BUSTAN: Environmental Justice in Israel's Negev
Sustainable Community Action for Land and People

BUSTAN BACKGROUNDER: NEGEV OIL SHALE

What is Oil Shale?

The proper term for oil shale is 'organic marlstone.' "Oil shale" is neither shale or oil. Oil shale is in fact an immature source-rock which has not yet generated any oil and needs to be heated at 600 ˚C to yield synthetic oil by pyrolysis. Oil shale is commonly defined as a fine-grained sedimentary rock containing organic matter yielding oil and combustible gas upon destructive distillation. Oil shale with economic potential is usually at or near enough to the surface to be developed by open-cast or conventional underground mining or by *in situ* methods. Oil shales were deposited millions of years ago in a variety of depositional environments including freshwater to highly saline lakes, epicontinental marine basins and subtidal shelves, and in limnic and coastal swamps, commonly in association with deposits of coal.

Oil shales should be classified with coal and peat, though they provide less energy, and more pollution, than coal. (Oil shales are completely different from oilsands or extra-heavy oils, which are at the end of the oil cycle before being entirely degraded.)[1] Oil shales typically contain much larger amounts of inert mineral matter (ca. 60–90 %) than coals which have been defined as containing less than 40 % mineral matter. The organic matter of oil shale usually has a higher hydrogen to oxygen ratio than that of coal.[2] The gross heating value of oil shales on a dry basis ranges from about 500 to 4,000 kcal/kg. The high-grade kukersite oil shale of Estonia, which fuels several electric power plants, has a heating value of about 2,000 to 2,200 kcal/kg. By comparison, the heating value of lignitic coal ranges from 3,500 to 4,600 kcal/kg on a dry mineral-free basis.[3]

Oil shale is thus "a general term applied to a group of fine black to dark brown shales with enough in bituminous material (called kerogen) to make petroleum upon distillation. The United States Office of Naval Petroleum and Oil Shale Reserves estimates the world supply of oil shale at 1662 billion barrels of which 1200 billion barrels are in the

[1]Laherrere, John: "Review on Oil Shale Data;" Sept. 2005 http://64.233.183.104/search?q=cache:3B7SCr1XNKIJ:www.oilcrisis.com/laherrere/OilShaleReview200509.pdf+Shale+Oil+Estonia&hl=en&ct=clnk&cd=9

[2]The mineral component of some oil shales is composed of carbonate minerals including calcite, dolomite, and siderite, with lesser amounts of aluminosilicate minerals. For other oil shales, the reverse is true – silicate minerals including quartz, feldspar, and clay minerals are dominant whereas carbonate minerals are a minor component. Many deposits of oil shale contain, small but ubiquitous, amounts of sulfide minerals including pyrite, and marcasite.

[3]DYNI, J.R.: "Geology and Resources of Some World Oil Shale Deposits: U.S. Geological Survey;" Oil Shale, Vol. 20, No. 3, 2003 Estonian Academy Publishers

United States. This is comparable to reserves of conventional oil."[4]

There are two conventional approaches to oil shale processing. In one, the shale is fractured in-situ and heated to obtain gases and liquids by wells. The second method involves mining, transporting, and heating the shale to about 450°C, adding hydrogen to the resulting product, and disposing of and stabilizing the waste. Both processes use considerable amounts of water.

Around the world, oil shale has been most suitable for military aircraft and airplane fuel. In Estonia – the location of the largest-scale mines and processing plants in the world -- oil shale has generated electrical power for several decades.[5]

Oil Shale Deposits in Israel

Oil shale is the most abundant fossil energy resource discovered to date in Israel. The estimated reserves are about 12 billion tons of oil shales, located in limestone beds in the Mishor Rotem area, and under Beit Shemesh. Sizeable deposits of oil shale have been

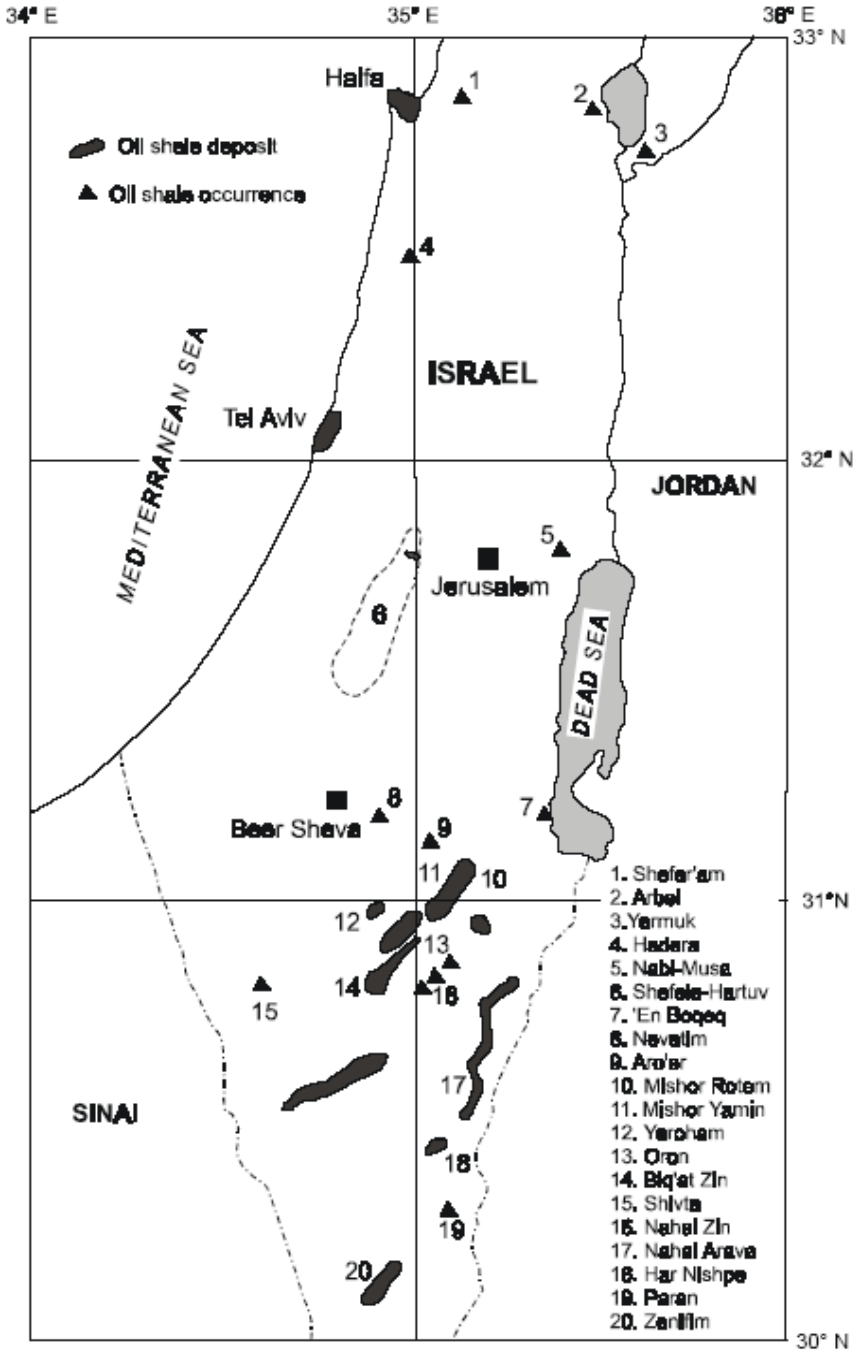

Fig. 10. Occurrences of oil shale in Israel. From Minster (1994, Fig. 1)

[4]Energy Information Administration

[5]Calvert, Chad: "The Vast North American Resource Potential of Oil Shale, Oil Sands and Heavy Oils – Part 2;" Testimony Before the Committee on Resources, Subcommittee on Energy and Mineral Resources United States House of Representatives Oversight Hearing, June 30, 2005

discovered in various parts of Israel, with the principal resources located in the north of the Negev desert. The Israeli WEC Member Committee reported in 1998 that the proved amount of oil shale in place exceeded 15 billion tonnes, containing proved recoverable reserves of 600 million tonnes of shale oil. The largest deposit (Rotem Yamin) has oil shale beds with a thickness of 35-80 m, yielding 60-71 litres of oil per ton.

The oil shale is of poor quality, containing just about 10-20% of viable organic material.[6] The average heating value of Israeli oil shale is 1150 kcal/kg of rock with an average oil yield of 6 wt%. Low in heating value and oil yield, Israeli oil shales are also high in sulphur content as compared with other major deposits globally.[7]

Table 4. **Characteristics of Ten Deposits of Oil Shale in Israel. Data from unpublished and undated (2000?) PAMA Ltd. brochure titled 'Energy from Oil Shale in Israel'**

Deposit	Overburden thickness, meters	Oil shale thickness, meters	Percent organic matter in oil shale	Oil shale resources, tons × 10^6
Nabi Musa	0–30	25–40	14–18	200
Hartuv	25–50	150–200	14–15.5	1100
Ein Boqueq	30–100	40–60	15.0	200
Mishor Rotem	20–150	20–150	11–17	2260
Mishor Yamin	20–170	20–120	10–18.5	5200
Yeroham	70–130	10–50	16.0	200
Oron	0–80	10–60	15–21	700
Zin	5–50	5–30	12–16	1500
Zenifim	30–50	10–60	8.0	1000
Sde Boker	50–150	15–70	15–18	3000

Some of Israel's oil shale deposits can be mined by open-pit methods.[8] A commercially exploitable bed of phosphate rock, 8 to 15 meters thick, underlies the oil shale in the Mishor Rotem open-cast mine.[9] A government-built pilot power plant fueled by oil shale began operation in 1989 (Fainberg and Hetsroni, 1996), and annual production of oil shale has averaged 450 000 tonnes in recent years.[10] The grade of the Rotem oil shale is not uniform, and its heating value ranges from 650 to 1200 kcal/kg.[11]

[6]"Cooperation in the Mediterranean and the Middle East: Energy Projects in the Framework of Middle East Peace Talks;" Ministry of Energy and Infrastructure, October 1994

[7]The oil shales range from 35 to 80 meters in thickness (V. Fainberg cited by Kogerman, 1996, p. 263) or 5 to 200 meters according to PAMA Ltd. (see Table 4). The organic content of Israeli oil shales is relatively low, ranging from 6 to 17 wt% with an oil yield of only 60–71 l/t. The moisture content is high (~20 %) as well as the carbonate content (45–70 % calcite). The sulfur content is also high (5–7 wt%) (Minster, 1994).

[8]*Minster, Tsevi, and Shirav (Schwartz), M.* 1982. National oil shale prospecting project – activity in 1981–82 // M. Shirav (Schwartz), and Tsevi Minster (eds.). Oil shale in Israel. Geological Survey of Israel Report GSI/24/84, 1982.

[9]*Minster, Tsevi.* 1994. The role of oil shale in the Israeli Energy balance // Energia. Univ. Kentucky, Center for Applied Energy Research. 1994. Vol. 5, No. 5

[10]Youngquist, Walter: "Survey of Energy Resources: Oil Shale;" World Energy Council, 1999

[11]*Fainberg, V., and Hetsroni, G.* 1996. Research and development in oil shale combustion and processing in Israel // Oil Shale. 1996. Vol. 13, No. 1

History

Oil shale fuel was first used in Europe during the Middle Ages for heating and cooking. The first major experiments in oil shale thermal destruction are conducted by G. Helmersen in 1838.[12] Major mines started in 1837 in France (the Autun mines, which were closed in 1957), Scotland (1850-1963), Australia (1865-1952; 1998-2004), Brazil (1881-1900;1941- 1957; 1972-), Estonia (1921-), Sweden (1921-1965), Switzerland (1921-1935), Spain (1922-1966), China (1929-), South Africa (1935-1960).

The Case of the US Mountain States: The Biggest Reserves, the Worst Investor Failure

The U.S. has the largest oil shale reserves in the world, located beneath the ground in northwestern Colorado, eastern Utah and southwestern Wyoming. In the U.S., in the 1970's, Shell researched Piceance Creek in-situ steam injection process for oil shale and nahcolite. In 1979 Congress passed the Energy Security Act and established the U.S. Synthetic Fuels Corporation; The Act authorized up to $88 Billion for synthetic fuels projects, including oil shale.[13]

When oil prices began to fall and government subsidies dried up in the 1980's, Exxon shut down its $5 billion project on May 2, 1982. People in the American Mountain States still call the day Exxon locked the gates and put 2,200 people out of work, after a boom and bust venture, "Black Sunday." In 1985 Congress abolished the Synthetic Liquid Fuels Program after 40 years and $8 billion.[14]

The Estonian case: The Most Major Oil Shale Mines, a Major Pollution Crisis,

In Estonia, in 2002, shale oil production equaled half the imports of heavy and light fuel oil' most of Estonia's electricity was generated through oil shale extraction, processing, and burning.[15] But as a result of disastrous environmental consequences and the pressure from the newly-forming European Union, Estonian began to phase out oil shale in the '90's.[16]

A 1985 analysis of reported diseases in 785 kindergartens in Estonia showed that respiratory morbidity was 1.5 times higher in polluted communities, usually in North-eastern region close to oil shale burning plants. Morbidity among adults in North-Eastern Estonia was much higher as well; Respiratory morbidity was 1.2 times higher than elsewhere, bronchitis 2.3 times more frequent, heart and vascular diseases 1.5 times more frequent, and hypertension was 2.7 times more

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[12] Aben, Hillar: "Oil Shale Contents and Abstracts;" *Proceedings of the Estonian Academy of Sciences http://www.kirj.ee/oilshale/ed-page3.html*

[13] Laherrere, John: "Review on Oil Shale Data;" Sept. 2005 http://64.233.183.104/search?q=cache:3B7SCr1XNKIJ:www.oilcrisis.com/laherrere/OilShaleReview200509.pdf+Shale+Oil+Estonia&hl=en&ct=clnk&cd=9

[14] Shore, Sandy: "High oil prices prompt new look at shale;" AP, October 2005

[15] Shore, Sandy: "High oil prices prompt new look at shale;" AP, October 2005

[16] Laherrere, John: "Review on Oil Shale Data;" Sept. 2005 http://64.233.183.104/search?q=cache:3B7SCr1XNKIJ:www.oilcrisis.com/laherrere/OilShaleReview200509.pdf+Shale+Oil+Estonia&hl=en&ct=clnk&cd=9

frequent.[17] The Institute of Preventive Medicine studied children's health in North-Eastern villages in 1989/1990 and found that children's level of heavy metals in polluted areas was two times higher than areas far from oil shale plants. Allergies, anæmia, inflammation of the urinary and genital tracts, EKG disorders and congenital microanomalies occurred more frequently in children in the cities of North-East Estonia as well.[18]"

In 1999, Estonia boasted the highest quantity of waste per inhabitant, worldwide, primarily due to the oil-shale industry. Only 20% of oil shale waste, most of which is classified as hazardous (mainly for its high alkali content) was re-used, in road building, and in liming of cultivated soils. In North-East Estonia, some oil shale waste mountains (terricones) are more than 100 meters high, cover thousands of hectares, and contain large quantities of organic substances and heavy metals easily spread by rain water.[19]

The Estonian journal, *Oil Shale* reported in 2004 that 97% of Estonia's air pollution, 86% of its total waste and 23% of its water pollution came from the power industry.[20] *91%* of Estonia's abundant water resources were consumed by the power industry.[21]

The History of Oil Shale in Israel

In the early 80's, Israel Chemicals, Israel Electric Corp. and Oil Refineries Ltd., all state-owned, begin to invest in oil shale, through the company PAMA.[22] From the mid 1980's on, PAMA remained a government company involved in the development of shale oil production in Israel. PAMA's efforts to develop shale oil for power production have been focused on two main lines of activity: the development of commercial technology for shale oil derived fuel production (retorting), and the development of commercial technology fossil shale combustion. [23]

In 1989, a pilot plant for the production of electricity and steam by direct combustion of oil shales was built by PAMA in the Negev, south of Arad. The plant started operation in 1989 and today produces 5 megawatts of electricity and 50 tons of steam per hour. In order to generate these 5 megawatts in the past few years, Israel has mined around 450,000 tons of oil shale a year.[24] Electricity is fed to the grid and steam is utilized by the Rotem Company fertilizer plant located near

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[17]"National Environmental Action Plan of Estonia: Approved by the Government of Estonia June 15 1999;" AS SPIN PRESS, Tallinn, Regati pst 1

[18]"National Environmental Action Plan of Estonia: Approved by the Government of Estonia June 15 1999;" AS SPIN PRESS, Tallinn, Regati pst 1

[19]"National Environmental Action Plan of Estonia: Approved by the Government of Estonia June 15 1999;" AS SPIN PRESS, Tallinn, Regati pst 1

[20]Raukus, Anto: Preface*: Oil Shale Journal,* 2004

[21]Raukus, Anto: Preface*: Oil Shale Journal,* 2004

[22]"Cooperation in the Mediterranean and the Middle East: Energy Projects in the Framework of Middle East Peace Talks;" Ministry of Energy and Infrastructure, October 1994

[23]"Cooperation in the Mediterranean and the Middle East: Energy Projects in the Framework of Middle East Peace Talks;" Ministry of Energy and Infrastructure, October 1994

[24]http://minerals.usgs.gov/minerals/pubs/country/2002/ismyb02.xls.

the power plant in Mishor Rotem.[25]

In 1991, Israel Chemicals, Oil Refineries Ltd and Israel Electric Corp. considered selling PAMA Development Ltd.. The former two decided to pull out of the project, in which $150 million had been invested over the previous ten years.

In1994, the Ministry of Infrastructure reported: "The Israel Electric Corporation (I.E.C.) is now considering building additional oil shale-fired power plants, in modules of 75 megawatts. A total of 1,000 megawatts of oil shale-fired power plants is envisaged."[26] The same year, the government-owned oil shale company, Lapidoth Israel Oil Prospectors Corporation Ltd – Israel's only oil drilling contractor, in control of Heletz field, Israel's only producing oil field -- is offered up for privatization.

In 1999 Israel showed interest in buying the know-how for the use of oil shale from Russia. Israeli experts approved Technopromexport's design of shale processing facilities to be built in Israel (Rotem deposit) with an annual capacity of 90,000 tons of shale oil and a 300 mWt (4 x 75 mWt) power plant to be fueled by pyrolised shale. Without Israeli government subsidies, the Russian company refused to build a plant.

The same year, in May 1999, MidAtlantic Energy Group of Pittsburgh cancels its agreement with IEC on a plan to build a 150-MW shale oil-fired power plant at Mishor Rotem, due to falling oil prices during that period.[27] Late the same year, Israel and Jordan hold talks regarding possible cooperation on a shale-oil-fired plant as stipulated in the two countries' peace treaty.[28] However, falling oil prices and the clashes of October 2000 delay cooperation. Also during that time, plans to build the world's largest solar plant, in the Negev, are put on hold due to the cheap price of oil.

In 2001, as oil prices begin to rise, the Ministry of Infrastructure hands down a 20-year license to Rotem Amfert to exploit 662 dunams of land for oil shale prospecting. Meanwhile, at the same time, the government begins to reveal plans to move towards the privatization of energy in Israel.

Two years later, in 2003, the government pledges to overcome the challenges involved with going solar and fulfilling its self-stated goals to produce just 2% of electricity from renewable resources by 2007.[29] Yet while the Israeli Ministry of Infrastructure owns several oil-prospecting and oil-tech companies, including A.F.S.K. Industries, the government does not own a single solar or other renewable energy company.

In 2004, Lapidoth Israel Oil Prospectors Corporation (TASE: LAPD), controlled by businessman Jacob Luxenburg, forms a limited partnership, Lapidoth-Heletz.[30] In 2005, as oil prices skyrocket with no drop in sight, Lapidoth renews its attempts

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[25]"Cooperation in the Mediterranean and the Middle East: Energy Projects in the Framework of Middle East Peace Talks;" Ministry of Energy and Infrastructure, October 1994

[26]"Cooperation in the Mediterranean and the Middle East: Energy Projects in the Framework of Middle East Peace Talks;" Ministry of Energy and Infrastructure, October 1994

[27]http://www.globalsecurity.org/wmd/world/israel/mishor_rotem.htm

[28]"More Country Briefs: Israel;" Marcon International, Inc., 2003

[29]"Strategic Plan for Sustainable Development in Israel: Government Decision no. 246," 14 May 2003

[30]"Lapidoth Files Prospectus in Attempt to Raise Exploration and Drilling Funds on the Tel-Aviv Stock Exchange – Funds to be Used to Explore Areas Adjacent to Israel's On-Shore Heletz Oil Field;" Zion Oil & Gas, August 29, 2004

to extract oil from oil shale rocks.[31] The Ministry of Infrastructure hands down a permit to Lapidoth-Heletz Ltd. Partn. to exploit 22,500 dunams of land to carry out oil shale extraction trials (valid until the summer of 2006).[32]Taking advantage of the testing permit granted by the Ministry of Infrastructure, the firm drills down 80 to 90 meters in the oil shale in the Mishor Rotem area and tries to extract the oil by heating the shale with hot air.[33]

Environmental Repercussions: When the 'Alternative' is Worse than Conventional

Oil shale is often classified as an "alternative" energy source because it has thus far hardly been tapped, for one reason only: It is extremely expensive to extract. Where it has been extracted, it is being phased out due to the impacts of extreme pollution.

Traditionally, even coal has offered more 'oil,' when processed, than oil shale. As Petrole Informations noted in 1972: "One ton of coal can give 650 liters of oil while one ton of oil shale can give only 150 liters of shale oil. Production of oil shale should start only after that coal is completely depleted! Oil shale is classified by USDOE/EIA within lignite."[34]

Environmental Impacts:

Wherever it has been attempted, whether in Estonia, Australia, or the U.S. Mountain states, oil shale processing has required stellar amounts of water - i.e. normally 3 gallons per barrel for conventional processing - and has left behind immense amounts of toxic wastewater.[35] In technical terms, distillation of oil shale generates wastes and effluents, which may contain trace metals, semivolatiles, polycyclic aromatic hydrocarbons, oil fractions, phenolic compounds, sulphides and others.

When asked about the water-intensive nature of oil shale extraction, Avraham Arbib, Director of Research and Development at the Ministry of Infrastructure insisted that the new oil shale technology is not water-intensive.[36] It may be that scientists at A.F.S.K. Industries have located ways to extract oil shale without using as much water as in the past. As Arbib says, "It's the desert. If there's no water, there's no water." However, we can not assume that if water concerns are reduced by the new technology, they will be eliminated. It is important to remember that water concerns have not stopped the government from approving plans to build the Ashkelon Coal firing plant, nor from continuing to concentrate still more toxic industries in the parched Ramat Hovav industrial region. There is no doubt that increased oil shale

[31] Luxenburg transforms Lapidoth into a successful investment company. In September 2004 it holds 2.5 % of Scitex, as well 5 % of ILD Insurance. It takes control of publicly traded venture capital fund Inventech, previously controlled by the Shoval family. ("There is still hope of extracting oil from the earth of the holy land;" Alexander's Gas & Oil Connections, Vol. 9, Issue #18, Sept. 21, 2004)

[32] "Oil and Gas Section Ownership in Petroleum Rights;" State of Israel Ministry of National Infrastructures, August 01, 2005

[33]Cohen, Amiram, "Lapidoth renews attempts to extract oil from shale;" Haaretz, 12/08/2005

[34]Laherrere, John: "Review on Oil Shale Data;" Sept. 2005 http://64.233.183.104/search?q=cache:3B7SCr1XNKIJ:www.oilcrisis.com/laherrere/OilShaleReview200509.pdf+Shale+Oil+Estonia&hl=en&ct=clnk&cd=9

[35]Bartis, James T.; LaTourrette, Tom; Dixon, Lloyd; Peterson, D.J.; Cecchine, Gary: "Prospects and Policy Issues: National Energy Technology Laboratory of the U.S. Department of Energy;" RAND Corporation, 2005

[36]Phone Interview, June 5th, 2006

consumption via the building of extraction and power plants will have dire new impacts on Israel's water at all stages of the oil shale extraction, processing, and burning process.

The pre-refining process to obtain synthetic oil generates ash and a carcinogenic waste rock which expands by around 30% after processing due to a popcorn effect from the heating.[37] The new technology will also produce two tons of "environmentally problematic refinery byproducts" every year, according to the Ministry of Infrastructure .[38] Arbib points out that AFSAK Hom-Tov's mining technology will leave refuse with multiple uses, such as industrial absorption materials, as well as cat litter and substances useful for managing environmental contamination. Indeed, the government-owned company Alganite, a producer of such goods, stands to benefit from the mining of oil shale in Mishor Rotem.

Oil shale extraction produces four times more greenhouse gas than conventional oil. In 1985 the International Agency for Research on Cancer (IARC) conclusively confirmed that human contact with heated oil shale leads to the development of malignant tumors.[39] With cancer rates in the Negev higher than the rest of Israel – according to a 2004 preliminary study funded by the largest toxic waste facility in the Middle East (Ramat Hovav) – the region cannot withstand another polluting industry.[40]

The Oil Shale 'Alternative' to Peak Oil = A Twilight Illusion of Brilliant Light

In 1969, prominent geologist M. King Hubbert predicted that world oil production would approximate a bell curve with a peak around the year 2000. Hubbert's 1956 forecast that U.S. domestic oil production would peak in the early 1970s proved correct. Kenneth Deffeyes, who worked alongside Hubbert at Shell's Houston labs, became so convinced by the 'Hubbert Theory' that after only 5 years in the field (by 1963) he had left the oil business.[41] Deffeyes argued that "by 2010, pressures will grow so intense that they'll create the resolve necessary to develop a new energy-economy..."[42]

In the last 150 years, humans have used 1 trillion barrels of conventional oil.[43] According the 2005 Chevron website, oil production is in decline in 33 of the 48 largest oil-producing countries, and of 44 significant producing nations, 24 are past their individual all-time peaks. Between 2002 and 2003, there was a sharp decline in discovery of new oil reserves. Notes Kjell Aleklett, a professor at the Department of Radiation Sciences at Uppsala University in Sweden, "Fifty years ago the world was consuming 4 billion barrels of oil per year and the average discovery rate was around 30 billion barrels per year. Today we consume 30 billion barrels per year and the discovery rate is dropping toward 4 billion barrels per

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[37]"Oil shale - an alternative energy resource?;" GeoExPro, Nov. 2004

[38]Krauss, Leah: "Israeli firm explores oil shale production;" United Press International, March 27, 2006

[39]International Agency for Research on Cancer (IARC): "Summaries & Evaluations: SHALE-OILS;" p. 161, VOL.: 35 1985

[40]Sarov, Batia, and peers at Ben Gurion University: "Major congenital malformations and residential proximity to a regional industrial park including a national toxic waste site: An ecological study;" *Environmental Health: A Global Access Science Source* 2006, 5:8; Bentov *et al.*, licensee BioMed Central Ltd.

[41]Williams, Mark: "The End of Oil?;" Technology Review, MIT; February 2005

[42]Williams, Mark: "The End of Oil?;" Technology Review, MIT; February 2005

[43]Udall, Randy and Andrews, Steve: "Oil shale may be fool's gold;" Denver Post, Dec. 18 2005

year."[44] Meanwhile, demand is soaring higher than ever in China, Japan, Korea, and the US.

As increased demand for oil in the 'developing' world lead some to predict that crude will peak a mere three years from now, and as prices peak in turn, oil shale production looks viable.[45] In 2006, prices reached 75$ a barrel.[46] Will oil shale tech developers and big oil companies take advantage if the rising cost of oil to push ahead this inefficient fossil fuel?

Emerging Developments: The Resurgence of Oil Shale Technology:

2005: Shell

In 2000, Shell initiated its Mahogany Research Project, aimed at "electrically heating some wells (500-1000' deep) during a long period (several years) to generate oil from the kerogene. To avoid the coming water to disturb the heating, they freeze the formation around the producing area. Shell does not release too much data. The production with 50 workers on site (+100 at headquarters) is rumored to be 10 b/d with an electric bill of 2000 $/d! and the total production is about 2000 b in 5 years."[47]

"This acceleration of natural processes is achieved by drilling holes into the resource, inserting electric resistance heaters into those heater holes and heating the subsurface to around 650F over a 3 to 4 year period. The process results in the production of about 65 to 70% of the original "carbon" in place in the subsurface. The ICP process is clearly energy intensive as its driving force is the injection of heat into the subsurface."[48]

In October 2005, Terry O'Connor, a Shell vice president, says the company believes the process to be economical as long as crude oil stays above $30 a barrel.[49] At the time, said Russell George, head of the Colorado State Department of Natural Resources. "Nothing is going to happen very fast and frankly shouldn't."[50]

Shell Oil cautiously reveals of the development of an economical 'in situ conversion' process to Rocky Mountain News,

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[44]Aleklett, Kjell: "Oil: A Bumpy Road Ahead;" *World Watch* Magazine: January/ February 2006

[45]Brendow, Dr. K.: "Global Oil Shale Issues and Perspectives - Synthesis of the Symposium on Oil Shale (Estonia);"World Energy Council, Geneva, November 18-19, 2002\

[46]Hargreaves, Steve: "Oil breaks through record $75 - Continued fears over Iran and Nigerian supplies, reports of gasoline shortage in the U.S. lead to 2 percent jump;" CNNMoney.com, Apr. 21 2006

[47]Laherrere, John: "Review on Oil Shale Data;" Sept. 2005 http://64.233.183.104/search?q=cache:3B7SCr1XNKIJ:www.oilcrisis.com/laherrere/OilShaleReview200509.pdf+Shale+Oil+Estonia&hl=en&ct=clnk&cd=9

[48]Laherrere, John: "Review on Oil Shale Data;" Sept. 2005 http://64.233.183.104/search?q=cache:3B7SCr1XNKIJ:www.oilcrisis.com/laherrere/OilShaleReview200509.pdf+Shale+Oil+Estonia&hl=en&ct=clnk&cd=9

[49]Shore, Sandy: "High oil prices prompt new look at shale;" AP, October 2005

[50]Shore, Sandy: "High oil prices prompt new look at shale;" AP, October 2005

in fall of 2005.[51]

2006: *A.F.S.K. Industries*

In early 2006, 3 companies approached the Ministry regarding oil shale retorting (including A.F.S.K. Industries, Lapidoth, and a third unknown company); 1 company approached the Ministry regarding building an electrical power plant (PAMA).

In March, the public company A.F.S.K. pitched its proposal for an oil shale extraction mine in the Mishor Rotem area to the Ministry of Infrastructure. Seeking subsidies and permission, the company was told that it had th Ministry's full blessings. However, the Ministry of Infrastructure's policy of energy privatization, in addition to limited resources, precluded government investment in the project.

Soon after, ownership of the new technology was transferred from A.F.S.K. CEO's Shimon Kazansky and Israel Feldman, to businessman Ofer Glazer[52] (husband of billionaire heiress Shari Arison,[53] the richest woman in Israel and close to the 100th richest in the world).[54] Glazer forms a new private company, AFSAK Hom-Tov, and maintains70% ownership of AFSAK Hom-Tov, as the rest goes to private investors. Early on, undisclosed foreign oil companies show interest in the new technology, and the company appears likely to secure the outside private investment necessary for implementing oil shale extraction plans.

Similar technology mixing shale and bitumen to produce oil was assessed by the chief scientist of the Energy Ministry in the mid-90s when Moshe Shahal served as minister, but oil shale plans were put on hold when oil prices fell. The study was updated in light of the new technology in recent months and concluded that "oil" could be produced at about $16 to $17 a barrel.[55]

The plant would use 6 million tons of shale and 2 million tons of bitumen from the Mishor Rotem area to produce 3 million tons of oil. A100-kilometer pipeline would emerge from the Ashdod refinery to collect the bitumen, and a parallel pipeline would return the heated kerogen to the refinery for processing.[56]

In a March 2006 statement responding to AFSAK Hom-Tov's request for permission to mine the oil shale and for government funding to build a factory to manufacture the synthetic oil, Senior Deputy Director General of the Ministry of National Infrastructure Eli Ronen wrote: "The ministry will promote with its blessings the initiative that will allow the

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[51]Seebach, Linda: "Shell's ingenious approach to oil shale is pretty slick;" Rocky Mountain News, Sept. 2, 2005

[52] Ofer Glaser was convicted on counts of indecent assault several years ago.
Dubrovitzky, Lital, and Bar, Dorit: "We are a jealous nation;"*Yedioth Ahronot* , 7 February 2006

[53]Shari Arison was involved in an investigation on the suspicion of money laundering at the Hayarkon Street branch of her company, Bank Hapoalim. During the furor, in 2003, left the country. She recently returned.
Dubrovitzky, Lital, and Bar, Dorit: "We are a jealous nation;"*Yedioth Ahronot* , 7 February 2006

[54]Avriel, Eytan: "Ofer Glazer's show of faith;," Haaretz 10.5.06

[55]"Israel Develops Oil from Shale;" Red Herring, March 9, 2006

[56]"Israel Develops Oil from Shale;" Red Herring, March 9, 2006

production of oil."[57]

It appears that the new technology may make oil shale cheaper, but that the environmentally destructive characteristics of oil shale extraction, processing and burning remain. Acknowledging that environmental concerns still needed to be addressed, Israel Petroleum Commissioner Ya'akov Mimran told United Press International, "Ronen's encouragement was...not an official endorsement of the project."[58]

However, Ronen's comment came in the form of a written, official Ministry of Infrastructure statement. Furthermore, since the revelation of the new technology, major international companies in the energy sector have expressed interest in the project. Many question still need to be answered: Which international companies have approached the Ministry? What is their relationship with local companies? Will Israel be used as a testing ground for the introduction of a new Oil Shale Age?

May 2006: Raytheon Integrated Defense Systems:

On May 9, 2006, Raytheon IDS revealed new shale oil extraction technology, based on a combination of two defense technologies: Radio frequency (RF) energy combined with critical fluid (CF) technology.

Lee Silvestre, director of Mission Innovation at Raytheon explained, "What makes this effort a breakthrough is that similar RF technology that we have been applying in core defense products -- radars for tracking and guidance systems -- has demonstrated applications in the energy crisis."[59] According to John Moses, president of CF Technologies, the oil produced is a light product, comparable to kerosene.

Raytheon is the defense company known for its adaptation of World War II radar technology to invent microwave cooking, and its development of the first guided missile. One of the three founders of Raytheon, Vannevar Bush, initiated the National Defense Research Committee (NDRC), to bring together government, military, business, and scientific leaders to coordinate military research, with the blessing of President Roosevelt. As President of NRDC and the Carnegie Institute, Bush initiated the Manhattan Project, the creator of the first atomic bomb.[60]

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[57]Krauss, Leah: "Israeli firm explores oil shale production;" United Press International, March 27, 2006

[58]"Israeli firm explores oil shale production;" The Israel Export and International Cooperation Institute, March 2006 http://www.export.gov.il/Eng/_Articles/Article.asp?CategoryID=640&ArticleID=3244

[59]"New Shale Oil Recovery Process Proposed;" The Energy Blog, May 09, 2006

[60]Zachary, G. Pascal: Endless Frontier: Vannevar Bush, Engineer of the American Century; Free Press. New York, NY., 1997

Environmental Impacts on Israel:

Water

According to the Jewish National Fund (JNF), population growth and boosted consumption patterns have led Israel to over-consume its water resources by 25 percent. Israel's water resources currently yield 449 billion gallons each year, but population growth and a general increase in the standard of living have boosted annual consumption to 580 billion gallons.[61] According to the Israeli Ministry of Foreign Affairs, a cumulative 2 billion m^2 deficit in Israel's renewable water resources has led to the deterioration ofIsrael's potable aquifers into brackish or otherwise polluted waters.[62] Already, 18 of the 21 military conflicts over water worldwide have occurred between Israel and her neighbors.[63]

Waste

At least two tons of toxic waste will be produced annually.[64] The government-owned company Alganite will process a portion of the toxic ash for re-use as cat litter and an industrial absorbant, which in turn will leave behind toxic waste once consumed.

Mishor Rotem: A Saturated Industrial Area

Existing phosphate mines at Mishor Rotem already emit nuclear residue into the vicinity of Dimona. Radon is embedded in phosphate deposits. There is an estimated thirty to sixty thousand tons of uranium contained in low-level phosphate ores. Active mining of phosphate deposits takes place in the Negev near Beersheba.

The Nuclear Engineering International industry handbook lists the Negev Phosphates Chemicals Company (Rotem Amfert Negev), at Mishor Rotem, as Israel's only fuel cycle facility. [65] Rotem Amfert Negev is an integrated, multinational phosphate group manufacturing and marketing a comprehensive range of products based on phosphate rock as raw material and leading to downstream derivatives including phosphoric acids, fertilizers, specialty chemicals and phosphate salts. The Rotem's production capacity includes 1.8 million tpa of fertilizers, 540,000 tpa of P2O5 fertilizer grade phosphoric acid, more than 100,000 tpa (as P2O5) of food grade phosphoric acid, 4 million tpa of phosphate rock, and about 50,000 tpa MKP (monopotassium phosphate).[66]

An unrelated company, Haifa Chemicals, established a plant at the Mishor Rotem industrial zone in the Negev Desert in 1994, in addition to its main facility in Haifa. In addition to potassium nitrate, Haifa Chemicals manufactures and distributes a broad variety of products based on potassium nitrate and phosphoric acid. The company is wholly owned

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[61]Jewish National Fund: "Israel Water Crisis Facts & Figures, 2006;" http://www.jnf.org/site/PageServer?pagename=Water_facts

[62]Israel Ministry of Foreign Affairs: "Israel's Chronic Water Problem;" Aug 10, 2002 http://www.mfa.gov.il/mfa/facts%20about%20israel/land/israel-s%20chronic%20water%20problem

[63]Alon, Tal. Pollution in a Promised Land, University of California Press, 2002

[64]Krauss, Leah: "Israeli firm explores oil shale production;" United Press International, March 27, 2006

[65]"Israel: Uranium Processing and Enrichment;" The Risk Report, Volume 2 Number 4, July-August 1996

[66]Israel Chemicals Limited site: http://b7prt05.iclfertilizers.com/irj/servlet/prt/portal/prtroot/com.sap.portal.navigation.portallauncher.anonymous?NavigationTarget=ROLES://portal_content/com.sapro.iclportal/roles/com.sapro.portal_user/Production_Marketing/com.sapro.Rotem_Amfert_Negev/com.sapro.Rotem_Amfert_Negev_About_Us

by the multinational US-based Trans-Resources Inc.

In August of 2004, at least 100 storks migrating between Africa and Europe died a day after stopping to drink from Rotem Amfert's toxic waste water pools, near the Israeli nuclear reactor at Dimona.[67] Despite desperately needed development in the Negev, the southern planning committee recently turned down plans by Rotem Apart to develop another phosphate mine in the area – an indication of the extremely polluting nature of such mines.[68]

VIABLE ALTERNATIVES OF A SIMILAR SCALE?

As Avraham Arbib, Director of Research and Development at the Ministry of Infrastructure, rightly emphasizes, the only real solution to Israel's energy problem is conservation in conjunction with a diversified energy strategy that does not rely on centralized power. The options are many. The government could offer tax incentives for citizen investment in solar. Rather than subsidizing state oil shale corporations, the government could invest in companies and NGOs engaged in solar, wind, biogas and biomass projects. The construction of the largest solar plant in the world, and the development of a 'Red Sea to Dead Sea Wind Tunnel,' would significantly reduce the energy crisis Israel is currently confronting.

Mandatory Conservation Standards:

"We have a frustrating array of little things in the way,' says Arbib, citing a multitude of easily surmountable barriers to conservation and diversified energy. For instance, Arbib notes, the 'stand-by' lights on televisions and cd players consume 4% of Israel's overall electricity. Furthermore, in Israel no law has been passed protecting 'solar rights,' i.e. the rights of those who invest in buying a solar panel for their roof to protection against blocked energy via the construction of high-rises.

In particular, mandatory green building standards would significantly reduce energy demands in Israel. Summer brown-outs such as that of the summer of 2006 were largely due to hiked air-conditioning in response to a heat wave. Better ventilated homes, with well-placed windows, thick walls, and properly-constructed roofs, could have prevented the brown-outs. Instead, the government decided to re-open the Tel Aviv area crude oil Reading power plant, closed in preparation for conversion to natural gas.[69]

The Standards Institution of Israel, SII, an independent NGO responsible for the passage of such codes (according to its special status, as spelled out by the Standards Law of 1953)[70] is dominated by industry executives and contractors.

Solar Plant at Ashalim (Solel)

According to the Israeli Ministry of Foreign Affairs, "an estimated 10 square kilometers of the Negev/Naqab desert receive an annual average of solar energy equal to all of the electricity generated by the Israel Electric Corporation."[71]

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[67]"Migrating storks killed by toxic pools in Negev;" Associated Press, Aug. 23, 2004

[68]Rinat, Zafrir: "Environmentalists save ancient Perfume Route from destruction;" Haaretz, Mar. 21, 2006

[69]Rinat, Zafrir, and Ashkenazi, Eli, and Kedmi, Sharon: "Power outages to be probed; IEC: More brown-outs unlikely;" Haaretz Service, 06/06/2006

[70]http://www.iso.co.il/sii/#status
http://www.sii.org.il/siisite.nsf/HomePage?OpenForm

[71]"Environmental Research in Israel;" Israel Ministry of Foreign Affairs, September 9, 2002

The government originally approved the building of a large solar power plant at Ashalim, in the Negev. However, plant building has been stalled for years, by mere paperwork and zoning conlficts. The process of negotiating the land for the power plant, parcel by parcel, has involved objections from the IDF, the JNF, and local planning committees. In the end, rather than a single power plant, the private company Solel will construct 5 companies over several stages.

Biogas and Biomass Electricity

BUSTAN has initiated a Waste-to-Energy Biogas Project in the Negev, aimed at improving health in Arab-Bedouin communities – particularly women and children – while providing a clean source of energy to power homes off-the-grid. *BUSTAN*, working in partnership with the Center for Women's Health Studies at Ben Gurion University and the Arava Institute for Environmental Studies, is building a Biogas Digester System for the purpose of reducing the negative effects of organic waste and producing clean energy for home use, as well as non-toxic fertilizers.

Starting with the development of three pilot self-contained biogas systems, our biodigesters will work on the anaerobic digestion of any organic material (animal and/or human waste products and plant matter) to produce marketable amounts of methane gas, as well as organic matter which can be used to fertilize crops.

The Waste-to-Energy Project aims to address the lack of waste disposal infrastructure. In addition to producing gas for home use, the project will reduce the negative effects of un-managed waste, thereby improving the health of women and children in the Negev. The Waste-to-Energy Project will have wider environmental benefits as well, reducing contamination of the water table, protecting natural resources throughout the project area, and setting an example for surrounding Negev communities.

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