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**ENVIRONMENTAL SYSTEMS AND SOCIETIES  
STANDARD LEVEL  
PAPER 2**

Thursday 8 May 2014 (afternoon)

2 hours

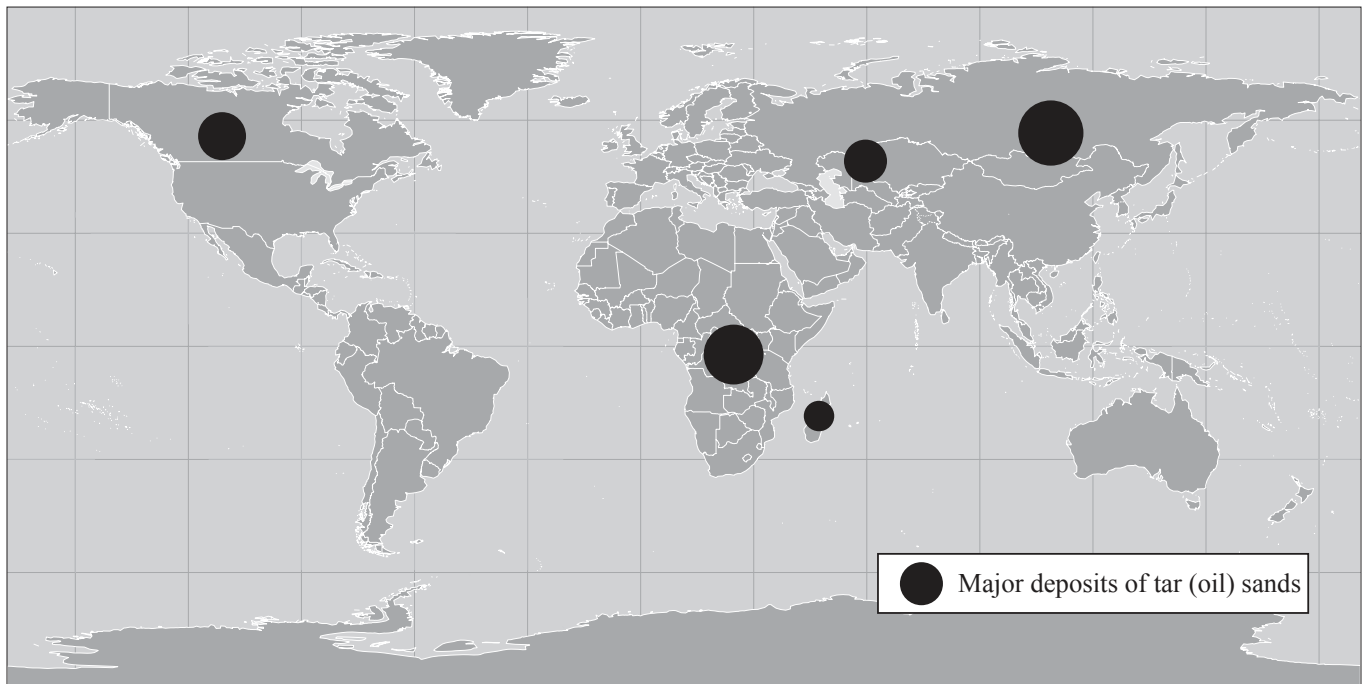
# RESOURCE BOOKLET

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INSTRUCTIONS TO CANDIDATES

- Do not open this booklet until instructed to do so.
- This booklet contains **all** of the resources required to answer question 1.

**Figure 1 World map showing the location of major tar (oil) sands deposits**



[Source: © International Baccalaureate Organization, 2014]

**Figure 2 Key facts on tar (oil) sands**

**What are they?**

- Deposits of heavy crude oil found inside a mixture of bitumen or tar (very thick black oil), sand, clay and water.
- Too thick to flow unless heated.

**Why extract now?**

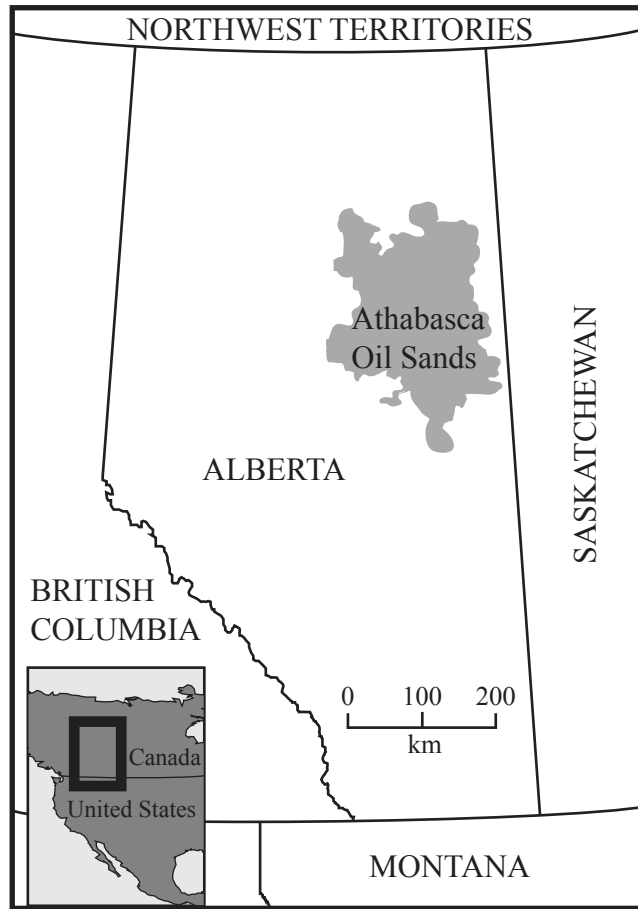
- Difficult and expensive to get out of the ground, but as oil prices increase, extraction becomes financially worthwhile.
- Extraction means Canada and USA can become self-sufficient in oil and not buy imported oil.

**How are they extracted?**

- Pump water from local rivers.
- Make steam from this water and pump it into the tar (oil) sands at 305°C. This makes them liquid and they are pumped to the surface.
- The mixture then has to be refined (split into different types of oil).
- Mined by strip-mining or deep pit mines.

**Figure 3 Information on Canadian tar (oil) sands**

**(a) Location of Athabasca tar (oil) sands**



[Source: © International Baccalaureate Organization, 2014]

**(b) Facts on Canadian tar (oil) sands**

- About 80% of the global tar (oil) sands deposits are found in Alberta province, Canada, most in the Athabasca field.
- There are potentially 1350 billion barrels of oil – more oil than used by humans to date.
- This is the second largest reserve of oil after Saudi Arabia.
- About 10% could be extractable.
- The extraction of the oil is the largest capital project on Earth at the moment.
- The Keystone XL pipeline is a 3500 km long pipeline carrying crude oil from the Athabasca tar sands southwards to oil refineries in the USA. Extensions to the pipeline could reach Houston in Texas. The pipe is buried no less than 1.3 m deep. An extension of the pipeline may go over the Ogallala Aquifer, one of the largest reserves of fresh water on Earth that provides drinking water to 2 million people.

**Figure 4 Photographs of habitat and mining in Alberta**

**(a) Boreal forest or Taiga**

Coniferous tree biome with lynx, snowshoe hare, lemmings, voles, red squirrel, moose, red deer, beaver



[Source: © Greenpeace / Richard Brooks]

**(b) Muskeg habitat**

Low-lying marsh or peat bog, water table near surface, beavers' habitat, permafrost below



[Source: [http://en.wikipedia.org/wiki/File:Wrangell\\_Muskeg.JPG](http://en.wikipedia.org/wiki/File:Wrangell_Muskeg.JPG)]

**(c) Mining of tar (oil) sands**



[Source: [www.earthobservatory.nasa.gov/IOTD/view.php?id=40997](http://www.earthobservatory.nasa.gov/IOTD/view.php?id=40997)  
© NASA]



### Figure 5 The case for and against mining tar (oil) sands

Exploitation of the Athabasca tar (oil) sands is controversial.

Opponents of the industry say that:

- It produces three times more greenhouse gas emissions than burning conventional fossil fuels.
- Fossil fuels are burned to heat the water to steam to extract tar sands.
- Underground carbon stores become available.
- Oil produced is burned.
- Boreal forest is cut down so releasing another carbon store.
- Wildlife is displaced or dies.
- Only 10% of water taken from the Athabasca River is returned.
- Fresh water supplies are polluted by toxic waste in ponds that leak into the river and groundwater (estimate of 11 million litres per day).
- Indigenous people (first nations) may be displaced and may have increased rates of rare forms of cancer.

[Source: [www.wwf.org.uk/what\\_we\\_do/changing\\_the\\_way\\_we\\_live/oilsands.cfm](http://www.wwf.org.uk/what_we_do/changing_the_way_we_live/oilsands.cfm)  
Figures courtesy of WWF (panda.org). Some rights reserved.]

Supporters of the industry say that :

(a)

- Tar (oil) sands are a secure source of energy for Canada and the USA (enabling energy security).
- In 2009 Canada was the largest supplier of crude oil to the USA.
- The Keystone XL pipeline development will create jobs.
- It will provide additional 300 000 jobs in USA.
- Companies reinvest in Carbon Capture and Storage (CSS) technology that will mitigate carbon emissions.
- 7.5 million trees have already been replanted to restore forest.

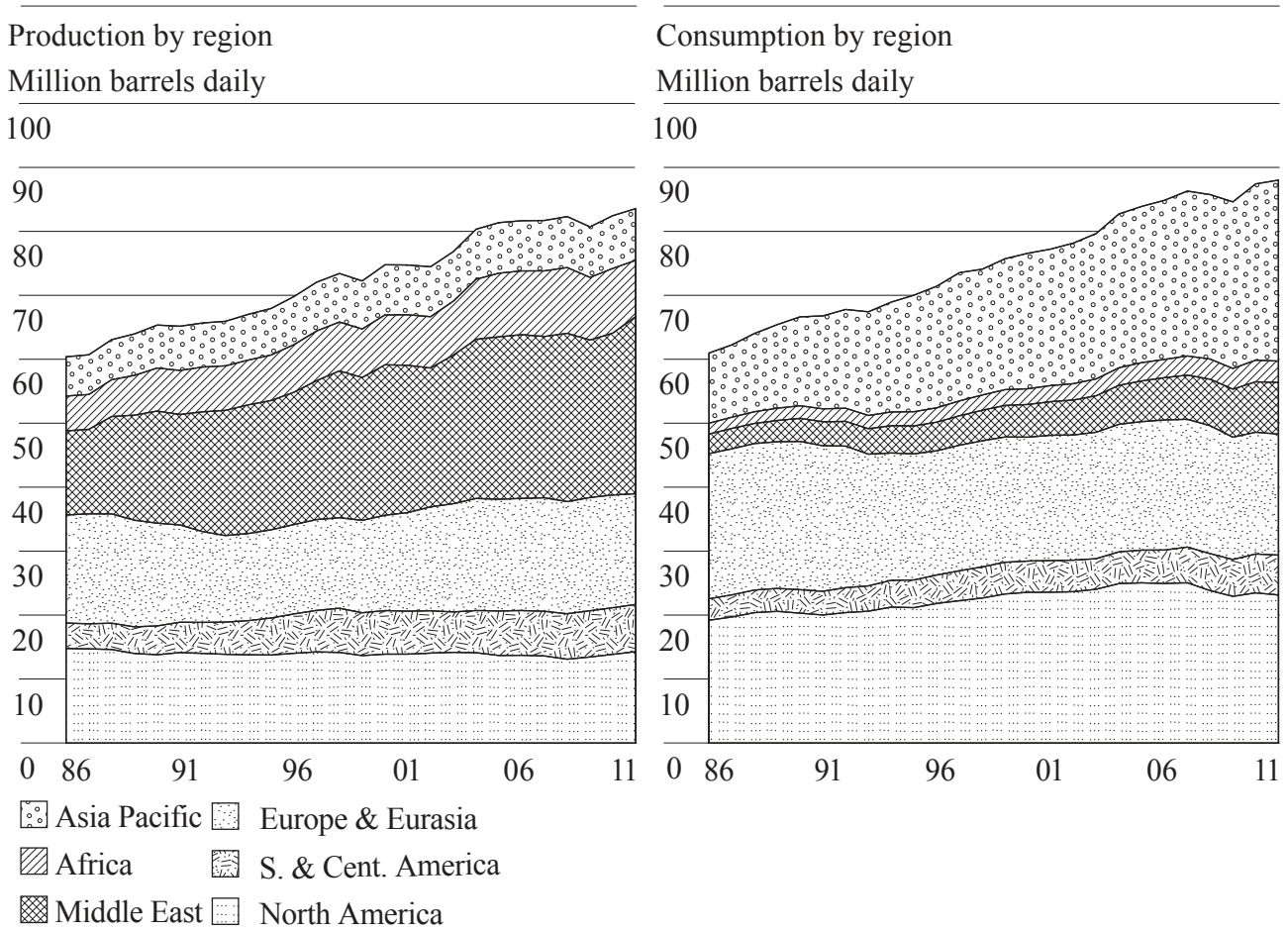
[Source: [www.politico.com/news/stories/0710/39836.html](http://www.politico.com/news/stories/0710/39836.html)]

(b)

*“A good neighbor lends you a cup of sugar.  
A great neighbor supplies you with 1.4 million barrels of oil per day.”*

–Ed Stelmach July 2010

Figure 6 Oil production and consumption by world region (1986–2011)



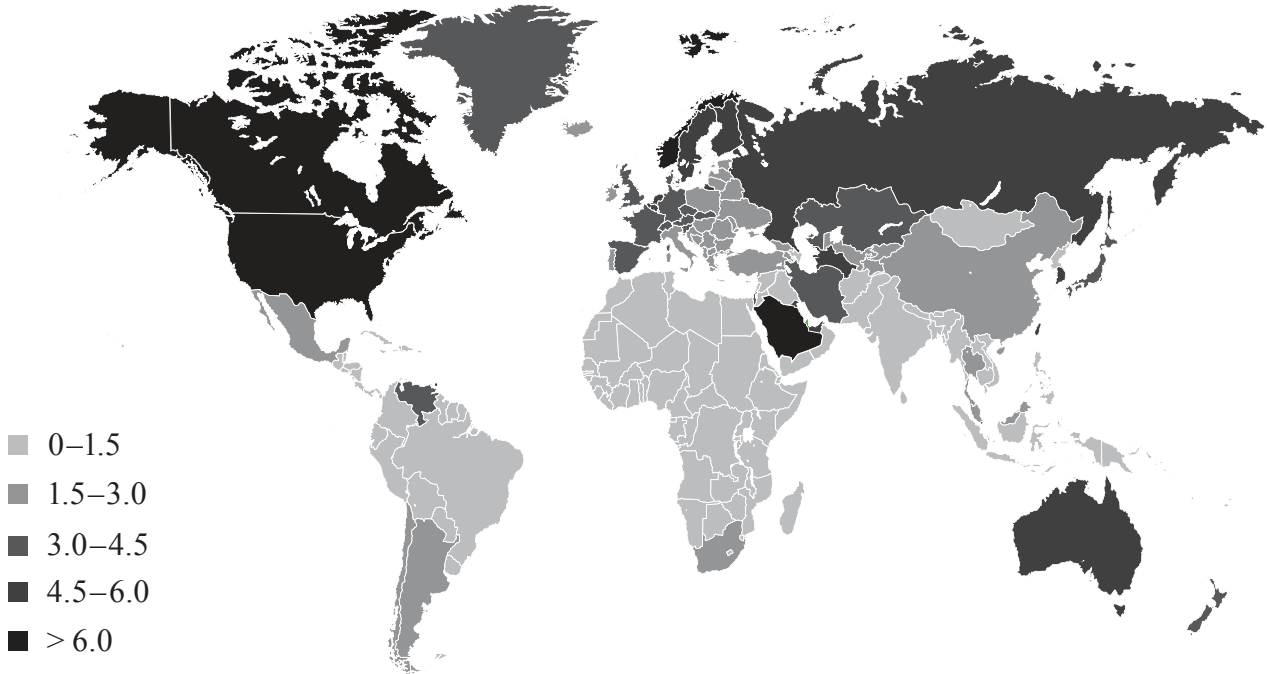
[Source: adapted from [www.bp.com/assets/bp\\_internet/globalbp/globalbp\\_uk\\_english/reports\\_and\\_publications/statistical\\_energy\\_review\\_2011/STAGING/local\\_assets/pdf/statistical\\_review\\_of\\_world\\_energy\\_full\\_report\\_2012.pdf](http://www.bp.com/assets/bp_internet/globalbp/globalbp_uk_english/reports_and_publications/statistical_energy_review_2011/STAGING/local_assets/pdf/statistical_review_of_world_energy_full_report_2012.pdf)  
BP Stats Review data used with permission.]

**Figure 7 Oil equivalent consumption per capita in 2011**

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**Consumption per capita 2011**

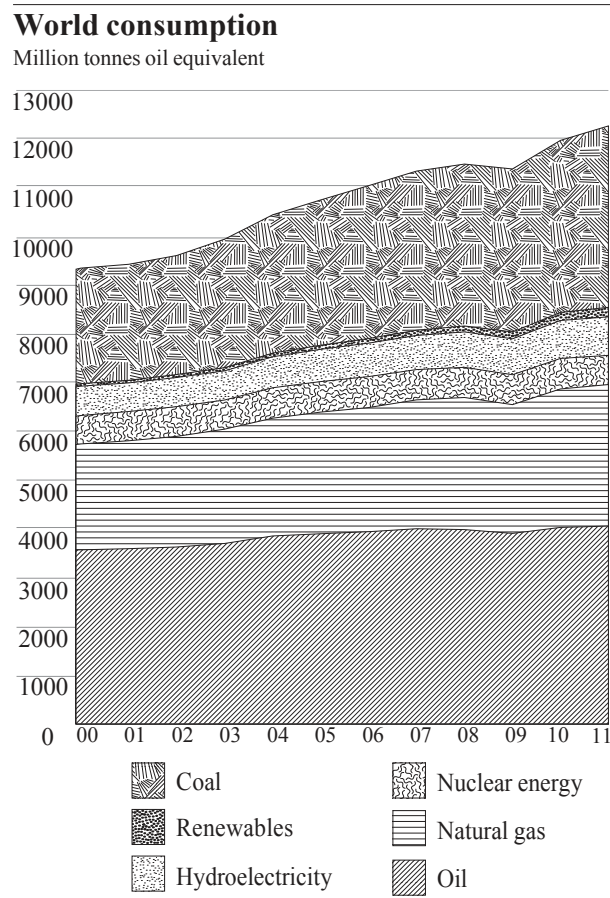
Tonnes oil equivalent



[Source: adapted from [www.bp.com/assets/bp\\_internet/globalbp/globalbp\\_uk\\_english/reports\\_and\\_publications/statistical\\_energy\\_review\\_2011/STAGING/local\\_assets/pdf/statistical\\_review\\_of\\_world\\_energy\\_full\\_report\\_2012.pdf](http://www.bp.com/assets/bp_internet/globalbp/globalbp_uk_english/reports_and_publications/statistical_energy_review_2011/STAGING/local_assets/pdf/statistical_review_of_world_energy_full_report_2012.pdf)  
BP Stats Review data used with permission.]



**Figure 8 World consumption of oil equivalent by type of fuel (2000 – 2011)**



[Source: adapted from [www.bp.com/assets/bp\\_internet/globalbp/globalbp\\_uk\\_english/reports\\_and\\_publications/statistical\\_energy\\_review\\_2011/STAGING/local\\_assets/pdf/statistical\\_review\\_of\\_world\\_energy\\_full\\_report\\_2012.pdf](http://www.bp.com/assets/bp_internet/globalbp/globalbp_uk_english/reports_and_publications/statistical_energy_review_2011/STAGING/local_assets/pdf/statistical_review_of_world_energy_full_report_2012.pdf)  
BP Stats Review data used with permission.]

Figure 9

**Writer A**

Infrastructure for mining projects have cleared 30 000 ha of forest and 300 000 ha more could be cleared in future mining.

“This is the largest single industry emitting carbon dioxide on Earth – 0.1 % total global emissions”



[Source: UK Tar Sands Network. [www.no-tar-sands.org](http://www.no-tar-sands.org).  
Used with permission.]

**Writer B**

Surface mining has affected 0.1 % of Canada’s boreal forest.

“The total greenhouse gas emissions from all Alberta’s oil sands projects account for less than one-tenth of one percent of global greenhouse gas emissions.”



[Source: Adapted from <http://www.shell.ca/en/aboutshell/our-business-tpkg/upstream/oil-sands/quest.html>]