

Peeking at Peak Oil

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Kjell Aleklett

With Michael Lardelli

Illustrated by Olle Qvennerstedt



Springer

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To my wife, daughters, and grandchildren

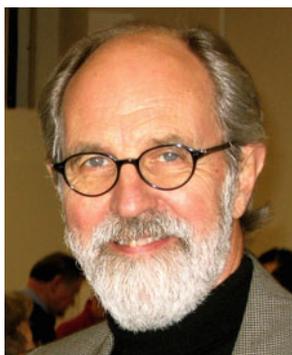
About the Author, Illustrator, and Translator



Kjell Aleklett

Kjell Aleklett is Professor of Physics at Uppsala University in Sweden where he leads the Uppsala Global Energy Systems Group (UGES). He holds a doctorate in nuclear physics from the University of Gothenburg, Sweden, and worked as a postdoctoral fellow and staff scientist from 1977 to 1985 at the Natural Science Laboratory at Studsvik, Sweden. In 1978–1979 and again in 1983, he was invited to work with Nobel Prize winner Glenn T. Seaborg at the Lawrence Berkeley Laboratory of the University of California, Berkeley, United States. His collaboration with Seaborg spanned 20 years. He was appointed as an associate professor at Uppsala University in 1986 and promoted to full professor in 2000. His interest in the world's energy supply began in 1994 when he acted as energy advisor to the deputy prime minister of Sweden. He subsequently changed his field of research from nuclear physics to the depletion of oil, gas, and coal and its global consequences in 2002. Together with Colin Campbell he organized the *First International Workshop on Oil Depletion* in May 2002 at Uppsala University.

It was in connection with this workshop that ASPO, the Association for the Study of Peak Oil & Gas, was established. Since 2003 he has been president of ASPO International (official website: www.peakoil.net). In 2005 the Prime Minister of Sweden, Göran Persson, became aware of Peak Oil and the research of UGES. He decided to appoint an Oil Commission for which Kjell Aleklett gave the introductory seminar. In that year Kjell Aleklett was also asked to give testimony on Peak Oil before the U.S. House of Representatives Subcommittee on Energy and Air Quality. In 2007 he was asked by the OECD to write a report on "Peak-Oil and the Evolving Strategies of Oil Importing and Exporting Countries: Facing the Hard Truth about an Import Decline for the OECD Countries." In 2009 he testified on Peak Oil for the Australian Senate Standing Committees on Rural and Regional Affairs and Transport. Kjell Aleklett frequently lectures and gives interviews on Peak Oil at community, national, and international events. His hosts have included international transport and oil corporations, governments, and security agencies.



Olle Qvennerstedt

Olle Qvennerstedt was educated as an illustrator and graphic artist at Berghs Reklamskola in Stockholm from 1961 to 1964. Since then he has been active as an illustrator for, among others, Sweden's foremost broadsheet newspaper *Dagens Nyheter* and numerous advertising agencies. Between 1977 and 1981 Olle also worked in animated film. In 1981 he took the step into freelance work with a broad spectrum of commissions and since the early 1990s he has been active as an independent artist. He has now presented over 70 exhibitions of painting, drawing, and graphic art both in Sweden and internationally. In the mid-1990s Olle began producing evocative and light-hearted illustrations for Kjell Aleklett's lectures, and was the obvious choice to illustrate *Peeking at Peak Oil*.



Michael Lardelli

Michael Lardelli received his doctorate in developmental genetics from the Council for National Academic Awards of the United Kingdom in 1991. He then worked in Sweden as a postdoctoral fellow and assistant professor before returning to Australia in 1997. He currently teaches genetics and investigates the molecular mechanisms underlying Alzheimer's disease at the University of Adelaide. He has been engaged in spreading awareness about Peak Oil and other resource issues since 2004 and has translated Kjell Aleklett's blog, *Aleklett's Energy Mix*, into English since 2008. To provide a more nuanced text, Professor Aleklett wrote the first drafts of *Peeking at Peak Oil* in his mother tongue of Swedish for subsequent translation by Michael.

Prologue

We live in a world that can no longer function without oil. Our dependence on oil has become so great that we can justifiably state we are addicted to it. We know that oil was formed under highly unusual and uncommon circumstances during the past 500 million years. Most of the world's extractable oil was discovered between 1945 and 1970. We know where on our Earth it is still possible to find new oilfields, however, the amount those new oilfields will yield will be limited compared to those oilfields already discovered.

During the past 100 years, detailed information on oil reserves and oil production has mostly been kept confidential by oil companies and national and international organizations. Over the past 10 years independent and university-based researchers have presented research that has made some of this information available to the wider community. Among the leaders in this work have been the researchers at the Uppsala Global Energy Systems group (UGES) at Uppsala University in Sweden. One aim of this book is to summarize the research findings of UGES in an easily understood manner.

To understand and prepare ourselves for a future that is not "business as usual" we must comprehend certain basic principles about oil. We must know where oil occurs and how much can be "produced" (extracted from underground). One of the most important things to understand is that, in any year, we can only produce a certain limited proportion of the oil that exists underground. This knowledge leads inexorably to the conclusion that there is a point in history when oil production reaches a maximum possible rate, Peak Oil, before declining. We must also understand what "unconventional" oil is and how it, together with new technology, can influence our future.

The western lifestyle is an oil addiction, and China and other developing nations also want their share of this drug. In 1950, the world had 2.5 billion inhabitants. Now there are 7.0 billion and, following current trends, we will have an additional 2.5 billion by 2050. All of these new world citizens will

want to have their share of the world's oil at the same time as those concerned about climate change tell us we must stop using oil completely. Living in a world where oil production has peaked will mean competition (and maybe conflict) over the remaining oil resources where the unsuccessful will go without. You may choose to remain ignorant of your future and so yield control of it to others. However, if you want to understand where the world is heading then you need to be "Peeking at Peak Oil."

Acknowledgments

The path to completion of the book *Peeking at Peak Oil* has been long and sometimes difficult. First I would like to thank all of those who inspired me and then supported me as I began my research into Peak Oil. Without Colin Campbell there would have been no beginning and without support from Professors Bo Höistad and Mats Leijon there would presumably have been no research on Peak Oil at Uppsala University. Moral support from Professors Erkki Brändas, Leif Karlsson, Sven Kullander, and Svante Svensson has also been important.

Of equal importance has been the support I have received from my entire ASPO family around the world. I could name a great many people but to avoid the risk of overlooking someone I will simply say instead a huge THANK YOU to you all. Those of you with whom I have had especially close involvement know who you are and know that you are on my acknowledgment list.

This book is based on the research conducted by the Uppsala Global Energy Systems group (UGES) in the Department of Physics and Astronomy (from January 2012, Department of Earth Sciences), Uppsala University, Sweden. A crucial part of our research activity has been the work of my four doctoral students between 2003 and August 2011. I am very grateful to Mikael Höök, Kristofer Jakobsson, Fredrik Robelius, and Bengt Söderbergh. During the same period we have supervised 12 Diploma students and all of them have played important parts in our research work. It was especially gratifying when I was able to appoint our group's first Diploma student Anders Sivertsson.

A male colleague of mine has described the process of preparing a book as being like an extended childbirth. Of course, as men we have no experience of actually delivering a child but becoming a father is also a long

process from when one receives the happy news that a child is expected until one proudly holds that child in one's arms. For me, bringing the book *Peeking at Peak Oil* into the world has been a little like becoming a parent but it has taken somewhat longer than 9 months.

Work on this book began in November 2010 when Michael Lardelli, Olle Qvennerstedt, and I got together in Australia at what we called "Camp Peak Oil Adelaide." The fact that Michael had been a postdoctoral scientist in Sweden for 6 years and had learned Swedish meant that I could write in my mother tongue and so concentrate on the book's contents. As a scientist he was able to elegantly interpret my descriptions of our research into English. I would never have signed the contract with the publisher, Springer, if I had not had Michael with me. When I say thank you there is a great deal more behind the words than gratitude.

Since the mid-1990s Olle has helped me illustrate my research presentations and many have envied the fact that I have such a friend. That Olle was willing to prepare the illustrations for this book was also a precondition to my signature on the contract with Springer. During "Camp Peak Oil Adelaide" Olle extended his offer to include all the diagrams and graphs and this gave the book a completely new character with (in my opinion) a very approachable charm. My thank you to Olle also encompasses so much more than the simple meaning of those words. Olle, I am immensely proud to have your beautiful artwork in my book.

As an embryonic concept grows and takes form there are many midwives who check its progress. *Peeking at Peak Oil* has taken form under the watchful eyes of a number of skillful professionals who have checked its contents to ensure it developed correctly. Primarily I would like to name Colin Campbell, Bob Hirsch, and Jean Laherrère who each helped check particular chapters in the book. Colin has also carefully read the entire text. Others who have given their time to examine and critique this work have been my friends and colleagues Göran Nyman, Leif Karlsson, and Simon Snowden.

When we established Camp Peak Oil Adelaide, Bob Couch put his house at our disposal. Bob also describes himself as a "nitpicker" and without his final checking of the text the list of errors that slipped through into print would have been much longer. Many thanks for your generosity and help!

My wife Ann-Cathrine has literally lived with *Peeking at Peak Oil* during the entire time it took to write it. As a teacher with an appreciation of the written word she has, of course, given me much good advice along the way. She became the book's expectant mother and deserves so many thanks! The rest of my family – my daughters Malin, Lovisa, and Kristin and their families – have also patiently tolerated my obsession with the Peak Oil topic and with this book. Many thanks to you all! It was during one of our many

discussions about Peak Oil that Kristin's boyfriend David Kadish conceived the book's title of *Peeking at Peak Oil* for which I am very grateful.

Of course, I also owe a debt of gratitude to Dr. Liesbeth Mol, Editorial Director Physics at Springer who contacted me and came to Uppsala to persuade me to write *Peeking at Peak Oil*, and David J. Packer, Springer New York, who has been the executive editor of the book.

March 2012

Kjell Aleklett

Contents

1	Introduction	1
2	Peak Oil	7
3	A World Addicted to Oil	17
4	The Global Oil and Gas Factory	23
5	The Art of Discovering an Oilfield	31
6	The Oil Industry’s Vocabulary	41
7	The Art of Producing (Extracting) Oil	53
8	The Size of the Tap: The Laws of Physics and Economics	65
9	The Elephants: The Giant Oil Fields	73
10	Unconventional Oil, NGL, and the Mitigation Wedge	95
11	Peak of the Oil Age	121
12	Oil from Deep Water: The Tail End of Extraction	149
13	Peeking at Saudi Arabia: “Twilight in the Desert”	169

14 Russia and the USA: The Oil Pioneers..... 191

15 China and Peak Oil 205

16 Peak Transportation 219

17 Peak Oil and Climate Change 233

**18 Why Military and Intelligence Agencies
Are “Peeking at Peak Oil” 261**

19 How Can We Live with Peak Oil? 277

20 An Inconvenient Swede 317

Epilogue 323

Index 327

Abbreviations

1P	Proven reserve
2P	Proven and probable reserves
3P	Proven, probable, and possible reserves
ADCO	Abu Dhabi Company for Onshore Oil Operation
API	American Petroleum Institute
ASPO	Association for the Study of Peak Oil and Gas
BPSR	BP Statistical Review of World Energy
CCS	Carbon Capture and Storage
CDIAC	Carbon Dioxide Information Analysis Center
CIA	U.S. Central Intelligence Agency
CTL	Coal-to-Liquids
CP	Cumulative Production
CERA	IHS Cambridge Energy Research Associates
CEO	Chief Executive Officer
CO ₂	Carbon dioxide
DoE	U.S. Department of Energy
DRRR	Depletion of Remaining Recoverable Resources
EIA	U.S. Energy Information Administration
EU	European Union
GDP	Gross Domestic Product
GFF	Global Futures Forum
GOM	Gulf of Mexico
GTL	Gas-to-Liquids
IEA	International Energy Agency
IIASA	International Institute for Applied Systems Analysis
IOC	International Oil Company
IPCC	United Nations Intergovernmental Panel on Climate Change
ITF	International Transport Forum
MUST	Sweden's Military Intelligence and Security Service
NGL	Natural Gas Liquids
NOC	National Oil Company

NYMEX	New York Mercantile Exchange
OECD	Organization for Economic Co-operation and Development
OGJ	Oil and Gas Journal
OOIP	Oil Originally In Place
OPEC	Organization of the Petroleum Exporting Countries
PPP	Purchasing Power Parity
RRR	Remaining Recoverable Resources
SRES	Special Report on Emission Scenarios
SSA	Sub-Saharan Africa
UAE	United Arab Emirates
USGS	U.S. Geological Survey
URR	Ultimately Recoverable Resources
UGES	Uppsala Global Energy Systems
WEO	World Energy Outlook

Units

b	Barrels – 159 liters
boe	Barrel of oil equivalents
G	Billion (giga)
Gb	Billions of barrels, Gigabarrels
Gb/y	Billions of barrels per year, Gigabarrels per year
Gb/a	Gigabarrels per annum
J	Joule
k	Thousand (kilo)
kWh	Thousands Watthours
L	Liter
M	Million (mega)
Mb/d	Million barrels per day
ppm	Parts per million
T	Thousand billion (tera)
Tcf	Trillions of cubic feet
Tcm	Trillions of cubic meter
Wh	Watthour
ZJ	Zettajoule (1Z = 1,000,000,000,000,000,000)