (2006), McClelland Wetland Complex – a jewel in the boreal crown, available at http://www.cpaws-edmonton.org/factsheets/McClelland_Fen.pdf
- 83 Kurz, and Apps (1999), A 70-Year Retrospective of Carbon Fluxes in the Canadian Forest Sector, Ecological Applications 9:526-547
- 84 Alberta Government (2000), Guidelines for wetland establishment on reclaimed oil sands leases, available at http://www3.gov.ab.ca/env/protenf/landrec/documents/GuidelineforWetlandEstablishmentonReclaimedOilSandsLeasesMar00_S6.pdf
- 85 Edmonton Journal (26 February 2008), No brakes on oil sands, available at <http://www.canada.com/edmontonjournal/news/story.html?id=0529ba89-d54e-4f9c-a050-b57b5fd019c3>
- 86 Aboriginal chiefs want oil sands moratorium (25 February 2008), Calgary Herald, available at <http://www.canada.com/calgaryherald/news/story.html?k=23013&id=e2ecbd20-6ca4-49e4-8165-c458a225aa34>
- 87 Shell Canada advert, available at http://www.shell.com/static/ca-en/downloads/society_environment/stakeholders/repman_rob.pdf
- 88 Pembina Institute (2006), Troubled Waters, Troubling Trends, available at <http://www.pembina.org>
- 89 ibid
- 90 Andrew Nikoforuk, The University of Toronto Munk Centre (2007) On the Table: Water, Energy and North American Integration, available at http://www.powi.ca/pdfs/waterdiversion/waterdiversion_onthetable_new.pdf
- 91 Pembina Institute (2005), Oil Sands Fever, available at <http://www.oilsandswatch.org/>

- 92 National Energy Board of Canada (2006), Canada's oil sands: Opportunities and challenges to 2015 – an update, available at <http://www.neb-one.gc.ca/clf-nsi/rngynfmtn/rngyprtr/lsnd/pprntnsndchllngs20152006/pprntnsndchllngs20152006-eng.pdf>
- 93 University of Alberta (2007), Running out of Steam? available at <http://www.ualberta.ca/ERSC/water.pdf>
- 94 ibid
- 95 ibid
- 96 Oil Sands Ministerial Strategy Committee (2006), Investing in our future – responding to the rapid growth of oil sands development, available at <http://www.alberta.ca/home/395.cfm>
- 97 Pembina Institute (2006), Troubled Waters, Troubling Trends available at <http://www.pembina.org>
- 98 WWF Canada & Pembina Institute (2008), Undermining the Environment, available at <http://www.wwf.ca/RESOURCES/PDF/OilSandsReport.pdf>
- 99 Golder Associates Ltd, (2005), A compilation of information and data on water supply and demand in the lower Athabasca River Reach.
- 100 Public apology from Syncrude CEO (2 May 2008), available at http://www.syncrude.ca/users/news_view.asp?FolderID=5690&NewsID=121
- 101 Andrew Nikoforuk, The University of Toronto Munk Centre (2007), On the Table: Water, Energy and North American Integration, available at http://www.powi.ca/pdfs/waterdiversion/waterdiversion_onthetable_new.pdf
- 102 Alberta Government (2007), Investing in our Future: Responding to the Rapid Growth of Oil Sands Development, available at <http://www.alberta.ca/home/395.cfm>
- 103 Suncor reclamation brochure, available at http://www.suncor.com/data/1/rec_docs/758_Suncor%20Reclamation.pdf
- 104 Suncor Energy Inc (2007) Suncor Energy Inc Annual Information Form, available at http://www.suncor.com/data/1/rec_docs/1269_AIF%202007%20FINAL.pdf
- 105 CBC News, (10 March 2006), Cancer rate in Fort Chipewyan cause for concern: medical examiner, available at <http://www.cbc.ca/canada/edmonton/story/2006/03/10/ed-fortchip20060310.html>
- 106 Watch the interviews and its News piece at http://www.wwf.org.uk/core/ge_000004661.asp
- 107 Treeline Ecological Research (2007), A study of water and sediment quality as related to public health issues, Fort Chipewyan, Alberta, Canada, available at <http://www.borealbirds.org/resources/timoney-fortchipwater-111107.pdf>
- 108 Edmonton Journal (5 June 2008) "Native groups sue government over oilsands", available at <http://www.canada.com/edmontonjournal/news/story.html?id=c6ad1232-d73a-4dde-bc19-3f872013b5a2>
- 109 CBC News (22 May 2008) "Comprehensive review of Fort Chipewyan cancer rates announced" <http://www.cbc.ca/canada/north/story/2008/05/22/edm-fort-chip.html?ref=rss>
- 110 Financial Times (31 January 2008), Suncor in \$20 billion oil sands plan, available at <http://search.ft.com/ftArticle?queryText=suncor+&aie=false&id=080131000259&ct=0>
- 111 PetroCanada presentation (28 June 2007), Moving Forward in Oil Sands, available at http://www.petro-canada.ca/pdfs/investors/FortHills_DBProject_Final_June-27-2007.pdf
- 112 Financial Times (3 April 2007), "Shell £3.8 billion buyout of Canadian Unit" available at http://search.ft.com/ftArticle?queryText=shell+canada&aie=false&id=070403000890&ct=0&nclck_check=1
- 113 International Herald Tribune (5 October 2006), "Conoco, EnCana to boost Canada oil output, refining with \$10.7 billion investment", available at http://www.ihf.com/articles/ap/2006/10/05/business/NA_FIN_US_Conoco_EnCana.php
- 114 <http://www.reuters.com/article/governmentFilingsNews/idUSN2742391420070227>
- 115 David Ebner, The Globe and Mail (Canada), (8 May 2007), "Massive project gets started in oil sands"
- 116 Syncrude website, available at <http://www.syncrude.ca/users/folder.asp?FolderID=5626>
- 117 Strategy West, (January 2008), Existing and Proposed Canadian Commercial Oil Sands Projects, available at <http://www.strategywest.com/oilSands.html>
- 118 http://www.shell.com/home/content/ca-en/news_and_library/press_releases/2006/unindex/november21_shell_enhance.html?LN=news_and_library/press_releases/2006
- 119 Royal Dutch Shell (17 March 2008) "March 2008 strategy update: Investing in new heartlands for Shell" presentation, available at http://www.shell.com/home/content/investor/news_and_library/presentations/2008/dir_presentations_2008.html#march_2008_strategy_update_investing_in_new_heartlands_for_shell_-_17_mar_2008_7
- 120 The Guardian (11 December 2007), "Big oil lets sun set on renewables", available at <http://www.guardian.co.uk/business/2007/dec/11/oil.bp>
- 121 The Guardian (2 May 2008), "'Dishonest, irresponsible': Shell lambasted for pulling out of world's biggest wind farm", available at <http://www.guardian.co.uk/environment/2008/may/02/renewableenergy.royaldutchshell?gusrc=rs&feed=environment>
- 122 Shell Wind Energy website, available at http://www.shell.com/home/content/uk-en/about_shell/what_we_do/alternative_fuels/renewables_wind_energy_280606.html
- 123 Royal Dutch Shell plc (2008), Shell energy scenarios to 2050, available at http://www.shell.com/static/aboutshell-en/downloads/our_strategy/shell_global_scenarios/shell_energy_scenarios_2050.pdf
- 124 "Difficult yes, impossible no" advertising from Shell. More details available at http://www.shell.com/home/PlainPageServlet?FC=/aboutshell-en/html/iwgen/shell_real/shell_solutions/stories/app_shell_stories.html
- 125 US Government Oil Shale & Tar Sands Guide, available at <http://ostseis.anl.gov/guide/index.cfm>
- 126 RAND Corporation (2005), Oil shale development in the United States: Prospects and Policy Issues, Prepared for the US Department of Energy, available at http://www.rand.org/pubs/monographs/2005/RAND_MG414.pdf
- 127 More details of Shell's technology available at http://www.shell.com/home/Framework?siteld=us-en&FC2=/us-en/html/iwgen/leftnavs/zzz_lhn4_1_3.html&FC3=/us-en/html/iwgen/shell_for_businesses/exploration_production_shared/mahogany_shared/dir_mahogany.html
- 128 World Energy Council (2005), Shale Oil Resources and Production at end-2005, available at http://www.worldenergy.org/documents/shale_table_3_1.pdf
- 129 <http://www.estoniaenergy.com/>
- 130 US Government, 2005, Energy Policy Act Section 369, available at <http://ostseis.anl.gov/documents/docs/Section369ExtractEnergyPolicyAct.pdf>
- 131 US Government Oil Shale & Tar Sands Guide, available at <http://ostseis.anl.gov/eis/why/index.cfm>
- 132 BLM Press Release (15 December 2005), Interior Department Issues Oil Shale Research, Development and Demonstration Leases for Public Lands in Colorado, available at http://www.blm.gov/wo/st/en/info/newsroom/2006/december/blm_announces_waiver.html
- 133 National Resources Defense Council, available at <http://www.nrdc.org/media/2007/070611.asp>
- 134 US Government Emissions Inventory 2005 (2007), US Environmental Protection Agency, available at <http://epa.gov/climatechange/emissions/downloads06/07ES.pdf>
- 135 Based on Stern Review calculation: 15 – 20 GtCO₂ of emissions = atmospheric CO₂ increase of 1 ppm, available at www.hm-treasury.gov.uk/media/2/5/Part_III_Introduction_Group.pdf
- 136 US Government Oil Shale & Tar Sands Guide, available at <http://ostseis.anl.gov/guide/index.cfm>
- 137 Natural Resources Defence Council, Western Resources Advocates and Pembina Institute, 2007 "Driving it home", available at <http://www.nrdc.org/energy/drivingithome/drivingithome.pdf>

138 US Department of the Interior (2007), Secretary Kempthorne Signs Historic Decision For New Colorado River Management Strategies, available at http://www.doi.gov/news/07_News_Releases/071213.html

139 US Bureau of Land Management (2007), Programmatic Environmental Impact Statement, Chapter 3, available at <http://ostseis.anl.gov/documents/dpeis/index.cfm>

140 Aizhong Ding, Jiamo Fu, Guoying Sheng, Puxin Liu and P.J. Carpenter (2003), Effects of oil shale waste disposal on soil and water quality: hydrogeochemical aspects, available at http://www.scilet.com/Papers/csb/csb14/CSB_Ding.pdf

141 Fortune Magazine/CNN online (30 October 2007), Oil shale may finally have its moment, available at http://money.cnn.com/2007/10/30/magazines/fortune/Oil_from_stone.fortune/index.htm

142 Royal Dutch Shell website on oil shale technologies, available at http://www.shell.com/home/content/aboutshell-en/swol/oct_dec_2007/harold_vinegar_29102007.html

143 Joe Carroll, Deseret Morning News/Bloomberg News (10 June 2007), "Oil shale – Colorado, Utah deposits rival OPEC reserve", available at <http://www.deseretnews.com/dn/view/0,1249,660227927,00.html>

144 Royal Dutch Shell press release, available at http://www.shell.com/home/content/china-en/news_and_library/press_releases/2005/sure_jvc_0109.html

145 <http://www.china.org.cn/english/2004/Dec/114547.htm>

146 <http://www.chevron.com/news/press/Release/?id=2006-09-25>

147 Joe Carroll, International Herald Tribune/Bloomberg News (30 May 2007), "Energy companies pin hopes on shale oil in Colorado and Utah", available at <http://www.ihf.com/articles/2007/05/29/business/bxshale.php>

148 http://mines.conference-services.net/programme.asp?conferenceID=1128&action=prog_list&session=2021

149 Joe Carroll, International Herald Tribune/Bloomberg News (30 May 2007), "Energy companies pin hopes on shale oil in Colorado and Utah", available at <http://www.ihf.com/articles/2007/05/29/business/bxshale.php>

150 http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf

151 ibid

152 http://www.wvf.org.uk/filelibrary/pdf/science_ad.pdf

153 James Zachos, Professor of Earth sciences at the University of California Science (10 June 2005) "Rapid Acidification of the Ocean During the Paleocene-Eocene Thermal Maximum" and University of California, Santa Cruz press release (9 June 2005) "New findings show a slow recovery from extreme global warming episode 55 million years ago", available at <http://press.ucsc.edu/text.asp?pid=706>

154 Cindy Shellito, Professor of meteorology and climatology at the University of Northern Colorado, Geotimes (October 2006) "Catastrophe and Opportunity in an Ancient Hot-House Climate", available at http://www.geotimes.org/oct06/feature_Geocatastrophes.html#top

155 Higgins, A., and Schrag, D., (2006) 'Beyond methane: Towards a theory for the Paleocene-Eocene Thermal Maximum', Earth and Planetary Science Letters, 245, 523-37

156 Lenton: <http://news.bbc.co.uk/1/hi/sci/tech/4720104.stm>

157 Jim Hansen speech on acceptance of WWF Duke of Edinburgh Conservation Medal, St James' Place, London, (21 November 2006) "The threat to the planet: how we can avoid dangerous human-made climate change?" available at http://www.columbia.edu/~jeh1/2006/DukeEdin_complete_20061121.pdf

158 Based on Stern Review calculation: 15 – 20 GtCO₂ of emissions = atmospheric CO₂ increase of 1 ppm, available at www.hm-treasury.gov.uk/media/2/5/Part_III_Introduction_Group.pdf

159 The Guardian (13 May 2008) "World carbon dioxide levels highest for 650,000 years, says US report" available at www.guardian.co.uk/environment/2008/may/13/carbonemissions.climatechange

160 www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf

161 Lenton, T. et al (February 2008) "Tipping elements in the Earth's climate system" Proceedings of the National Academy of Sciences of the United States of America, vol. 105, no. 6, 1786-1793

162 Jim Hansen (13 July 2006) "The threat to the planet" The New York Review of Books, Volume 53, Number 12, available at www.nybooks.com/articles/19131

163 Scientific American (26 March 2007), "100-Year Forecast: New Climate Zones Humans Have Never Seen", available at www.sciam.com/article.cfm?id=100-year-forecast-new-cl

164 www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf

165 HM Treasury (2006) The Stern Review on the Economics of Climate Change, available at http://www.hm-treasury.gov.uk/media/3/2/Summary_of_Conclusions.pdf



WWF-UK registered charity number 1081247 and registered in Scotland number SC039539. A company limited by guarantee number 4016725
© 1996 Panda symbol and © "WWF" Registered Trademark of WWF-World Wide Fund For Nature (Formerly World Wildlife Fund)
Printed on recycled paper. Project number 2565, July 2008

The mission of WWF is to stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature, by

- conserving the world's biological diversity
- ensuring that the use of renewable natural resources is sustainable
- reducing pollution and wasteful consumption



www.panda.org/oilsands

for a living planet®

WWF-UK
Panda House
Weyside Park
Godalming
Surrey, GU7 1XR
t: +44 (0)1483 426444

WWF Canada
21 Perron Street
Suite 200St. Albert
Edmonton
Alberta T8N 1K5
t: +1 780 459 9453

www.goodwithmoney.co.uk

The **co-operative** bank
insurance
investments

The Co-operative
New Century House
Corporation Street
Manchester
M60 4ES
t: 0161 827 6172