# Oil depletion: One of the most important problems of the world

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# Introduction to the problems

In the 21st century the world must solve two great problems. These problems are rarely discussed by the public and have received little media attention. Neither are they discussed by those in power, at least not publically. The two problems are:

- Overpopulation in the developing world.
- Overconsumption in the developed world.

Of course it's all about resources: Either too many people consume a few resources each totaling a lot of resources, or a few people each consume too many resources again totaling a lot of resources. What is important to note is the absolute consumption, not the relative consumption.

It is difficult to differ between the developing world and the developed world, but the canonical values usually used are that:

- The developing world has 80% of the world's population and consumes 20% of its resources.
- The developed world has 20% of the world's population and consumes 80% of its resources.

Today (spring 2002) there are about 6,200 million persons in the world. In 1998 energy was consumed at a rate of about 12.69 (US) trillion Watts (12.69TW) [USGSE98].

# Why is this a problem

I have reasons to believe that

- The ecological systems from which the developing world derives their food, water, and energy can not be sustained with an increasing demand from an increasing population base. If the demand keeps increasing the systems will eventually collapse. As the systems collapse the population which is a part of these systems will collapse, die off, or try to escape to places where resources are more abundant.
- The resource base from which the technically more adept developed world derives their food, water, and energy will eventually be depleted in such a way that the production rates will fall due to physical restrictions. This will change the geopolitics and the economic system of the developed world. Eventually this will lead to a paradigm shift.

# What is my focus

The problems mentioned above have similarities and they are not separated as the developed world interacts with the developing world in many ways. The problems in the developing world are water shortages, droughts, floods, famines, forest losses, soil erosion and loss of biodiversity.

These all decrease the carrying capacity of the life support system. The number of people and their behavior determine the rate of loss of this support system. Usually their behavior is motivated by personal survival instincts. E.g. energy is required to cook and make the available low-quality foods edible, but as most of the trees have been cut down already, dung is collected and burned which in turn decreases soil fertility and increases erosion. Many of these people already live using a minimum of resources. Their problems are determined by their huge numbers which increase rapidly since most choose to have many children.

The problems in the developed world - and these problems are not so visible - are pollution, damage of eco systems, loss of biodiversity, loss of forests, soil erosion and depletion of the mineral and energy resource base on which their society is based. The loss of resources is determined by the behavior and rate of consumption of these people. Their behavior is motivated by greed - to sell and buy an increasing number of consumer goods, but also by necessity, since it is easier to successfully fit into society and swim with the stream than to drop out or swim against the stream. Their problem is their overconsumption and dependence on a great and cheap resource base to fuel their economy and the setup of their society.

These problems are grand in scope and it is unfortunately impossible to be an expert on all aspects of the problems. Experts tend to focus too much on their own area and might even be completely ignorant on other areas which is worse, but with this caveat in mind, I will try to give a general non-expert overview of the problems facing the developed world. The developed world consume the greater amount of power which indicate that they also have the greater power in the geopolitical sense. Furthermore I am lucky to live in the developed world, which makes a focus on this part of the problem personally relevant.

# Oil depletion: The primary problem of the developed world

In dealing with several problems it is worth to spend time singling out the most important problem of the set such as not to waste too much time on relatively trivial matters. I believe that the *primary problem* is that of a sustained energy supply. Energy unlocks all other resources. Energy is required to transport raw minerals, to refine these, to manufacture goods, and to transport the goods to their destination. Without energy none of these functions which are essential to society are possible.

Today the primary energy source is oil. **Oil accounts for 40% of all energy use** [USGSE98], therefore continued access to this resource or an equivalent or an improved replacement is essential to continue the world as we know it.

A reader with some foresight may suspect that I believe that continued access to the oil resource is not possible. He may also suspect that I do not believe that any immediate replacements exist. He would be absolutely correct. Now I will try to explain why.

# The scale of the problem

To solve a problem one must understand the magnitude of the problem. To reiterate previous numbers energy is consumed by humans at a rate of about 13TW (1TW equals one (US) trillion Watts). A very large fraction (around 40%) comes from oil. Oil is therefore the primary energy source, and it is the primary energy source which should concern us.

The world consumes 77 million barrels (one barrel is 42 (US) gallons or 159 (SI/metric) liters) of petroleum daily, which makes 26 billion barrels annually. The biggest extractors are Saudi Arabia, Russia, the United States, and Mexico. The biggest exporters are Saudi Arabia, Russia, and Norway. The biggest importers are the United States, Japan, Korea and Germany [IEAKEY2003].

A nuclear power plant produces about 0.5-1.0GW. It does not run continuosly and is offline some 20-40% of the time. A rough calculation shows that a replacement of the energy of oil by nuclear energy will require the construction of at least 5,000 nuclear power plants. A modern off-shore wind turbine produces about 2MW depending on the wind speed. Hydroplant power depends on the site, so I can not give an estimate. Solar power using PV cells depends on the sun facing area of the cells. I do not know the output of coal or gas fired plants. If anyone has some good numbers, please tell me.

These numbers do not tell the entire story. A nuclear power plant produces electricity, and one can not use electricity to make plastics, fertilizer, and a whole bunch of other industrial products. Additionally the world's transportsystem is based on the internal combustion engine which in terms of output/mass is much more effective than any other engine (steam, Stirling, electric, etc.) only gas turbines are more effective, but they are not as robust, and they also depend on fossil fuels. Electricity is an inconvenient source of energy for many purposes. It is only transportable through batteries, by cable, or by converting water into hydrogen. Both conversion methods loose energy in the process, especially the former. In conclusion oil is a source of energy as well as a mineral source which is difficult or impossible to replace.

Do not forget Liebig's law. Even if the energy problem is solved the world will still be facing water shortages, topsoil loss, and loss of biodiversity. One can only hope that possible replacement sources will be used wisely.

Now I will explain why these substitution calculations are not mere academic exercises.

# Oil follows the extraction pattern of all other resources

Generally the easy to reach and rich resources will be found and used first. These resources can be exploited using simple technology and often a hole in the ground in the right place which is not so hard to find will do the trick. Later more complex technology is required. Oil fields will be

smaller, require more effort, and ultimately yield less oil than the first big fields. Later still, advanced technology like 3D or 4D seismic searches, directional drilling, steam injection, and drilling in difficult terrain like off shore or arctic conditions is required. At some point the effort, namely the energy which goes into the process i.e. of manufacturing drilling rigs, actually finding the oil, keeping the crews supplied, and getting the oil to the surface will surpass the energy yield at which point further drilling makes no sense. Presently the limits are determined by economical arguments i.e. the money-price of oil since the energy yields are still much greater than the energy efforts. If the development of an oil field will cost less than the estimated price of the oil which is pumped up the field will be developed.

There is some uncertainty attached to the estimation of oil resources. Although it is reasonably clear how much oil has been extracted from the ground (cummulative production) and what the current rate of extraction is, it is debated how much oil is actually left (resources) and how much of it will be extracted (reserves).

# How oil reserves are estimated

It turns out that there are actually two quite opposing views, because people confuse reserves with resources and tend to focus too much on one or the other. Reserves include the amount of oil which can and will be extracted with a given probability. The P90 reserve i.e. the amount of oil which can be extracted with a 90% probability is usually refered to as *proven* reserves. A P50 reserve is called *proven and probable*.

The two different views are:

1. Since the amount of oil is in principle unknown we can never know how big the resources are. What is relevant is whether we can find more oil or not. A rise of oil prices rise will motivate people to develop new methods to find more oil, to extract more oil from known wells, or to make development of shut-in wells economically possible.
2. Although the total amount of oil is unknown it is still finite. Once all resources have been turned into reserves no more oil can be discovered. The total amount of reserves can be estimated by noticing that the biggest fields are found and developed first afterwhich increasingly smaller fields are found and brought into production. Eventually the new fields will be small and hard to find. Plotting the so-called creaming curves i.e. the cumulative discoveries against the cumulative number of wildcats (exploration wells) the asymptotic value will indicate the ultimate amount of reserves.

Please keep these differing views in mind while reading the rest of this section.

Governments and oil companies some of which have economic turnovers compared to the GNP of entire countries might not benefit from revealing their true reserves, since many political and economic decisions depend on these numbers. Thus data are divided into freely available *official* data and confidential "technical" data which determine the development strategies of the oil companies. The freedom in reporting *official* data leads to so-called "reserve growth" which is not true growth, since the amount of oil in the ground does not increase, but an increase in the reported *official* number.

## Reserve growth

Reserves are inherently unknown, but they can be estimated within a range and assigned to a probability. A P90 estimate denominate the amount of oil which can be extracted economically with a probability of 90%. Naturally a P10 estimate will be higher than a P90 estimate, and oil companies are free to report whatever number suits their purposes. Usually they will not even give the probability but simply give the *official* reserves.

Economists may then add all these official numbers and arrive at the total world reserve which tend to grow suggesting that more and more oil is discovered/available. This growth is not surprising. Initial estimates will be conservative since a company would develop the field only if they were quite sure that the investment would be returned. As the initial estimate is conservative, later times will demonstrate that the field most likely contains more oil. US companies are required by SEC to report "proven reserves with a reasonable certainty". As the fields are likely to be bigger than what is reported most likely the reserves will "grow" in subsequent reports. Updating of the *official* number will tend to increase the stock value of the company.

The opposing view is that **the initial estimate was wrong** and the reserves (amount of oil) has not grown. Instead of marking the increase as newly discovered oil the addition is **backdated** and added to the original estimate of the size of the field at the time when it was first discovered. This gives a discovery curve which has been corrected for wrong initial estimates.

Today about 6Gb are discovered and 26Gb are consumed each year. Since **oil has to be discovered, before it can be extracted** the known reserves are being depleted. This is clearly not sustainable.

> ...we estimate that world oil and gas production from existing fields is declining at an average rate of about 4 to 6 percent a year. To meet projected demand in 2015, the industry will have to add about 100 million oil-equivalent barrels a day of new production. That's equal to about 80 percent of today's production level. In other words, by 2015, we will need to find, develop and produce a volume of new oil and gas that is equal to eight out of every 10 barrels being produced today. In addition, the cost associated with providing this additional oil and gas is expected to be considerably more than what industry is now spending.
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> Equally daunting is the fact that many of the most promising prospects are far from major markets -- some in regions that lack even basic infrastructure. Others are in extreme climates, such as the Arctic, that present extraordinary technical challenges. ...

Jon Thompson, President of ExxonMobil Exploration Company

Now I will consider why the rate of extraction is more important than the final amount which will be extracted.

# Why the extraction rate is more important than the total amount

Policy makers have previously been concerned with R/P ratios to strategically account for resource depletion. R/P means the total amount of reserves divided by the current production rate. This number does not take into account that the reserves may grow, and in particular it does not consider that the extraction rate will change later on. The R/P ratio gives the false impression that the current rate of extraction can continue for a time of R/P until we one day abruptly run out. In a more realistic scenario one would expect that the extraction rate would decrease and finally slow to a trickle after which it might not even be feasible using either money-economy or energy-economy to extract the last drop. In that case the resource might in principle last forever, but that is irrelevant to society. What we are interested in is the extraction rate, at present and in the future. The extraction rate determines the amount of oil which will reach the market in the near future. After it has passed through the refineries and the distribution system the free market will try to determine the market value. The market value is quite susceptible to the supply rate. So-called swing producers use this to control/increase the prices. Oil importers can counteract/decrease the prices by selling oil from their *strategic reserves* to the market or by decreasing their demand, perhaps involuntarily.

# The peak of the extraction rate

Adding the extraction rates for all the wells in an oil field gives the total extraction rate for the field as a function of time. According to the central limit theorem the total extraction rate of several such fields is distributed as a Gaussian (bell shaped) curve, if they all have the same individual distribution. The integrated area under this curve is the total amount of oil which will ever be extracted. It is evident from the curve that the extraction rate will decrease after half of the oil has been extracted. This point is called the **peak year**. The peak year is dependent on the estimate of the total reserves.

It is not known when the extraction rate will peak. There has been a few local peaks in history, so the peak year will not be known until several years after when it can be confirmed that the extraction rate will never again reach its previous maximum.

The peak year depends on the total amount of oil(unknown), the future extraction rate (unknown) which is correlated to future demand(unknown). Prediction is a highly uncertain business. People have been wrong before and they will be wrong again. However, what is important is not the exact peak year rather it is a range of years. Everybody who subscribes to the Hubbert school calculate a peak year within the next two decades. The most popular year at the moment of writing seems to be around 2007. This is certainly within the life time of most people alive today.

It is obvious that oil has to be found before it can be pumped from the ground. A plot of the (backdated) discovery curve shows the extraction curve lagging by about 40 years. The discovery curve peaked in the 1960s.

One can get a good estimate of the total reserves by plotting the integrated discovery rate. This graph approaches an asymptotic value as the newly discovered fields are becoming increasingly smaller and more rare. Such a plot is called a creaming curve.

# Replacements as a possible solution

The world consumes energy at a rate of about 13TW and petroleum accounts for 40%. Predictions estimates a world drop in supply by 3%/a with less in some regions and more in other regions e.g. the North Sea. Therefore the world must find a substitute and construct and bring it online quickly enough to alleviate the effects of a diminishing oil supply after the peak year.

Using the above figures about 150,000 MW has to be brought online each year for the next several decades in order to continue to meet demand which will increase if possible. Compare this number to a large nuclear power plant (1000 MW) or a modern off-shore wind turbine (2 MW).

Obviously the current energy infrastructure is not designed to handle alternative forms of energy so this has to be replaced. Neither are the current users like aeroplanes, ships, cars, etc. These will have to be replaced as well.

Some replacements under consideration are listed below.

- Hydrogen
- Natural gas
- Tar sands
- Coal
- Coal-bed methane
- Biofuels e.g. ethanol
- Nuclear fission *(Upcoming: LWR, FR, IFR, ADS and other closed fuel cycles)*
- Controlled fusion
- Hydro power
- Solar power

- Wind power

# Greater efficiency as a possible solution

The population pressure of the developed world is already quite high. It has been estimated that 30-40% of the biosphere is already exploited by the human species leaving the rest for all other species. Gains in efficiency allows a further increase of the number of humans which will increase the other limiting factors. Furthermore gains in efficiency e.g. more fuel efficient cars, efficient lighting, etc. is typically eaten up by increased use of the efficient device as long as the rate of use is has not reached its natural maximum limit. This is also known as Jevon's Paradox.

# References

1. USGSE98 http://energy.cr.usgs.gov/energy/stats_ctry/Stat1.html
2. IEAKEY2003 http://www.iea.org/STATIST/key2003.pdf

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# Off-site Links

**Didn't find what you where looking for? Try the OIL SEARCH: http://quasar.physik.unibas.ch/~fisker/401/oil/oilsearch.html**

## Energy Resource Sites

These sites are good points to start learning about the Hubbert peak and the interplay and relevance of other energy resources.

- www.oilcrisis.org, www.hubbertpeak.com The Hubbert Peak of Oil Production - is *the* place to go for references. It contains articles from Bartlett, Campbell, Duncan, Hubbert, Ivanhoe, Laherrere, Youngquist, and many others. This site is updated about once a month with new articles.
- hubbert.mines.edu M. King Hubbert Center for Petroleum Supply Studies - is run by L.F. Ivanhoe and C.W. Van Kirk. It produces a quarterly newsletter of 2-3 articles in about 8-10 pages by the leading experts in the field.
- www.dieoff.org Jay Hanson's famous or notorious Die-Off! website. Jay has put a lot of work into this and it contains a wealth of articles which are well worth reading.
- www.asponews.orgThe Association for the Study of Peak Oil - The unofficial archive of the ASPO Newsletter
- www.odac-info.org Website of the Oil Depletion Analysis Centre (ODAC).
- www.runningonempty.org ROE's website. Originally founded by Bruce Thomson but now maintained by Robert Waldrop. *dead link*
- www.wolfatthedoor.org.uk The Wolf at the Door - The Beginner's Guide to Oil Depletion - by Paul Thompson (also available in french)
- www.oilcrash.com Robert Atack's site including reference articles on the coming oil crash.
- www.energiekrise.de, www.energyshortage.com Primarily a German site by L-B-Systemtechnik GmbH which gives a good overview. You can also get the ASPO newsletter here.
- www.eia.doe.gov Energy Information Administration
- www.after-oil.co.uk The Busby Report - UK Survival in the 21$^{st}$ Century - by John Busby
- www.simmonsco-intl.com Simmons & Co International. A banking firm specializing in the energy industry.
- greatchange.org Steve Morningthunder's site.
- www.mecheng.ohio-state.edu/~korpela/oil.html Seppo Korpela's Oil depletion page
- www.planetforlife.com The Coming World Oil Crisis - is run by Jack Kisslinger. This well-structured site provides a good starting point with briefings on oil use, oil depletion, the gas crisis, supply vulnerability, and the futility of hydrogen.
- http://www.physics.emich.edu/ebehringer/FossilFuels/overview_fossilfuels.html E.R. Behringer's site with a resource/rate-of-use calculator in JAVA.
- http://www.oildepletion.org Oildepletion.org is run by Roger Bentley.
- http://www.mnforsustain.org/energy.htm The energy section of "Minnesotans For Sustainability" with several articles on energy and population.
- http://www.crisisenergetica.org/ Crisis Energetica - Daniel Gomez (in Spanish)
- http://www.lifeaftertheoilcrash.net/ - by Matt Savinar (description coming up)
- http://tvset.org/peakoil.html (description coming up)
- http://peakoil.com/ - by Daniel Colonnese, A portal site with news and forums
- http://www.peakoil.de/ - by Susanne Schaefer, a very complete overview (in German).
- http://PeakOilAction.org/ - People working together to raise awareness about oil depletion and preparing for a post fossil-fuel age.
- http://www.drydipstick.com - by Mich Winter, a meta directory with link descriptions.
- http://www.tceconomist.blogspot.com/ - The Cultural Economist - by Ronald R. Cooke, an economist's perspective on oil issues.

## Groups

Find like minded individuals and world experts. Many of these groups are very active and full of great people.

- groups.yahoo.com/group/energyresources energyresources - is an open group with about 450 members (including several keynote experts) discussing realistic replacements for oil and the peak of oil production. *Daily flow is very high ~ 50 msgs/day*
- groups.yahoo.com/group/RunningOnEmpty The first discussion group focused on the practical aspects of a post-peak world and one can learn a lot from it. It contains an archive of more than 20,000 messages. It is closed to the public and posting is reserved for a moderated discussion between experts. *Daily flow is practically zero*
- groups.yahoo.com/group/RunningOnEmpty2 The successor to ROE. Carried on in the spirit of the original ROE. It is open to the public. *Daily flow is moderate ~ 5-8 msgs/day*
- groups.yahoo.com/group/EnergyInvestment A group to discuss ways of making money off the coming Natural Gas shortage in North America, and the coming Worldwide Oil shortage. *Daily flow is low ~1 msg/day*
- http://de.groups.yahoo.com/group/Energiekrise/ A new group in German.
- http://OilAwareness.meetup.com/ International Peak Oil awareness meetup - meet others in your area on the second Wednesday of the month.

## Conferences & Workshops

- www.isv.uu.se/iwood2002 International workshop on oil depletion, Uppsala, Sweden, May 23-25, 2002

## Articles

Most links have been culled from the ER discussion group and google searches. The most recently added links are generally at the bottom of this list.

- quasar.physik.unibas.ch/~fisker/401/oil/hubbheir.html M. King Hubbert and his heirs: A Hubbert peak half-bibliography. C. Kuykendall's 30+ page list of references sorted in time and authors.
- **quasar.physik.unibas.ch/~fisker/401/oil/hubbweba.html** A Hubbert Peak Web-bibliography - by C. Kuykendall. A shorter annotated list of the most important references.
- geopubs.wr.usgs.gov/open-file/of00-320 Are We Running Out of Oil? Poster by Lester B. Magoon of the USGS.
- cdegea.free.fr/.pub/er_worksheet.html Attempting to collect some conclusions.
- groups.yahoo.com/group/globaloilwatch
- buddycom.com/reviews/campbell/index.html Key individuals who have moved and shaken the oil industry..
- www.gulland.ca/depletion/depletion.htm Gulland - a collection of the best articles on oil depletion.
- www.users.on.net/rmc/01sorry.htm
- members.aol.com/vrex/oil/price_forecast.htm
- members.aol.com/trajcom/private/trajcom.htm Many pages dedicated to the tragedy of the commons.
- www.islandnet.com/~ncfs/ncfs The Global Problematique headed by Yves Barjard. *dead link*
- www2.tpgi.com.au/users/resolve/globalcrisis/part1.html GLOBAL CRISIS by Ted Trainer.
- www.justpeace.org/02-16.htm A novel in the form of a letter from 2001, the future (written in 1998).
- www.provide.net/~kssustain "Sustainability, Energy, Resources, and Housing" by Kermit Schlansker
- sepwww.stanford.edu/sep/jon/world-oil.dir/lynch2.html Closed Coffin: Ending the Debate on "The End of Cheap Oil" A commentary by Michael C. Lynch.
- www.latimes.com/la-000018768mar14.story Oil Doesn't Grow on Trees - by David Goodstein.
- zebu.uoregon.edu/1996/ph162/l1.html Forms of alternative energy.
- www.oilcrisis.org/blanchardThe Impact of Declining Major North Sea Oil Fields upon Future North Sea Production.
- www.altenergy.org/core/The_Oil_Problem/the_oil_problem.html When Will The Joy Ride End?
- www.financialsense.com/series3/part1.htm Powershift - Oil, Money, & War - Part 1: Hubbert's Peak & The Economics of Oil
- www.eia.doe.gov/emeu/cabs/choke.html EIA: World Oil Transit Chokepoints
- www.theage.com.au/articles/2002/04/16/1018333501447.html National oil, gas reserves dwindle - Australia
- www.arts.unsw.edu.au/tsw/D50NatCapCannotOvercome.html Ted Trainer: Natural Capitalism Cannot Overcome Resource Limits.
- www.arts.unsw.edu.au/tsw/D49DematerialisationMyth.html Ted Trainer: The "de-materialisation" myth.
- www.abc.net.au/rn/science/earth/stories/s156837.htm Ted Trainer: Natural Capitalism Challenged.
- healthandenergy.com/gasoline_prices.htm
- www.simmonsco-intl.com/domino/html/research.nsf/0/3AD817AA8379224186256BC2006910C1?open The Global Energy Scene - Simmons & Co.
- www.asme.org/groups/energyresources/energybajura.pdf Our Energy Future, U.S. and World - by Rita A. Bajura, Director, National Energy Techonology Laboratory
- www.eia.doe.gov/oiaf/servicerpt/depletion/index.html EIA: Accelerated Depletion: Assessing Its Impacts on Domestic Oil and Natural Gas Prices and Production.
- www.simmonsco-intl.com/domino/html/research.nsf/0/e2186545187da48486256bce006dc343/$FILE/Depletion.pdf Matthew Simmons: Depletion & U.S. Energy Policy (Uppsala paper).
- www.hermes-press.com/impintro1.htm The New U.S.-British Oil Imperialism, Norman D. Livergood
- gadfly.igc.org/liberal/oiltrap.htm Ernest Partridge, "THE OIL TRAP", The Online Gadfly
- cryptome.org/spr-eyeball.htm Eyeballing the strategic petroleum reserve, Cryptome *dead link*
- kondratyev.com/reference/position_papers/position_paper_on_energy.htm Position Paper on Energy by Eric Von Baranov, The Kondratyev Wave Theory
- news.bbc.co.uk/1/hi/sci/tech/2225334.stm UK 'running out of gas', BBC article
- www.sunpath-designs.com/DavidPrice Energy and Human Evolution by David Price

- www.industry.gov.au/resources/netenergy/aen/aen22/17curve.html Oil production curve causes convern - Australian Energy News
- www.mees.com/news/a45n36d01.htmThe New Geopolitics Of Oil: The US, Saudi Arabia And Russia, by Gawdat Bahgat
- Peak Oil: an Outlook on Crude Oil Depletion - Revised February 2002 by Colin J. Campbell
- www.bp.com/centres/energy2002/conversioncalculator/index.asp - an online Conversion Calculator for crude oil and natural gas
- healthandenergy.com/fuel_shortages.htm The Coming Fuel Shortages by Jay Hanson, April 2, 2000
- www.bgr.de/b123/hc_era/e_kw_aera.htm Will the hydrocarbon era finish soon? by the Federal Institute for Geosciences and Natural Resources in Germany
- www.evworld.com/databases/storybuilder.cfm?storyid=403 Part I: The Assessment and Importance of Oil Depletion - by Colin Campbell
- evworld.com/databases/storybuilder.cfm?storyid=409 Part II: Assessment and Importance of Oil Depletion - by Colin Campbell
- evworld.com/databases/printit.cfm?storyid=418 Coming To Grips With Oil Depletion - by Colin J. Campbell
- www.wordwright.com.au/paul/oil_crisis.html Oil Crisis by Paul Maynard
- www.obeleoil.com/oilshock2.htm Oil shock, You could profit - by Robert Meier, Janet Roundtree, and Michael Schaefer
- www.ppu.org.uk/war/future_wars.html Future causes of conflict - a paper by the Peace Pledge Union.
- www.dw-1.com Douglas-Westwood
- mwhodges.home.att.net/energy/energy-b.htm World Oil & Gas: reserves, production, consumption - by Michael Hodges and Jean Laherere
- www.rice.edu/projects/baker/Pubs/workingpapers/cfrbipp_energy/energytf.htm Strategic Energy Policy Challenges for the 21st Century - Report of an independent task force sponsored by the James A. Baker III Institute for Public Policy of Rice University and the Council on Foreign Relations
- www.southwestenergy.org/Oil%20End%20Game.htm The Oil Endgame - by Mark Sardella
- www.anwr.org/features/oiluses.htm A list of products made from oil.
- www.taxrefusal.com/oiltable.html
- www.warwick.ac.uk/fac/soc/Economics/oswald/interviewonoil.pdf Oil and the real economy: Interview with Andrew Oswald.
- www.radio4all.net/proginfo.php?id=5573 The end of the age of oil(1) - Michael C. Ruppert
- www.radio4all.net/proginfo.php?id=5620 The end of the age of oil(2) - Colin J. Campbell
- www.radio4all.net/proginfo.php?id=5663 The end of the age of oil(3) - Jeremy Rifkin and Allen Pfeiffer
- www.agiweb.org/geotimes/nov02/feature_oil.html Global Petroleum Resources: A View to the Future by Thomas S. Ahlbrandt and Peter J. McCabe of the American Gelogical Institute
- www.gold-eagle.com/editorials_02/chapmand111902pv.html War, Money and Oil! by David Chapman
- www.geocities.com/davidmdelaney/oil-depletion/oil-depletion.html Oil Depletion - by David Delaney
- en-env.llnl.gov/flow Energy flow charts for the United States - from the LLNL.
- beheer.oprit.rug.nl/deenen/Nuclear_sustainability_rev.PDF Can nuclear power provide energy for the future; would it solve the CO2-emission problem? - by Storm van Leeuwen and Philip Smith
- www.world-nuclear.org/info/infl1.htm Energy Analysis of Power Systems - by the World Nuclear Association (a critique of the above article)
- beheer.oprit.rug.nl/deenen/Rebuttal.html (a critique of the critique of the above article)
- www.eia.doe.gov/emeu/steo/pub/steo.html EIA's Short-Term Energy Outlook - January 2003
- www.ems.org/oil_depletion/story.html End of Cheap Oil Poses Serious Threat to World Economy, Experts Say - by Environmental Media Services
- www.ecen.com/eee9/ecoterme.htm Economy and thermodynamic - by Borisas Cimbleris
- www.financialsense.com/Experts/2002/Economides.htm Venezuela's Oil Crisis - by Michael Economides
- www.financialsense.com/transcriptions/Oligney.htm The Color of Oil: The History, The Money and the Politics of the World's Biggest Business - a transcription of an interview with Ronald Oligney
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# Book list

- Walter L. Youngquist, Geodestinies (out of print, again!)
- William Catton, Overshoot (in print)
- Kenneth S. Deffeyes, Hubbert's Peak (in print)
- Kenneth S. Deffeyes, Beyond Oil: The View From Hubbert's Peak (to appear)
- Colin J. Campbell, The Coming Oil Crisis (in print)
- Colin J. Campbell, The Golden Century of Oil 1950-2050: The Depletion of a Resource (in print)
- Daniel Yergin, The Prize (in print)
- Richard Heinberg, The Party's Over (in print)
- Richard Heinberg, Powerdown (in print)
- Dale Allen Pfeiffer, The End of the Oil Age (in print)
- Paul Roberts, The End of Oil (in print)
- David Goodstein, Out of Gas (in print)
- Thom Hartmann, Last Hours of Ancient Sunlight (in print)
- Donna Leeb, The Oil Factor: How Oil Controls the Economy and Your Financial Future (in print)
- Ronald R. Cooke, Oil, Jihad and Destiny (in print)
- Howard T. Odum & Elisabeth C. Odum, A prosperous way down (in print)
- Charles Allen (ed), Maximum Power, The ideas and applications of H.T. Odum (in print)
- T.F.H. Allen, Supply-side sustainability (in print)
- Joseph Tainter, The Collapse of Complex Societies (in print)
- Jared Diamond, Collapse: How societies choose to fail or succeed (to appear)
- Thomas F. Homer-Dixon, Environment, Scarcity, and Violence (in print)
- Michael T. Klare, Resource Wars (in print)
- Michael T. Klare, Blood and Oil (in print)
- Matthew Yeomans, Oil: Anatomy of an Industry (in print)

- Lutz Kleveman, The New Great Game: Blood and Oil in Central Asia (in print)
- Vaclav Smil, Energy at the Crossroads: Global Perspectives and Uncertainties (in print)
- Vaclav Smil, Energies: An Illustrated Guide to the Biosphere and Civilization (in print)
- Vaclav Smil, Energy in World History (out of print)
- Vaclav Smil, Feeding the World: A Challenge for the Twenty-First Century (in print)
- Vaclav Smil, Energy, Food, Environment: Realities, Myths, Options (in print)
- Vaclav Smil, Cycles of Life: Civilization and the Biosphere (in print)
- Julian Darley, High Noon for Natural Gas: The New Energy Crisis (in print)
- Colin Mason, The 2030 Spike (in print)
- Donella Meadows, Jorgen Randers, Dennis Meadows, Limits to growth, the 30 year update (in print)
- Herman Daly & Joshua Farley, Ecological Economics: Principles and Applicatons (in print)
- Clive Ponting, A Green History of the World: The Environment and the Collapse of Great Civilizations (in print)
- Andrew McKillop, The Final Energy Crisis (to appear)
- Matthew R. Simmons, Twilight in the Desert: The Coming Saudi Oil Shock and the World Economy (to appear)

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# Additional

- Who am I? - a short introduction of the author.
- The author's homepage.
- - in Association with Amazon.com



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