Sustainability of Energy-related Development Projects in the Middle East Peace Region

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SUSTAINABILITY OF ENERGY-RELATED DEVELOPMENT PROJECTS IN THE MIDDLE EAST PEACE REGION

A. Introduction: Report Perspective and Assumptions

Egypt, Jordan, Israel, and the Palestinians are eager to exploit the economic opportunities created by the newly emerging geopolitical reality in their region. Each group has put forward a broad menu of "regional projects" that promise not only to physically change this "peace region," but also the way it operates collectively.

There is no area in which accelerated development is more highly anticipated than in the energy sectors of these countries. At the same time, the proposed peace projects, almost without exception, have not been thoroughly assessed for feasibility or environmental impacts. Despite this fact, however, it is not premature to offer an initial assessment of their merits within the context of a paradigm that emphasizes sustainability in new regional development. This paper evaluates the primary energy sector projects that are on the agenda of international donors.

Energy has emerged as a major issue of concern in the peace region for obvious security reasons. Even if conservation measures prove successful, the burgeoning populations and growing industrial base of each country will require the expansion of energy-generating capacity for the foreseeable future. Hence, meeting this demand, while at the same time establishing greater energy independence, has both economic and strategic importance.

With 840 million metric tons of proved recoverable crude oil and 341 billion cubic meters of natural gas, Egypt is the only country in the peace region with meaningful commercial fossil fuel reserves. Nonetheless, with energy generation and demand more than quadrupling between 1981 and 1994, some projections suggest that Egypt will be forced to import energy by early next century. The Israeli and Palestinian territories' currently linked energy systems are largely reliant (98 percent) on imported crude oil and, to a lesser extent, coal. Jordan's 991 megawatt (mw) power generation is predominantly fueled by heavy fuel-oil and diesel units. It is therefore little wonder that so many of the peace projects are designed to expand local energy options and generating capacity.

Our evaluation of the overall sustainability of peace projects affecting the energy sector is made under the following assumptions:

- Tourism will emerge as a predominant source of foreign currency in each part of the region by the year 2000; (Israel alone earned US$2.3 billion from tourism in 1994).

- While expanded tourism increases energy demands, it also dictates that energy sources are to the largest possible extent environmentally benign.

- The lack of commercial energy reserves can be environmentally advantageous by enabling countries to select energy sources compatible with the need to preserve a clean environment (e.g., natural gas).

- The vulnerability associated with excessive dependence on a single source of energy is economically unsound and often politically unacceptable. Beyond diversifying imported energy sources, a sustainable strategy must involve expanding effective energy capacity through development of renewable resources such as solar and geothermal energy, and reduction of local demand through innovative energy conservation programs.

- Most of the region's energy sectors are dominated by direct government control or government-controlled utilities. In Jordan, 866 mw of current generating capacity is produced by the government-owned Jordanian Electricity Association, while the remaining 125 mw is generated by the private sector. Given the parallel trend toward privatization in each country, the private sector will inevitably play a growing role in the energy field—a factor that must be considered in any assessment of energy projects' sustainability.

- Privatization by itself is environmentally neutral. Because government industries in the region have never been paragons of efficiency, and have frequently been more difficult to monitor and regulate than private corporations, privatization in theory can play a positive environmental role. However, privatization will not further sustainable development unless a strong, technically competent regulatory authority is in place.

Proceeding from these assumptions, this report considers most of the peace projects affecting the region's energy sector. Given the report's limited scope, descriptions are not exhaustive, and Appendix I provides better documentation of the various proposals at hand.

B. Expansion of Thermal Power and Oil Refinery Capabilities

B1. Project Descriptions

Jordan. To meet anticipated power demands and participate in regional power systems, the Jordanian government is rapidly expanding the new Aqaba Thermal Power Station (ATPS). The two existing 130 mw heavy fuel-powered units are to be doubled by 1997, and by 1999, this capacity will increase through the addition of two more 130 mw units. This project also calls for construction of a boiler island, a turbine generator island, civil works, and heavy fuel oil storage tanks.

In addition to these proposed thermal power activities, plans exist to build an Aqaba oil refinery. The current Jordan Petroleum Refinery, which has a capacity of 100,000 barrels/day, is considered inadequate to meet the country's growing needs. Given the present low motorization rates in Jordan (60 vehicles per 1,000 people), projections of a 100 percent increase in demand by 2010 are not unreasonable. Few details of this plan are available, though implementation is set for 1996-2000 at a price of $500 million.

Egypt. Egypt is promoting plans to establish three new oil refineries in Sidi Krir, Suez, and Port Said, at a combined cost of almost $4 billion. As these facilities are to be for export production, the petroleum they create will be marketed as environmentally friendly (low sulfur, lead-free, etc.). In addition, Egypt intends to upgrade its existing refineries, including secondary processing to produce cleaner products (gasoline, jet fuel, diesel and propylene) and begin a multibillion-dollar expansion of petrochemical products (rubbers, solvents, paints, foams, wires cables). Beyond a depiction of these new plants as "state-of-the-art," no details have been offered regarding emission control technologies or pollution prevention innovations to be used.

B2. Sustainability Considerations

Air quality. Power plants and refineries are the primary generators of sulfur dioxides and major contributors of particulate pollution. While control technologies can be extremely efficient in reducing emissions, they are also extremely costly (particularly for refineries) and not presently used by utilities in Jordan or Egypt. Since most countries in the region do not have updated ambient air quality criteria, (or, as in Jordan, have never promulgated such limits), it is not clear how design or emission standards for the new plants would be determined. Yet given the designation of the Sinai and Aqaba regions as major tourist development areas, the importance of investing in clean air technologies cannot be over-emphasized.

Particulate pollution's role in impairing visibility is especially problematic in a pristine area such as the Gulf of Aqaba. Standards such as those used to provide aesthetic protection in comparable desert vistas (e.g., in the Grand Canyon region of the U.S.) should be made a legislative priority concern in this region.

Oil spills. With 40 percent of the world's oil passing through its waters, the Mediterranean Sea will be the inevitable sight of oil spills, despite broad international participation in marine pollution prevention treaties. The Gulf of Aqaba, with its uniquely sensitive aquatic ecosystems, has a much lower threshold for environmental damage than the Mediterranean. Hence, an underlying objective of any regional strategy should be the minimization of all marine transport of oil, and of risks of spills from land-based sources. Establishing new coastal refineries inherently runs counter to such a strategy, thereby raising questions about the optimal location for such facilities, assuming they are economically essential. Furthermore, such projects would have a negative impact on tourism, destroying beaches, coral reefs, and other popular attractions.

General. Because tourism offers the primary economic opportunity in the Gulf of Aqaba and Sinai region, the above environmental concerns raise serious questions about the sustainability of the proposed Jordanian refinery and power station. International agencies must be insistent in requiring an environmental impact statement (EIS) for each project, with notice and comment provisions for Gulf States and local NGOs. Alternative sites for the oil refinery should be considered in the EIS, even within the context of the parallel Egyptian efforts. The relatively copious coastal areas in Egypt, coupled with Sinai's rich fossil fuel supplies, provide a stronger case for Egyptian refineries—even though the potential for widespread environmental havoc in the Sinai is no less acute. It is therefore important that an EIS pay considerable attention to siting, process design, and control technologies. Moreover, given the uncertainty of world petroleum demand post-2000, it is unclear whether there will be a sufficient return on an export-based investment that may preclude other, more promising areas of development (e.g., tourism).[1]

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[1] Some experts, such as Amory Lovins of the Rocky Mountain Institute, hold that the world demand for petroleum will drop precipitously by the year 2010, with the widespread marketing of hybrid-electric supercars that get 250+ miles/gallon. Other experts cite the growth of developing countries as the cause of ever-increasing petroleum demand.

If the Jordanian government chooses to proceed, despite environmental concerns surrounding the power plant and refinery, there must be a meaningful expansion of technical capabilities to ensure effective monitoring and inspection at the two facilities. Assuming appropriate normative standards can be enacted, the government must purchase air pollution monitoring equipment. It is critical for Amman to recognize that it is far easier to integrate air pollution control equipment during the course of construction than to try to retrofit existing plants. Consequently, international support for these projects must stipulate that scrubbers, particulate controls, and environmentally sound methods of disposing of liquid and solid waste residues must all be part of initial facility designs.

Given the region's limited familiarity with state-of-art air quality control technologies, imposing emission controls may be easier if projects are developed by private firms (presumably involving foreign partners) with experience running facilities in regulated climates. At the same time, it is doubtful that private utilities will invest adequately in environmental controls unless a powerful regulatory agency forces them to do so. This being the case, these projects highlight the importance of a multinational environmental commission in the Gulf with regulatory powers.

C. Interconnection of Electrical Networks

C1. Project Description

Even if domestic electrical infrastructures were efficient, the present generating network is less than optimal at the regional level. A multinational link-up offers the potential to diminish spinning reserve and back-up capacity and reduce the need for peak load generation. Toward this end, several interconnection projects have been proposed, of varying magnitudes.

At the smaller end, a 500 kilovolt (kv) Egypt-Jordan linkage of 300 kilometers ($150 million cost) has been proposed. At the more grandiose end, the Egyptian-Jordanian linkage discussed above will be incorporated into a five-country, 2,000 mw power grid (Syria-Turkey, 124 km; Turkey-Iraq, 129 km; Iraq-Syria, 165 km; Syria-Jordan 210 km; and Jordan-Egypt, 300 km). This project has a proposed cost of $508 million. Other interconnection projects include expansion of Israel's connection to the West Bank and Gaza, and a $2.5 billion project connecting the 11 countries in the "Arab Meshreq" by the year 2000.

C2. Sustainability Considerations

Environmental concerns. Environmental gains from international cooperation in this field are well-documented. Since participating nations do not have to maintain a full range of facilities to support base and peak loads, more efficient planning can take place, and overall combustion of pollution-producing fuels can be reduced. In addition, inefficient configurations can be avoided. For example, coal-fired plants—highly appropriate in their design to meet base loads—should not automatically follow demand, since they become more environmentally problematic when used to supply peak loads.

Overall, transmission losses resulting from interconnection are not sufficient to outweigh the anticipated reductions in generation. The distances involved in the proposed projects are not excessive by any international standards. For example, 1,100 km high-voltage lines planned by the Quebec Hydroelectric Commission (exceeding a 604 km. existing line) are expected to have line losses of only 5-10 percent. Under the proposed peace projects, line losses would be more than compensated by the potential in reduced generation and reserve margins through the optimization of a peace region grid.

Regional environmental concerns will naturally focus on potential electromagnetic radiation (EMR) exposures, right of way, and landscaping issues. While the scientific verdict on EMR is still out, prudence dictates distancing new lines from densely populated and sensitive areas (e.g., schools). New York State's relatively conservative guidelines may be an appropriate example for adoption by the proposed regional network. The importance of a comprehensive EIS authorized to make recommendations on line routes to reduce EMR exposures and aesthetic damage cannot be underestimated.

Privatization. Most of the proposals set forward recognize that a regional grid will require new international utilities to oversee equitable usage and expenditures within the system. Given the complexity of sovereignty issues, participating governments will be involved both during construction and at least the initial stages of utility operations.

Interconnection holds very positive implications for privatization, since it can create a market for private sector contribution. International agreements could force the multinational utility to pay "avoided cost fees" to local small producers. Moreover, in the area of renewable energy development—crucial to the long-term independence of the oil-poor countries—such a demand has the potential to offer real incentives to bring new, clean energy production facilities (geothermal stations, solar facilities) on-line.

D. Oil Pipelines

D1. Project Descriptions

With two-thirds of the world's oil resources located in the Middle East, real economic savings in crude oil transport can be made within a peaceful and stable region. Israel and Jordan have been enthusiastically promoting several crude oil pipelines. At present, most oil transport to Jordan is done overland by trucks, with all the attendant safety and environmental ramifications. Palestinians and Israelis receive their petroleum at the ports of Eilat and Ashdod. Given that in 1992 the largest portion of Middle East oil exports (26.5%) was sent to Europe, direct access to Mediterranean ports will save tanker costs involved in transport around Africa or through the Suez Canal, and will reduce the risk of oil spills in the increasingly polluted Red Sea.

Under to a Jordanian plan, an Iraqi-Jordanian Crude Oil Pipeline ending in the Gulf of Aqaba would be laid during 1996-1998, running 98 km at a cost of US$ 1.4 billion. Israel, meanwhile, is emphasizing the revitalization of the region's old lines, only half of whose 290 million ton capacity is used today due to security reasons. For example, the Saudi Arabia-Jordan-Golan-Lebanon line could transport 25 million tons of oil annually, with direct Mediterranean access. Similarly, the old IPC line, originating in Iraq and crossing Jordan to end at the port of Haifa, has a 70 million ton/year potential. Other plans, such as linking the South Suez oil fields to Alexandrian ports offer similar logistical advantages.

D2. Sustainability Considerations

Environmental concerns. Generally, pipelines are considered more environmentally benign than oil tanker or truck transport. Environmental concerns focus on the potential for leakage, sabotage, and explosions, and high-profile disasters in Russia have confirmed these fears. However, it is not clear that such experience is instructive. Russia combines the harshest imaginable climatic conditions (huge temperature swings) with overall under-capitalization and negligence (poor welding, inadequate cathodic protection), to produce the noted deleterious results.

Nonetheless, the re-initiation of old lines will require extremely methodical inspection to ensure that the pipelines meet current safety standards designed to prevent future leaks and spills, and to minimize the damage from catastrophic events. Ongoing maintenance and monitoring (e.g., shooting "pigs" down the pipeline to check welds, etc.) and adequate surface water separation facilities stations can prevent most problems. An EIS should include an expanded section on pollution prevention measures.

There appears to be little reason why pipelines could not be privately operated, although given their multinational character, government involvement is probably inevitable. Of greater importance is ensuring that private energy developers have access to pipe capacity.

E. Oil Shale Exploration

E1. Project Description

Oil shale constitutes Jordan's and Israel's sole potential commercial energy reserve, with 40 billion tons located in Jordan and 12 billion tons in Israel. The relatively low percentage of reclaimable organic material (approximately 10 percent), combined with the low price of coal and crude oil, continue to raise questions about the economic feasibility of this energy option. Yet, to the extent that conventional fuel prices rise, or energy independence becomes an increasingly important political objective, there will be greater justification (and pressure) to develop these oil shale reserves.

Jordan estimates that it can extract four billion tons from its present resource and is planning to construct a pilot plant that will ultimately produce 75 barrels/day, in addition to sulfur by-products. Israel's efforts in this field focus on oil shale fuel production and combustion commercial technologies. In the regional context, Israel has suggested joint oil shale exploration projects with Jordan, including an evaluation of deposit quantities and quality, construction of an oil shale power station, and research and development to reduce extraction costs.

E2. Sustainability Considerations

Environmentally, oil shale is not a high-priority energy source. Considered to combine "the world of coal and oil," it is both dirty and water-intensive. While commercial mining invariably causes immediate damage to landscape, reclamation is possible if adequate financial resources are reserved for it.

Israel's oil-shale development is spearheaded by PAMA Ltd., an example of a primarily government-owned company that is being transferred to private investors. If subsidies are provided, or if fuel prices rise, such an investment might be attractive. Indeed, the Ormat Corporation has already approached Israel's Electric Company regarding an exploration project to identify potential mining locations. According to Ormat officials, oil shale development is perceived as "inevitable," given the absence of alternative fuels in the country.

If indeed oil shale is to become part of Israel and Jordan's energy portfolio for security reasons, it is important that adequate precautions are taken to minimize environmental impacts. As an example, solid waste disposal problems are considered massive relative to other fuel sources. If long-term damage to the landscape is to be reduced, it is crucial that any mining of oil shale resources be conditional on sufficient investment in publicly run reclamation funds. While Israel is the only peace region country with such a legal requirement at present, even there the provision is frequently not enforced, particularly in cases of government-owned corporations (e.g., the Dead Sea Works).

The intense demand for water in existing refining technologies raises both ecological and economic questions about the wisdom of pursuing this option with present technologies. Assessment of oil shale reserves as a peace project has certain merits if it goes beyond simply mapping deposit properties and includes carrying capacity, landscape sensitivity, aesthetics, etc. The EIS for any extraction program should pay adequate attention to waste disposal and post-project land restoration.

F. Renewable Resources: Solar and Geothermal Power Development

F1. Project Descriptions

Solar energy. As all peace region countries enjoy a plentiful supply of sunlight for most of the year, solar energy has an intuitive appeal as part of any energy strategy. As of 1994, 25 percent of all Jordanian homes were supplied with solar heaters, up from 12 percent in 1986. In Israel, solar heaters help save 640 million kilowatt-hours (3.2% of the nation's energy requirements) each year. However, since the onset of the solar heater diffusion program in the 1970s, the field of solar technology has experienced little innovation in the peace region. For example, Luz, the Israeli corporation whose reflector technologies gave rise to the first "solar city" in California, has never generated a watt of energy in Israel. With proper incentives, however, development could catapult the region to the leading edge of this most sustainable of technologies. Experts estimate that by the year 2050, solar cells will produce 20-30 percent of the world's electricity. If these projections prove correct, the export of solar technology could prove to be a major source of income in this region in the coming century.

Among the projects promoted by Jordan is the expansion of solar ponds. Due to the variation in the salinity of area water, temperatures a few meters below the surface in solar ponds can rise as high as 100 degrees Celsius, and the heat trapped in between the salinity strata can be tapped. The Dead Sea, with its high temperatures and natural salinity, is an ideal natural location for applying this technology, as a now defunct Ormat pilot project demonstrated. The proposed Jordanian pilot project would establish a solar pond to generate electricity and heat a greenhouse at a cost of only $1 million.

Due to power loss during conversion from heat to electrical current, solar ponds may not yet be market competitive as a means of electrical production. Yet for certain projects such as desalinization, which require heat rather than electrical power, losing no energy to conversion, they may in fact be highly cost-effective.

An Israeli project proposes construction of solar towers with heliostat fields at the Dead Sea Works or the Jordan Potash facility. The feasibility of solar towers was first demonstrated in 1976 at the 10 mw electric generating station in Daggett, California. The Daggett facility uses a 72-acre field of mirrors to concentrate sunlight at the top of a central tower and generate thermal energy from the sunlight to heat steam that then powers electricity-generating turbines. Similar smaller projects exist in Israel, including the Weitzman Institute's solar facility.

Some analysts believe that solar power towers have relatively low net useful energy yields and are expensive to build. Indeed, while their impact on air and water is low, solar energy stations require large areas of land for solar collection. Moreover, the desert biomes in which they are often built usually lack the water needed in the cooling towers to re-condense spent steam. At the same time, new designs and innovations could make these towers economically competitive.

Photovoltaics might also be integrated into new regional solar projects. With the upscaling of U.S. projects based on this technology (most notably the recent Envron/Solarex 100 mw Nevada joint venture), there is a sense of optimism regarding feasibility. With significant economies of scale in place, costs can be reduced sufficiently to compete with more conventional technologies. The advantage of photovoltaics is its ability to generate meaningful quantities of power independent from a central grid. This holds clear advantages for the more rural and remote districts of Jordan and Egypt, even if for the foreseeable future there will be a need for a back-up power source (e.g., hybrids, using wind or standard diesel turbines).

The use of solar power cells could be limited by insufficient amounts of cadmium and gallium. What's more, without proper pollution control, the manufacture of photovoltaic cells can cause moderate water pollution from chemical and hazardous wastes. Therefore, peace projects should remain small-scale, focusing on overcoming these difficulties so that the region may become a world leader in environmentally benign solar power.

Geothermal energy. Geothermal energy can be exploited in two ways—by tapping the heat of underground geological formations, or by harnessing direct hydrothermal power. Despite its environmental merits, however, geothermal power is not a panacea. For example, only about 1 percent of total potential hydrothermal energy can be used and converted to electricity.

For geothermal energy to be successfully generated, a temperature threshold no lower than 100 degrees Celsius is required. Geothermal potential in Jordan appears limited at present to a series of hot springs, primarily in the Dead Sea region, whose combined flow is 2000 m^3 per hour. Jordan has planned a pilot plant that would entail drilling deep wells into the hot dry rock. Injected water would then be heated during transit through the fractures, and the emerging steam would be harnessed to turn turbines. Such a plant could be operational within a few years at a cost of $1.6 million.

Israel's Ormat Corporation has become a world leader in geothermal technologies, although ironically, it has established no facilities in Israel. The Ormat system does not use steam turbines, but involves a closed circulation system whereby steam is recondensed into water and reinjected into the hot rocks. This method essentially eliminates the release of underground pollutants and is capable of producing energy at relatively lower temperatures than other systems.

F2. Sustainability and Privatization Considerations

The environmental and self-sufficiency merits of solar energy are self-evident, and hardly need elaboration. The environmental advantages of geothermal power sources are also well-documented. As no fuel is burned, there are practically no emissions with steam units (at most, releases of trace quantities of natural sulfur, H_2SO_2 and silicon) and none associated with the Ormat closed system. What's more, neither contributes meaningfully to greenhouse warming through gas emissions. Aesthetically, the smaller scale and lack of smokestacks make geothermal plants less conspicuous in natural landscapes.

It is worth mentioning that because of the relatively modest costs of establishing small and medium-sized solar and geothermal plants, they may offer the most promising area for entrepreneurial participation in regional energy schemes. Funding of regional interconnection should include "buy-back" requirements to provide additional economic incentives. For instance, in Israel, the opening of the National Electric Company grid to private generators has created small solar initiatives on desert *kibbutzim*. There is also greater justification for providing market subsidies to renewable energy projects than for other technologies that weaken the balance of trade and have harmful environmental impacts.

G. Canals

G1. Project Descriptions

Proponents cite numerous benefits associated with their canal proposals, but the present context is limited to a brief review of their implications for generating power. According to Jordanian proposals, exploiting the 400-meter elevation drop between the two seas, the Red Sea-Dead Sea Canal would produce up to 360 mw of power per year. Infrastructure would include pump stations, 220 kilometers of pipeline (in addition to the open canal), four reservoirs, and four hydroelectric stations. Israel estimates that the potential power generation capacity from three power stations each in Saudi Arabia, Israel, and Jordan would generate 600 mw of electricity. A Trilateral Committee report from Israel, Jordan, and the U.S. inserts a desalinization component in the proposal.

An Israeli proposal for a Mediterranean Sea-Dead Sea Canal would convey Mediterranean seawater from Haifa to the Jordan Rift Valley, where it would be desalinated in reverse osmosis plants, making use of the hydrostatic energy created by the elevation difference. The 800 million m^3 of desalinated water produced yearly would be stored for drinking in a new lake to be created in the Rift Valley. The "Med-Dead Canal project," as this venture is known, while designed to be self-sufficient, is not expected to produce excess energy.

An alternate Israeli Med-Dead Canal proposal, designed primarily to produce hydroelectric power, would carry water from the Mediterranean Sea near Qatif to an 800 mw power station at the Dead Sea. This project would entail two stages: a filling stage of 17-20 years, during which the Dead Sea would be restored to its pre-1930 level and electricity would be produced at 2,000 million kwh/year; and a steady state stage, during which flow to the Dead Sea would be reduced to maintain an elevation of -390.5 meters and electricity production would be 1,300 million kwh/year.

G2. Sustainability Considerations

Economists and environmentalists have raised numerous questions about the wisdom of these massive canal proposals and their ultimate benefits. Salient issues include particulate air pollution during construction, seismic risk, interference with wildlife, groundwater contamination, discharge of desalinated waste streams, modified water levels, and chemical composition of the unique Dead Sea waters. Impact assessments have yet to be prepared and are of course particularly important in projects with such broad geographical scopes and potential implications.

H. Yarmuk Dams

H1. Project Description

Construction of two dams on the Yarmuk River was included as part of the water resources agreement in the Jordan-Israel Peace Treaty. Given both parties' commitment to expeditious implementation of all provisions in the treaty, this project is most certainly on the fast track. Hence, it is unfortunate that relatively little data is available concerning the dams themselves.

The Yarmuk River flows west until it meets the Jordan River. A thumbnail description of a $300 million dam complex at Magarin, 20 kilometers north of Irbid, has been published by the Jordanian government. The dams, creating a 225 million m^3 reservoir, are primarily designated as water supply projects, and not hydroelectric facilities. Nonetheless, the 140-meter-high, concrete-covered complex will generate 15 mw of power. Construction is expected to take four years, and donors meetings have been held as early as 1988.

H2. Sustainability Consideration

The long-term benefits of dams are increasingly denounced, given the extended time horizons used in environmental impact statements. Indeed, the only major project of this type in the peace region, the Aswan Dam, is the subject of much criticism due to the impact it has had on agriculture, sand deposition in the Mediterranean, beaches, and fishing. Beyond the conventional damage caused by hydroelectric dams (lost recreational resources, silting, etc.), the location of the Yarmuk dams along the Syro-African Rift Valley raises questions about the potential for earthquakes and the impacts of resulting floods.

I. Conclusion

Table 1 summarizes the projects reviewed from the perspective of sustainability. It is unlikely that any single project will offer a sustainable panacea for the region's energy needs. As a general rule, projects deserving fast-track support include those that both contribute to long-term energy independence and are environmentally friendly. Interconnection of electrical networks, development of oil pipelines, and expansion of solar and geothermal sources are preferable, using these limited criteria. A burden of proof preventing implementation of potentially destructive projects such as dams and canals should be in place until detailed and scientifically reviewed environmental impact assessments prove otherwise.

It is important to emphasize that *none of the projects surveyed in this report have been adequately addressed from an environmental perspective*. Given the role that tourism is to play in the region, it is crucial that international donors make future support contingent on systematic preparation of environmental impact assessments, both for individual projects and for the cumulative impact of projects for each sub-region (e,g., the Gulf of Aqaba). An institutional forum for regional oversight capacity should be established that includes participation by competent NGO professionals and independent scientists.

With oil prices low in international markets, alternative energy development has receded in recent years. Yet, even recent history shows that the fossil fuel market is subject to vast fluctuations, and that in the long run prices will rise precipitously. Common sense therefore dictates the need to diversify fuel sources and suppliers. In countries with practically no domestic supplies, this need presents an opportunity to seek out relatively benign sources of energy (e.g., natural gas or South African coal). More important, in preparing for the eventuality of higher oil prices, it would be wise to direct resources toward expanding infrastructures and exploring pilot projects that create the capacity for using locally available and *renewable* energy resources.

As is often the case, the large number and variety of peace projects on the table suggest a supply-side approach by governments in question. However, in considering their overall energy portfolios, countries must examine demand-side options as well. Opportunities for cogeneration in industrial facilities, programs to improve energy efficiency in commercial and residential sectors, and diffusion of available solar technologies may reduce the need for building massive projects that threaten to damage the competitiveness of the region as a center for international tourism.

As a result, it is important that strategic decisions in the field are not made solely by engineers, whose professional bias tends to support construction of the power plants they so well know how to build, without a parallel commitment to energy efficiency. This is certainly analogous to the case of highway construction, where investment in public transportation rarely reflects its actual economic and environmental superiority. In the case of the peace region, where all countries have a relatively low rate of motorization, investment in public transport might prevent the geometric growth in car ownership that would otherwise accompany new societal prosperity, thereby softening future demand for polluting petroleum products.

There is little doubt that competition has the potential to improve the efficiency and the performance of the energy sector in the Middle East. From a strictly environmental perspective, the success of economic incentives in Germany and more recently in the utilities sector of the United States suggests that market forces can be harnessed for net environmental gain.

While some projects more readily lend themselves to private sector involvement (oil shale development, oil refineries, and solar and geothermal power), each requires a corresponding investment to expand regulatory capacities. Without clear regulations, strong institutions to oversee them, and meaningful sanctions for violators, expanded energy development, particularly if driven by the private sector, will have negative environmental impacts.

Table 1: Summary of Proposed Peace Region Energy Projects

Project	Countries	Cost (million $)	Contribution to Energy Independence	Negative Environmental Impact
Oil Refinery Expansion	Jordan Egypt	500 4,000	No Yes	High High
Electrical Supply Interconnection	Jordan/Egypt Israel/Palestine 5 country	150 100 508	Yes Yes Yes	Medium Medium Medium
Oil Pipeline	Iraq/Jordan SA, J, I, L	1,400 NA	No No	Medium Medium
Oil Shale	Jordan Israel	NA NA	Yes Yes	High High
Solar	Israel Jordan	NA 1	Yes Yes	Low Low
Geothermal	Jordan Israel	1.6 NA	Yes Yes	Low Low
Canals	Red-Dead Med-Dead #1 Med-Dead #2	3,000 3,500	Yes No	High High High
Dams	Jordan	300	Yes	High

An objective of environmental NGOs from the peace region should be to promote alternatives to conventional supply-side solutions. Demand-side management, conservation, regional interconnections, and preferences for renewable energy should constitute the focus of regional efforts. A strong environmental framework for energy that encompasses environmental impact assessment in the planning process, progressive laws, and sound enforcement needs to be integrated into the development process, if sustainable development is to be achieved.

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APPENDIX I

SUMMARY OF PROPOSED ENERGY PROJECTS

APPENDIX 1: PROPOSED ENERGY PROJECTS

1) Aqaba Thermal Power Station (ATPS) - Jordan

The aim of this project is to help meet anticipated power demands at the beginning of the next century and to prepare the Jordanian power system for its role in regional interconnection projects.

ATPS is located 19 km south of Aqaba city towards Saudi Arabia, at 35m above sea level. Stage one of this project, already completed, entailed the construction of two oil fired steam units, each 130 MW. Stage two (presently seeking funding, to be in service by 1997,) and stage three (not yet begun, to be in service by 1999,) with each to include construction of two 130 MW steam power units burning heavy fuel oil (4, p19).

Project components of stages two and three will include construction of a boiler island, a turbo generator island, civil works and a heavy fuel oil storage tanks island (4, p19).

Both stage two and three are estimated to cost US $210 million each (1994 prices) and should be completed by 1997 and 1999, respectively. Feasibility studies have already been completed (4, p20).

2) New Oil Refinery in Aqaba - Jordan

At present the existing Jordanian refinery has a maximum capacity of 100,000 barrels/day, whereas Jordanian demand beyond the year 2000 is expected to double to over 6 million tons/year (4, p24).

The new refinery will have a capacity no less than 100,000 b/d plus auxiliary units such as gasoline production, upgrading and cracking units. Surplus oil will be exported (4, p24).

The cost of the project is estimated at US$ 500 million. The project is currently under study. Implementation time is 1996-2000 (4, p24).

3) Interconnection of the Electrical Networks of Egypt, Jordan, Iraq, Syria and Turkey

The benefits of such a link-up would be substantial due to differences in peak load demand, major differences in the marginal costs of the diversified energy pool and reduced spinning reserve and emergency back-up capacity needs (1:5, p4).

Potential challenges of project implementation include the need for a regional organization representing relevant utility companies, forcing previously belligerent countries to agree as to the form and composition of this entity and a formula for sharing accrued benefits. Furthermore, operational system control at the national level must be stable to be fair to all and permit interconnection. Lastly, the financial situation of some utilities is such that it may affect their ability to meet commercial obligations under a regional agreement.

Although the project will require high voltage transmission lines and substations spanning vacant arid land, it would require little resettlement or destruction of forests.

A) Egypt-Jordan Interconnection:

On the Egyptian side this project would entail 500 kV transmission lines: 40 km in length from the Suez substation to the Oyoun Moussa thermal power station in Sinai, an underground cable of 2 km crossing the Suez, 250 km from Oyoun to a new Taba substation. Egypt would also cover the costs of this new Taba substation (500/400/220 kV, 1x750 MVA - 1x500 MVA) (3, p58).

The costs of a 400 kV submarine cable, 13 km in length, crossing the Gulf of Aqaba, would be shared by both sides (3, p58).

Jordan would be responsible for a 400 kV transmission line of 10 km length from the Gulf of Aqaba to the Aqaba Thermal Power Station (ATPS) and construction of the ATPS (see above) (3, p59).

This project will be of great economic benefit to both sides by allowing for an energy transfer of 130-400 MW in both directions and by providing support in emergency conditions. The project will also bring forth savings of 100 MW in the generation capacity of gas units in Egypt (costing US$ 32 million) and 130 MW steam units in Jordan (costing US$ 126 million).

Costs are estimated at 150 million, financed by the Arab Fund for Economic Development. This project should be completed by 1997 (3, p59-60).

B. Five countries Interconnection

To accomplish interconnection, tie lines of 400 kV must be established between the following:

Aleppo, Syria to Birecik, Turkey	- 124 km
Cizre, Turkey to Kezek, Iraq	- 129 km
Qaim, Iraq to Der Zor, Syria	- 165 km
Adra, Syria to N. Amman, Jordan	- 210 km

Furthermore, reinforcement of existing networks in participating countries must take place as follows:

Jordan	- 40 km
Syria	- 480 km
Turkey	- 28 km

Lastly, switching stations in participating countries must be established as follows:

Jordan	- one
Syria	- five
Iraq	- two
Turkey	- two (3, p60).

Once completed, this project will allow for savings in reserve generating capacity in the order of 2000 MW, on the basis of reducing the reserve margin of the five countries by 5%. It should also reduce operation and maintenance costs for each country involved (3, p61).

The project is estimated at US$ 200 million, to be financed by the Arab Fund for Economic and Social Development. Additionally, each party state will bear the costs of its own components (3, p60). The project will be divided into two phases. The first, to be completed in 1998, will connect all countries except Iraq. The second phase, to be accomplished by 2002, will connect Iraq to the loop via Syria and Turkey (3, p61).

C. Interconnection - Stage II

Stage one of this project was to establish interconnection between the five countries at 300 MW. The objective of stage two is to increase the interconnection capability to 600 MW (except between Turkey and Iraq where interchange capability is at 800 MW already), and to provide improved operation security. A necessary precursor to this stage is a third 400 kV circuit from the ATPS generating station to the Amman North substation, a distance of 345 km (4, p20). The project itself will then entail construction of a second 400 kV interconnection from the Amman North substation in Jordan to the Maraba Substation in Syria (4, p21).

Total cost will be US$ 308.8 million, to be divided between Syria and Jordan. A feasibility study has already been accomplished and project implementation should start in 2002, to be completed by 2005 (4, p22).

4) Arab Meshreq Interconnection

The Arab Meshreq, consisting of Egypt, Bahrain, Iraq, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, United Arab Emirates and Yemen, has a considerable mix of energy resources varying from hydro resources to abundant fossil fuel reserves. Interconnection of the countries would potentially reduce load probability loss from 0.2 to 0.02 days per year, would decrease the reserve margin from 21% to 13.5%, and facilitate energy back-up in each of the systems without adverse effect on other systems. The cost of such a project, to be operational after the year 2000, is estimated at US$ 2,500 million (3, p63).

Further interconnection projects include The Arab Maghreb countries (North Africa) and a Mediterranean Power Pool (3, p68).

5) Interconnection Expansion - Israel and the Occupied Territories

At a 1991 conference in Cairo on the subject of expanding interconnection to include Israel and the Occupied Territories, the Egyptian Minister of Energy approached the European Community to organize and fund a feasibility study. In 1993 consultants from Austria and Germany (Verbund-Plan GMBH and Lahemeyer International), undertook a comprehensive evaluation of all technical and economic facets involved in linking the electrical systems of Jordan, Egypt, Israel, and a Palestinian Self-Government Authority from 1995-2010. The report, now under revision, was submitted in May 1994 (3, p70).

As described above, presently the governments of Egypt, Iraq, Jordan, Syria and Turkey have agreed to link grids. Including Israel and the Palestinian Authority in this linkage, as proposed within the framework of multilateral negotiations conducted under the Madrid Conference umbrella, would clearly lead to greater cost efficiency for all parties involved (1:4, p1).

According to World Bank estimates, a link-up of 400 kV grids between Israel, Jordan, Egypt, Lebanon and Syria (including survey and feasibility tests, planning and implementation,) will cost US $200-300 million (1, p4). (This entails approximately 500 km of electricity lines at a cost of US$ 0.5 - 0.7 million per every km of a 400 kV line).

A. <u>400 kV/500 kV Network Along the Mediterranean</u>

This project would entail construction of a double circuit transmission line and substations which will connect the existing 500 kV grid of Egypt with Israel via a 400 kV line form El Arish to Zafit. Such a transmission line would offer the shortest connection between the load centers of Egypt and Israel. This project would supplement the existing line from Suez to Taba, Aqaba, Amman Jerusalem and Zafit, only the new line would be substantially shorter.

Completion of this project relies on Egyptian plans to link El Arish to the Egyptian system early in next century (1:5, p5).

B. <u>Interconnection at the Northern End of the Gulf of Aqaba</u>

At the Northern end of the Gulf of Aqaba, Egypt, Israel and Jordan converge within a 50 km radius. At this ideal point, several options exist for interconnection, all of which would entail the extension or construction of substations, which would include transformers and telecommunications equipment (1:5, p5).

Option 1: Erect a 400 kV transmission line through Israel from Taba to Aqaba and then connect in Israel through a161 kV line from Eilat either to Taba or Aqaba or to both.

Option 2: Erect a submarine cable instead of a transmission line from Taba to Aqaba (1:5, p5).

Option 3: Construct a double circuit transmission 400 kV line, one circuit to connect Taba with Aqaba, a second to extend from Taba to Eilat and continue from Eilat to Aqaba.

At the present time, Egypt and Jordan have already agreed to proceed with the submarine cable. With the peace process, these plans could change.

C. Interconnection of Israeli and Jordanian Load Centers Construction of a double circuit transmission line 400 kV with one circuit connecting Amman southward to the Zafit substation belonging to the 400 kV Israel network, and a second circuit linking Amman south with a substation to be erected close to Jerusalem and continuing from there to Zafit. As an alternative, both circuits could lead to the substation near Jerusalem and continue to Zafit (1, p7).

Interconnection would provide a strong kV line from Egypt to Israel in lieu of other domestic connections (such as from the load center in Cairo to El Arish and the 400 kV backbone from Eilat to load centers in Tel Aviv).

According to the Israel report, extension of the ATPS - stage 2 would be necessary to provide the additional capacity needed to permit power export to the Palestinian Authority in the event of interconnection with Israel and the Occupied Territories.

D. Interconnection of Israel Electric Corporation and Jordanian Electric Authority Networks at the Southern End of the Dead Sea.

This project involve construction of 50 km of 161 or 132 kV transmission lines connecting the IEC substation to the JEA substation at Chor Safi via Wadi el Hasa, the extension of related substations with line feeders for the interconnection link, the erection of an auto transformer in one of the two countries, and the installation of related telecommunications equipment. This project will yield additional safety of supply for the remote Ghor area, especially Ghor Safi which is connected as a double circuit t-off to the national grid (1:5, p7).

E. Transmission line from El Arish to Israel via Gaza:

This line would link El Arish on the West Sinai coast with the Palestinian Autonomy in Gaza. The project will entail construction of 80 km of 400 kV lines from the El Arish Steam Power Plant to Gaza. However, the line will be operated at 200 kV until El Arish is connected to the 500 kV grid in Egypt.

A new substation in South Gaza will need to be erected which can also be connected to a 161 kV substation in the Negev.

This system will serve as an alternative power system for the Autonomy, replacing an existing system which operates only at 20 kV. The system will also provide a second HV feeding point for the sub-transmission system in Gaza, which is presently supplied from only one substation within Gaza and from eleven outside feeders of 22 kV. Lastly, this project would enable exchanges between Israel and the local Sinai network (1:5, p8).

However, this project can only work if surplus generation capacity is in Egypt.

6) Sharing Plant Capacity at the Northern End of the Gulf

Jordan's thermal power plant will play an important role to boost voltage and provide reactive power for the transmission system since the closest puissant power plants will be situated in Ayoun Musa in Egypt, Rutenberg in Israel and at the Hussein Thermal Power Plant Station in Jordan. An Aqaba power plant can be extended and operated according to maximum effective criteria (1:5. p6).

7) Iraqi- Jordanian Crude Oil Pipeline

The demand for oil products in Jordan exceeds 3 million tons per year at present. This amount is imported by overland trucks, imposing safety and environmental hazards. The goal of this project is to supply Jordan with its basic energy requirements (including 100k b/d for the Zarka refinery (JPRC) and 150K b/d for a future refinery and industries in Aqaba - see below) through construction of a 950 km long, 48" diameter pipeline with pumping stations in Jordan and Iraq. This pipeline could also be used to export Iraqi oil through Jordan at 1 million b/d (4, p22).

The project will cost US $1.4 billion ($1 billion in Jordanian territory, $0.4 billion in Iraqi). The project is presently under study and construction should begin in 1996, to be completed by 1998 (4, p23).

8) Fuel Transportation System to Western Europe

The Middle East houses two-thirds of the world's oil reserves, most of which is located in Western Saudi Arabia, Kuwait, The United Arab Emirates and Iraq. Syria and Egypt have minor stores and also export. Currently, most oil is sent through a pipeline to the Red Sea and from there it is exported via the sea by supertankers that can hold up to 300,000 tons of oil each.

As of 1992, 26.5% of the Middle East's oil was exported to Europe. In fact, Western Europe alone imports 204 million tons from the Middle East annually, or a total of 680 super tankers (1:5, p11). To reach Western Europe, tankers leaving from the Red Sea must travel either around Africa or through the Suez Canal. Israel has proposed the construction of a pipeline to carry oil from its countries of origin to a port on the Eastern Mediterranean and from there by tanker to Europe directly (1:5, p10). Such a plan would reduce costs by reducing the number of days at sea.

While several pipelines exist with a total capacity of 290 million tons, only half are currently in use. The existing pipelines include:

1) Tapline pipeline: crosses North Saudi Arabia, Jordan, and the Golan Heights across Zidon. This line, thirty inches in diameter, can carry 25 million tons per annum if utilized. However, it has not been used since 1967 and requires repair.

2) Yanbu pipeline: traverses Saudi Arabia and ends at the Red Sea export terminal, Annual capacity: 75 million tons.

3) Eilat- Ashkelon pipeline: used to transport oil purchased from Egypt from Eilat to local refineries. Annual capacity: 55 million tons.

4) Sumed Pipeline: links the south Suez Gulf oil fields with Sidi Karir next to Alexandria to the Mediterranean shores. Annual capacity: 80 million tons.

5) Historic IPC line: originating in the Iraqi oil fields along the Gulf shore, crossing Jordan and Northern Israel towards Haifa. This line splits in the Tartar Gulf region crossing Syria for the Tartus Port. Currently not operable. Annual capacity: 70 million tons.

6) Iraqi-Turkish Line: runs from the Dortoil port in Turkey along the north eastern rim of the Mediterranean. Currently not operable. Annual capacity: 80 million tons (1:5, p13).

On the basis of trying to use as much existing pipeline as possible Israel proposes to use the Tapline pipeline, stretching it from Irbid, Jordan through Emek Israel to Haifa, a distance of 170 km. Repairs on the 1,400 km of existing line would also be necessary. The original capacity would also have to be increased from its present 25 million ton per annum which is too small in relation to the potential economic opportunity.

The Yombo Pipeline in Saudi Arabia would also be extended to the Gulf of Eilat and from the mountains of the western coast of Saudi Arabia to Aqaba, and from Aqaba to the Eilat Katza line. This proposal is limited by the Katza line's small capacity of 45 million from which Israel's consumption must be deducted (1:5, p13).

Each alternative will require investments in Israeli port terminals in Ashkelon and Haifa to prepare them for handling such activity.

The price of transport around Africa is US$ 20 per ton. From the Eastern Mediterranean to Western Europe, transportation would cost only US$ 6 per ton - a profit of US$ 12-14 per ton, divided between countries involved in the pipeline project and the companies investing in it. Assuming that total volume in such a project will be 50-75 mill tons/yr. (minimal consumption scenario), total income from such a project would be US$ 600-1000 million annually (1:5, p15).

Despite the potentially large economic advantage in developing such a pipeline, some quantities of oil will inevitably continue to travel to Europe through the Suez Canal anyway. Egypt can also change the calculation by lowering the fee it imposes for crossing the Suez. (The price component of crossing the Suez currently constitutes more than 50% of the transportation cost to the final destination.) Furthermore, a security coefficient must be figured in, in case a decrease in the demand for oil or an oil crisis arises. Furthermore, Iraq's international relationships are bound to improve and its existing pipelines will return to economical operation (1:5, p15).

9) Export Oriented Refineries - Egypt

Egypt plans to establish 3 modern, export-oriented oil refineries, located at Sidi Krir, Suez, and Port Said, capable of adapting to international market quality and quantity fluctuations. They will be designed to produce "environmentally-friendly products with proven export potential." Primary service will be to regional markets (3, p74).

Sidi Krir Refinery (Mediterranean Coast) - Cost: US$ 1.5 Billion
Planned capacity of 100-120 thousand barrels per day (b/d) fed from Libyan crude - Sumed crude pipeline. It will produce all major petroleum products (3, p74).

Suez Refinery - Cost: US$ 1.2 billion
Planned capacity of 100 thousand b/d fed from Gulf crude. It will produce all major petroleum products (3, p75).

Port Said Refinery - Cost US$ 1 billion
Planned capacity of 80 thousand b/d fed from Gulf and Egyptian crude. It will produce all major petroleum products (3, p75)

10) Refinery Upgrading - Egypt

Egypt hopes to achieve higher international product quality standards through the upgrading of existing refineries by installing new secondary processing facilities. Attention is also focused on facilitating the "phasing out of lead in motor gasoline" and reducing the sulfur level of gas, fuel and diesel oil (3, p76).

Proposed are three fuel oil cracking units of 30,000-40,000 b/d each, for development in Suez and possibly Cairo and Alexandria. Cost is estimated at US$ 1.5 billion. Feed stock supply will consist of fuel and gas oil from Egyptian refineries. Products will include Naptha, gasoline, jet fuel, diesel fuel and Propylene (3, p76).

Financing will be by private investment, international institutions and national and international banks (3, p77).

Furthermore, gasoline upgrading units (isomerization units) are planned for Cairo and possibly Suez and Alexandria, each with a proposed capacity of 1000-1500 tons/day each. These will produce unleaded gasoline - LPG gas oil. Estimated investment is 300 million dollars. Financing will be by national and international banks, suppliers and contractor's credit (3, p77).

11) Petrochemical Projects - Egypt

Long term prospects of growth in worldwide demand for petrochemical products appear bright, especially in developing markets. The Egyptian petroleum section plans to maximize the economic utilization of primary feed stock (natural gas, condensates, and naphtha produced for Egyptian refineries) for the production of secondary feed stocks required for petrochemical production (3, p77). Particular emphasis shall be placed on the production of rubber products, solvents, paints, foam, wires, cables, bottles, pipes, jerkins and films (3, p77).

East Alamein (Mediterranean Coast) Petrochemical Complex:

The complex will have a planned capacity of 300k tons per year of Ethylene (secondary main feed stock for the petrochemical industry), Propylene and Butadiene. Feedstock supply will derive from natural gas and condensates from fields in the Western Desert and Delta, and from (primary feed stock for petrochemicals) from Egyptian Refineries. Products will include PVC, polyethylene, Polypropylene, Ethylene, Glycol, Polystyrene, Butadiene, Polyamide, Plasticizers, Epoxy Resin and Polyurethane.

The cost is estimated at US$ 2 billion dollars. Financing will derive from investors, international institutions, banks and suppliers credit (3, p78).

North Gulf of Suez Petrochemical Complex

The complex will have a planned capacity of 200,000 tons/yr. of Ethylene. The cost is estimated at US$ 1.5 billion (3, p78).

12) Importing Natural Gas from Egypt and the Persian Gulf to Israel, the Palestinian Authority and Jordan

Natural gas is a relatively clean fuel with no ash or sulfur dioxide residue, thereby reducing the air pollution associated with regular fossil fuels. Egypt has increasing gas reserves, producing over 9 million tons yearly, mostly for domestic use. (3, p17).

As Egypt's gas reserves increase and convenient locations for export emerge, Egypt will probably begin to export natural gas. Recently Israel's Minister of Energy and Egypt's Minister of oil agreed to implement a project that would carry natural gas from Egypt to Israel via pipeline. A joint group of experts has been nominated to deal with the required measures (3, p18).

The French company Supregas has indicated that the transport of natural gas from Egypt is economically feasible, costing approximately US$ 800 million on the Israeli side and US $500 million on the Egyptian. Such a project could be operational in three years (3, p18).

Natural gas could also be imported from Qatar via the sea. Such a project would require the requisitioning of a fleet of suitable ships for transport, the construction of a port for unloading gas, and the preparation of underground storage facilities. The cost is estimated at US $4 billion - operational in 5 years.

13) Energy Conservation and Improvement of Thermal Comfort in Existing and Future Buildings in Jordan

Between 1980 and 1985, 108, 000 dwellings were built in Jordan and in the next 20 years Jordan will need to build an additional 431,500 new dwellings. Eighty percent of these dwellings are and will be in areas requiring heating, climatic control, or else they will suffer from dampness accompanied by fungus growth (4, p26).

The proposed project will study design, construction, maintenance and legislation in the field of energy and thermal comfort, leading to improvements that will cut down on heating energy consumption of existing buildings by 20-30% (US$ 3.7 million) (4, p26).

The cost of this project will be US$ 2.5 million with implementation between 1995 and 2000.

14) Oil Shale Exploitation

12 billion tons of oil shale are located in Israel, 40 billion in Jordan. Of poor quality, only 10%-20% of the shale is organic material, but so large a deposit could nonetheless potentially fulfill the energy needs of both countries for a long time (1:5, p19).

The low cost of coal versus the high investment cost of oil shale exploitation makes such a project a challenge. However, if crude oil prices increase slightly to US$ 55 per ton and US $20/bbl, then oil shale products will have a reasonable payoff for the incremental investment involved (4, p27). Furthermore, investment in oil shale exploitation as a long term goal makes strategic sense in case fossil fuels become unavailable for economic or political reasons.

PAMA is an Israeli government-owned company located near the Rotem oil shale deposit in the Northern Negev. Its efforts have focused on the development of commercial technology for oil shale derived fuel production and the development of commercial technology for oil shale combustion. Various methods being explored include Moving Bed Retorting and Fast Heat Retorting.

In its report to the Casablanca Economic Conference, Israel recommended that the two countries undertake joint projects in oil shale exploitation which could include:

*evaluation of deposits and properties

*construction of a commercial oil shale powered station near various oils shale sites in the region using PAMA know-how.

*accelerated R&D activities on retorting technology and the construction of pilot facilities to search for less costly oil extraction process (1:5, p20).

15) Demonstration Oil Shale Retorting Plant to Extract Oil and Other By-Products - Jordan

Jordan has oil shale reserves of over 40 billion tons from which 4 billion tons of crude oil and several million tons of sulfur are extractable via open-pit mining.

A pilot plant will be built to retort oil shale and treat it for the production of oil products at 75 b/d and by-products such as sulfur (4, p27).

The cost of the project is estimated at US$ 6 million for implementation between 1996 and 1999 (4, p28).

16) Demonstration Direct Burning Oil Shale Plant (50 MW) to Generate Electricity - Jordan

The goal of this project is to provide Jordan with electricity by using indigenous fuel. The project requires construction of a CFB unit to burn oil shale and other helping units including a turbine, generator and electricity network (4, p28).

The project is estimated at US$ 112 million, to be implemented between 1996 and 1999 (4, p29).

17) Canals

Israeli Mediterranean Sea - Dead Sea Canal:

A) Northern Alternative

The goal of this project is not to provide the country with excess energy reserves, but rather to create a desalinization plant for the production of drinking water that would meet its own energy needs in a secure, economic, environmentally friendly manner.

Mediterranean sea water would be conveyed across the Northern Valleys to a plateau above the Rift, where it would be pre-treated for desalinization. This water would then be fed by a pen stock into the Jordan Rift Valley, where it would be desalinated in Reverse Osmosis plants, making use of the hydrostatic energy which is available due to the 400m elevation difference between sea level and the Jordan Valley. The plants would produce desalinated water which would be stored in a new lake to be created in the Rift Valley, and a stream of brine which would be disposed of to the Dead Sea through a lined canal, operating hydroelectric facilities on its way (1:9, p28).

The complete project would take 14-15 years at a total investment of US$ 2.8-3.5 billion(1:9, p34).

B) Central Alternative

This project consists of two periods. During the first period of 17-20 years, more sea water will be pumped through the system than can be balanced by Dead Sea evaporation, and as a result the Dead sea will be raised to its pre-1930 elevation level of -390.5m. This period will be followed by a "Steady State Period" during which flow will be reduced from 1750 to 1200 million cu. m. per year (1:9, p10).

Starting at the Mediterranean, water will enter a pumping station near Qatif which will raise the water to elevation of +100m. Water will then flow through an open 20 km long canal, to the Main Tunnel near Ourim. Water will flow through the Main Tunnel to the Regulating Reservoir above the Dead Sea cliffs at a flow rate of 64 cu. m./sec (1:9, p11). Water will then flow to a newly constructed 800 MW power station at the Dead Sea (composed of four 200 MW generating units) which will operate mainly during peak demand hours. During the first "Filling" period, the Power Station will supply 2000 million kwh/year, to be reduced to about 1300 million kwh/year during the second "Steady State" period (1:9, p12).

The project would take ten years for construction and would cost US $1300 million (at 1984 prices). With interest included, the investment cost estimate rises to US$ 1550-1800 million (1:9, p14).

Jordanian/ Israeli Red Sea - Dead Sea Canal:

This project aims to generate 360 MWH per year by using the 400 meters difference in elevation between the two sites. Benefits of the project include a restored Dead Sea water level, production of electricity for consumption and desalinization, and ancillary benefits, mainly marine agriculture and resort lakes. Components of the project include pump stations, 220 km pipeline/open canal, four reservoirs, four hydro-electric power stations.

Water pumping will take place next to Aqaba (either on Jordanian territory or at an artificially constructed by-national gulf) and the conduit will continue for 100 km through one to three pumping phases, up to the Arava back ridge (an elevation of +220m) (1:9, p20).

From the Arava ridge, the canal alignment will return to the Jordanian territory (along an elevation line of +200m) until a width line of 31m is reached. At this point the water will turn west and flow through three Jordanian power plants with a total capacity of 600 MW. The water will then flow towards Israel, continuing north at an elevation of 100m, until close to Neot Hakikar where it will flow through three Israeli power plants with a total capacity of 600 MW. From here the water will flow around the salt ponds of the potash works and then into the Dead Sea (1:9, p21).

Water would be pumped 18 hours per day to maintain a continuous flow of 30-40m^3/second in the canal. The project is slated to cost US$ 1,900 billion (1988 prices) and to take eight years for construction. The project is expected to earn an overall rate of return of only 6% per year (including both hydroelectric components and the possible construction of a marine agriculture project). Therefore the project depends on special encouragement financing that will take into account its non-economic assets (1:9, p27).

18) Dams

Unity Dam - Jordan:

The objective of this project is to regulate the flow of the Yarmouk River (which flows westward towards the Jordan River, directly south of Lake Tiberias). and to increase Jordan's share of present water supplies to meet the rising needs of municipal, industrial and irrigation sectors (4, p142).

The project entails construction of a 140 meter high rockfill, concrete faced dam, a reservoir with a capacity of 225 million cubic meters and a 15 megawatt hydroelectric unit. The estimated cost is US$ 300 million. At present construction of the diversion tunnel for the dam is already completed and construction period of the whole dam is expected to be approximately four years from the date of award of contract (4, p143).

19) Solar Energy

In the next 10-15 years sun radiation will remain a secondary source of energy due to low fossil fuel prices. Within 20-25 years, however, a drive to increase solar share may emerge due to various causes including a perceived scarcity of oil and significant environmental concerns.

The Sinai peninsula, the Israeli Arava and Negev and the Jordanian and Saudi Arabian deserts are all deep inside the global sun-belt providing unlimited land to build and develop joint solar facilities of demonstration size, as well as joint research and training centers. Solar towers with heliostats fields could also be constructed at the Dead Sea Works or at Jordanian Potash Works for steam production or other uses.

Another potential use for solar power is the construction of a solar pond which is simultaneously a collector of solar radiation and a large thermal storage body. The gradient solar pond presents an attractive low cost solar collector for Jordan or Israel when implemented in the Dead Sea. The Dead Sea temperature reaches 100 degrees Celsius and its salinity helps to store thermal energy.

Potential applications of such a solar pond include electricity generation and heating greenhouses. According to Michael Gill of Israel's Ormat Industries, the problem with using a solar pond for such activities other than on an experimental scale, is that under current technology excessive amounts of power are lost in the transition from solar heat to electricity. However, even under current oil prices, a solar pond may be financially competitive when used for the desalinization of water, which requires only heat, not electricity. A further objective of the ponds is to utilize Dead Sea brine instead of NaCl as a medium to create storage and gradient zones (4, p25).

The cost of such a project is estimated at 1 million, to be implemented between 1995 and 1997 (4, p26).

20) Geothermal Energy for Power Generation - JORDAN

Jordan has limited geothermal resources existing in the form of hot springs located in Ma'in, Dead Sea, Zara and Hema. Their combined discharge into the Dead Sea is 2000 cu. m. per hour. These resources are useful for heating medicine and for generating thermal and electrical energy (4, p24).

This project aims to establish a pilot plant to generate electricity using local hot springs and deep hot water as a source of heat energy. This will entail creation of an artificial fluid circulation system in the hot dry rock to extract heat. Wells will be drilled into the rock from the surface. Water will be injected which will be heated during transit through the fractures. The hot water and steam which rush out can be captured for turning a turbine (4, p24).

Total estimated cost is US$ 1.6 million. The project is still under study; implementation should begin later this year, for completion in 1996 (4, p25)

21) Short-Term Investments in the Occupied Territories Power System:

The Northern Subsystem - there is an immediate need identified by the Nablus municipality for 12 km of 11 kV of underground cable, 10 km of overhead 11 kV line, a 20 MVA 11 6.6 kV substation and other rehabilitation work. Cost: US$ 45 million

In addition there is a need to expand the regional systems of all municipalities and to increase system capacity to meet a load level of 80 MW by the year 2000 (2, p39).

Central Sub-System - There is a need to rehabilitate and expand the system to a load level of 120 MW by the year 2000. Cost US$ 50 million (2, p39).

Southern sub-system - Three 33 kV feeders and a new 15 MVA substation are required in addition to other minimum rehabilitation needs. System expansion is also needed to meet suppressed demand. Total cost - US$ 35 million (2, p39)

Gaza Sub-system - Complete system must be rebuilt and expanded to meet a load of 110 MW by 2000. Order of magnitude estimate stands at US$ 40 million (2, p40).

System interconnection - A North to south transmission line, possibly 400 kV operated initially at a lower voltage, is needed to link Palestinian distribution companies. This could be a part of regional interconnections to allow for trade with Jordan, Israel and Egypt. The cost for the necessary 300 km of transmission line would be 180 million (2. p40).

22) Long-term Investment in the Occupied Territories

Gas Turbine Peaking Capacity - To complement the base load coal steam and mid-range oil steam capacity on the Israeli system in the West Bank. This would probably require two 100 MW distillate fueled gas turbines, near Atarot and Hebron. Cost: US$ 100 million.

Gas-Fueled Combined Cycle System - Assuming Egypt could supply gas via pipeline to Western Gaza, a gas fueled 2x300 MW combined cycle plant could be constructed in Gaza to provide electricity for the occupied territories. Excess electricity could be sold to Israel and Jordan. Cost: US$ 480 million

System Operating Center - A central system operation center is needed to serve as a dispatching and system switching control center for the Palestinian transition utility and also as a power pool control point for the Egypt-Gaza/West Bank-Israel-Jordan-Syria interconnection. The project will require technical support from external utility advisors. Cost: US$ 20 million (2, p41).