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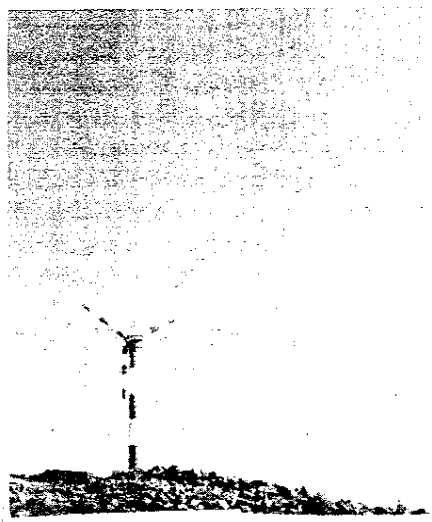
Reaping the Wind

Used in wind-mapping studies, this instrument-equipped balloon floats up to one kilometer above ground, sending back wind information via a radio transmitter.

Wind could prove a significant new energy source for Israel. Current studies aim to find the best sites for turbines and "wind farms" that would sell electricity to the Israel Electric Corporation. Two turbines are now operating, and investors are being sought to speed further development.

It is a sweltering day in July. As the temperature climbs, air conditioners begin to hum across Israel's central plain. Electric-Company engineers watch meters as the nation's electricity demand edges towards peak generating capacity.

Meanwhile, atop a mountain in the Galilee, breezes that have been strengthening all day are now, in mid-afternoon, at their strongest. Above a man-made forest of towers, turbines rotate silently in the invisible stream. In the Electric Company's control room, costly-to-operate gas turbines are turned off. The wind turbines provide enough electricity to keep the country running during the peak demand of a summer afternoon — thereby reducing the need for imported oil and gas.



Israel's winds could power 1,000 MW worth of turbines

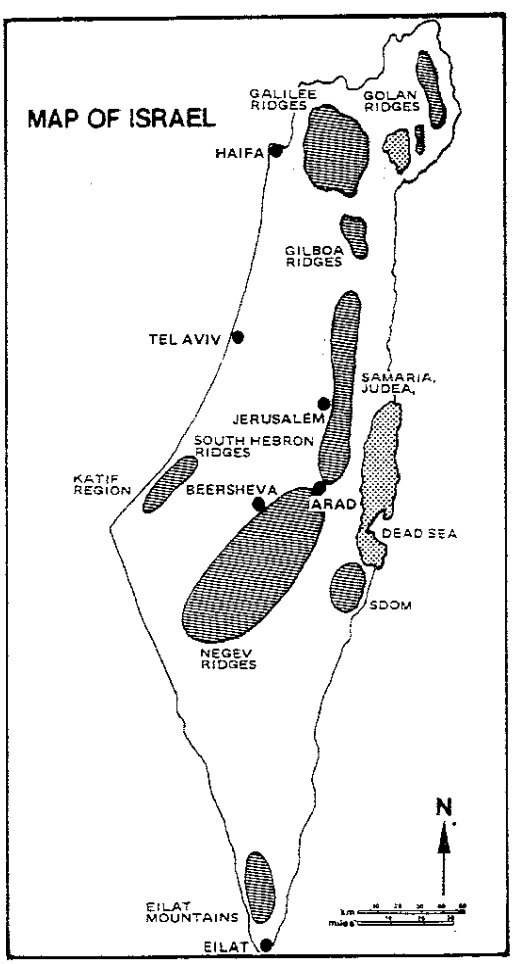
The wind towers described above are still imaginary, but their potential as an energy source is real, according to Israeli energy planners. The winds swirling across Israel's landscape could power 1,000 megawatts (MW) worth of turbines and other devices, says Dr. Moshe Hirsch, who helped prepare the Ministry of Energy's "Master Plan for Wind Energy". The plan calls for careful study of promising sites, and construction of arrays of wind turbines – called "wind farms" – in areas with the strongest, most consistent winds. Hampered by limited funds, the government hopes to attract investors to help realize Israel's wind-energy potential.

"In wind, we're where California was in 1980," says Hirsch, an engineer and wind-energy consultant

in the Energy Ministry. "Today, California already has functioning wind farms because the state government helped things along with tax-shelter legislation. In Israel, though," he concludes, "wind energy development will have to be based on purely economic criteria."

Mapping the Wind

Can wind energy be profitable in Israel? There are good reasons to think that it can. Israel certainly has the right geography. Strong breezes blow in from the ocean and sweep up over the hills and mountains that form the country's rocky spine, from the Golan Heights to the plateaus of the Negev.



Israel's windiest areas, shaded on map, are under study as potential wind farm sites.

Studies by academic researchers and the Energy Ministry have made it possible to chart the country's wind patterns, highlighting areas where winds are consistently strongest: the high ridges of the Galilee, the Golan Heights, the Judean hills, the northern Negev plateau near Arad, and the southern Negev near Eilat. Within these regions, follow-up studies are currently under way to find areas where the wind blows harder than a certain minimum velocity. "At a potential wind-farm site, the wind speed has to average at least 6 kilometers per second when measured 10 meters above ground," notes Hirsch.

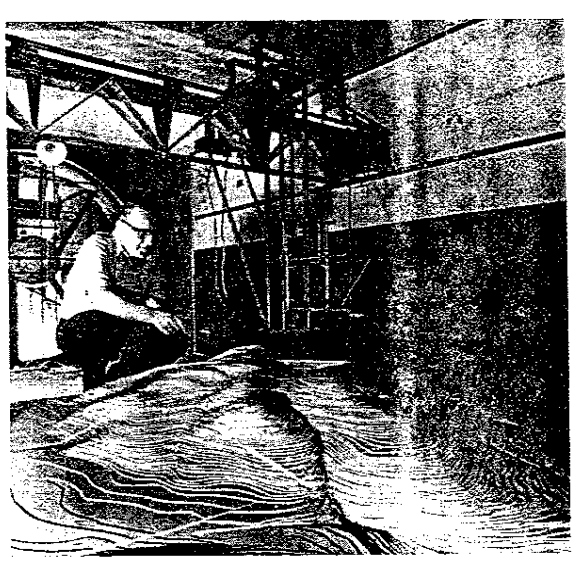
To chart the wind, scientists use instruments installed on specially built towers in remote locations, as well as balloons that can carry radio-transmitting instruments into the upper atmosphere. In many places, the wind apparently strengthens or weakens over the course of a day or a season according to a pattern. "Many winds blow in from the sea, and take a certain amount of time to reach a given point in the interior," explains Hirsch. "On a ridge in the Negev, you often find that the wind picks up at almost

Investors could profit by selling power to the IEC

exactly the same time every day." Seasonal variations in wind strength may also make wind a more useful energy source. "The wind gets stronger in the summer, when electricity demand peaks," Hirsch says. "In the transition months [i.e. October-November and March-May, when less artificial heating or cooling is required], the wind is weaker." Moreover, summer winds are strongest in the afternoon, when electricity use is heaviest.

More Wind, Less Oil

Since wind-power peaks often coincide with peak electricity-demand periods, wind could help the Israel Electric Corporation (IEC) supply power during such



In a Technion wind tunnel, Prof. Michael Poreh studies a model of the Yodfat ridge, proposed site of a 20-MW wind farm.

periods without operating the gas turbines and other reserve generators that it must otherwise use. This could both lower costs and reduce dependence on imported fuels. Connecting wind turbines to the IEC grid — rather than tying them directly to end uses — would help insulate electricity consumers from power fluctuations caused by changes in wind strength. "If there's a little more wind power than usual, the

grid soaks it up," Hirsch explains. "A little less, the grid makes up the difference."

The devices that would be used to harness Israel's winds look like airplane propellers mounted on towers. Many types of turbines are currently made; engineers are now assessing which would work best here. "The blades – there can be two or three – are either horizontal or vertical," says Hirsch. "Non-metal blades, which don't interfere with broadcasting, are best." The blades drive turbines which produce 50-100 kilowatts (kW); within 2 years, Hirsch predicts, 200-500-kW turbines will be widely used. Unless a site has especially strong winds, more than one turbine is needed to generate power economically. "In general, a wind farm needs enough turbines to generate about five MW," Hirsch estimates. The turbines are not cheap – about $1,000 per kW, for large installations – but they have the advantage of being modular: that is, additional capacity can be added one turbine at a time.

Wind power may prove cheaper than solar electricity

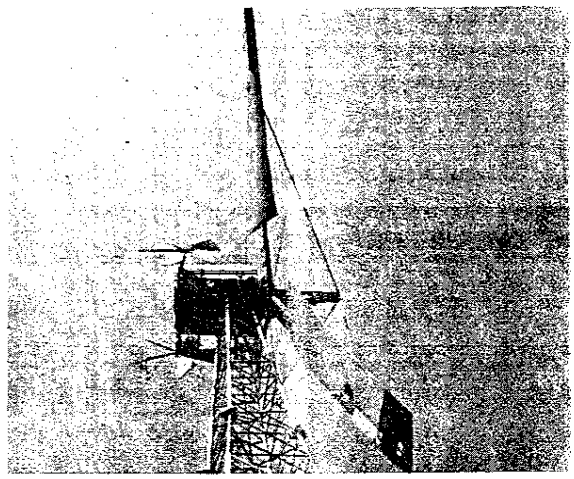
Bruce Brill (right) with prototype of horizontal panemone turbine.

Wind-energy consultant Dr. Moshe Hirsch.

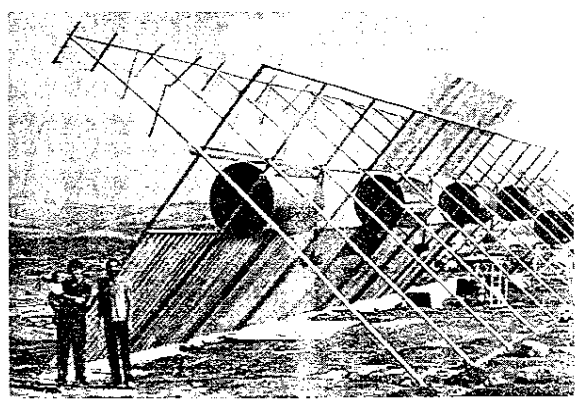
Israel could build 500-1,000 MW of installed wind-turbine capacity, Hirsch estimates. "Of course, not all of these would be working at peak capacity all of the time," he adds. "Actual average production would be about 30% of capacity – say, about 300 MW." This would still be enough to generate 2.5 billion kilowatt-hours (kWhr) of electricity annually, about one-fifth of Israel's current annual consumption. This electricity is presently generated from 650,000 tons of oil-equivalent of imported fuel – draining well over $100 million annually from the nation's foreign-currency reserves. Thus, wind power could reduce imports significantly.

Seeking Investors

But who will build all these turbines? Not the government – it doesn't have the resources. Instead, the Energy Ministry is trying to act as a catalyst – finding investors to participate not only in turbine building projects, but in the studies that precede them; and encouraging capable entrepreneurs to organize projects by helping with technical advice and promoting contacts with investors. The Energy Ministry is paying 30% of the costs of current pilot projects; it also pays for certain preliminary studies.



Supplying electricity to the Iscar Blades plant in Ma'alot, this 45-kW turbine was the first major installation of its kind in Israel.



The main incentive is the potential profits from sales of electricity to the IEC. Energy Ministry experts are working out the rules under which such wind-derived power will be sold. Prices will vary from 3.8¢ to 12¢ per kWhr, depending on voltage, with the average price about 6.5¢. In a good location, Hirsch asserts, a wind farm can pay for itself in five-six years (if the winds are less favorable, about eight years). By comparison, a coal-fired generating plant takes some 15 years to pay for itself; but since wind can't replace more than a fraction of coal-generated electricity, the

two cannot really be compared. A fairer standard is solar power, and "wind power may well prove cheaper than solar electricity," Hirsch believes.

So far, only two turbines have actually gone into operation. The first, rated at 45 kW, was built in 1981 at the Iscar Blades factory in Ma'alot; it supplies electricity directly to the plant, which manufactures precision cutting tools. This year, a second wind turbine was dedicated at Tel Katif in the Golan Heights, near Alonei HaBashan. The turbine was built at the initiative of Mei Golan, the local water-supply cooperative; rated at 55 kW, it will sell electricity to the IEC. Other projects are currently in the study and planning stage. One likely site for a wind farm is Yodfat, in the Galilean hills. The IEC plans to erect a 200-kW turbine there; with Energy Ministry support, the IEC is also carrying out preparatory studies for a proposed 20 MW wind farm at Yodfat. Four instrument towers, each 60 m tall, are now gathering wind data, using sophisticated computerized instrumentation. Other potential wind-farm sites now being assessed include the kibbutzim Ma'alei Gilboa and Toval, and the village of Koranit.

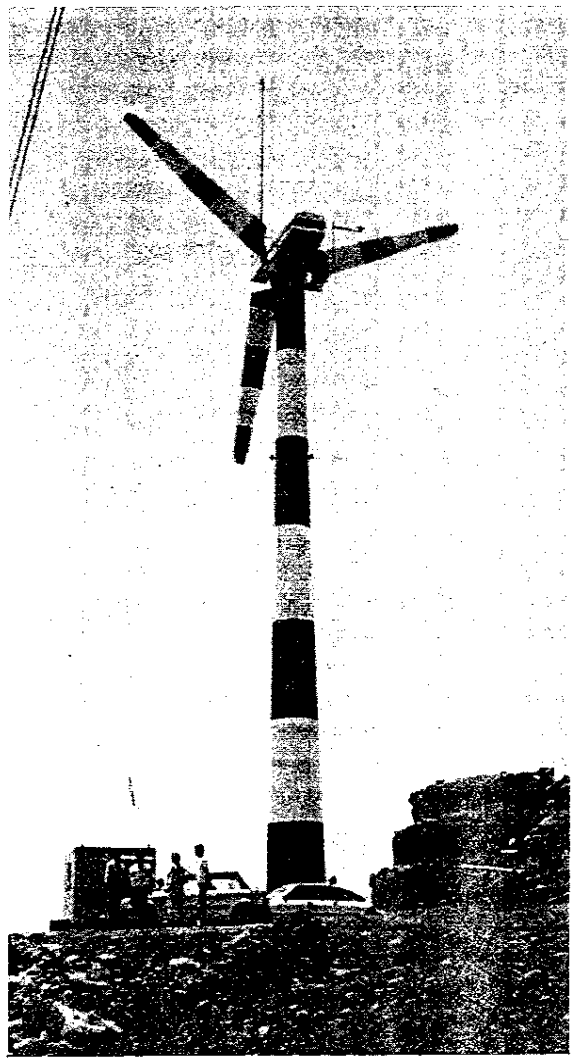
The growing technological, governmental, and commercial attention to wind energy almost guarantees that the number of turbines in Israel will increase. Most turbines now being considered are made abroad, but Israeli engineers have designed some innovative turbines and blades of their own; for example, a horizontally mounted panemone system designed by engineer Bruce Brill of the Sivivonius Corporation in Tekoa. A shroud directs air flow to the Savonius open-S rotor. The design lowers costs, Brill claims, because neither the shroud nor the panemone requires expensive three-dimensional contouring. (These and other Israeli wind-energy innovations will be profiled in an upcoming *Israel Energy News* article.)

Who's Involved

Israeli wind R&D goes back to the 1950s, when Professor Frankel of the Technion began surveying Israel's wind patterns. Since then, there have been contributions from nearly all of Israel's research institutions. Leading researchers have included: Professors Saginer, Kagan, Naot, Poreh and Dr. Rosen of the Technion; Dr. Yitzchak Marer of the Hebrew University; Dr. Dov Skiban at the Nuclear Research Center in Dimona; Professor Ozer Igra of Ben Gurion University; Alexander Manes of the Meteorological Service; and Dr. Eli Ben Dov of the IEC's R&D department. The Energy Ministry's Wind Energy Information Center, organized by Peretz Tura, began operating in 1981. Currently, researchers at the Meteorological Service, the Israel Institute for Biological Research, the IEC, Maalei Gilboa, and the Hebrew University are pursuing wind-related projects.

The Energy Ministry pays for preliminary studies and subsidizes pilot projects; the IEC, as noted above, is planning a wind farm. Representatives of these and other interested parties coordinate their efforts through a semi-official national steering committee, whose subcommittees oversee meteorological and siting studies, demonstration turbines, sales of wind-powered electricity to the IEC, and R&D.

Given enough wind, technology, and interest in high places, the major stumbling block is funding. The Energy Ministry is courting potential investors for a number of wind projects, and is also working with local companies and organizations that could build and maintain wind farms. They include Upper Galilee Waterworks; groups of settlements in Samaria; and others. Mei Golan, the water cooperative that erected the turbine in Tel Katif, plans a 20-MW, $20-million wind farm. Paz, a large oil company, and other Israeli energy firms are interested in investing. If the financial winds blow favorably, wind power could play a significant part in Israel's struggle for energy independence.



Israel's newest wind turbine: Tel Katif, near Alonei HaBashan on the Golan Heights.