The Historic Windmill

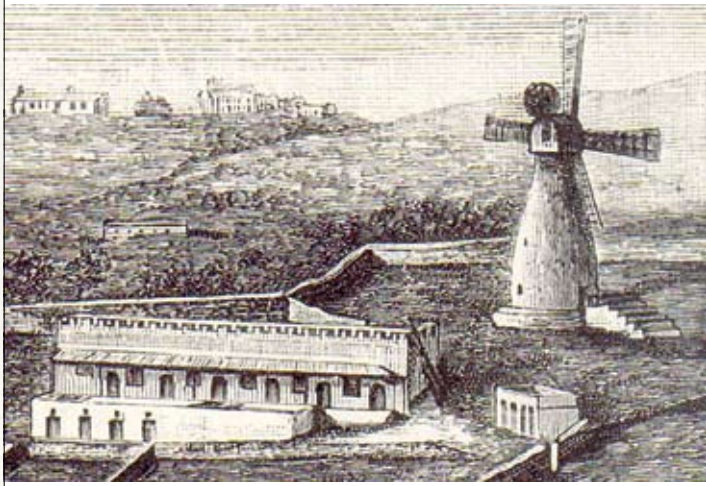
Mishkenot Sha'ananim, Jerusalem

In 1855, the Jewish British philanthropist Sir Moses Montefiore embarked on the fourth of his seven journeys to Palestine, then part of the Ottoman Empire. Employing funds from the estate of Judah Touro of New Orleans, Sir Moses purchased a plot of land outside Jerusalem's city walls, fortified it with a stone wall and named it Kerem Moshe VeYehudit / the Vineyard of Moses and Judith, after himself and his wife. That plot of land was to become the first modern, economically semi-autonomous Jewish neighbourhood in the Holy Land.

To provide employment, Sir Moses had a windmill constructed: the tower walls, of locally quarried stone, are over 15 meters high and almost a meter thick at the base; the windmill's machinery, technically advanced for the time, was manufactured by the English firm Holman Brothers of Canterbury, shipped to Jaffa, transported up to Jerusalem partly by camel, and assembled within the tower by local labourers and English millwrights.

MONTEFIORE

Mishkenot Sha'ananim with windmill, circa 1860



Etching from the book *Diaries of Sir Moses and Lady Montefiore*

"The windmill functioned whenever there was an opportunity to exploit the wind", explains Daniel Mimran, Director-General of the Jerusalem Foundation, "and with the help of the fantail, the wooden cupola rotated 360 degrees in order to position the sails in the right direction and optimally harness the wind."

For the next 18 years or so, the Montefiore windmill ground local wheat, providing flour and employment to the general Jerusalem Jewish community and particularly for the inhabitants of Mishkenot Sha'ananim, the Jewish neighbourhood financed by Montefiore and built in 1860 on his land adjacent to the windmill.

From *Illustrated London News*, 1858

Seal of Vineyard of Moses and Judith Montefiore Society in Jerusalem

Rev. W. A. Parker photograph, 1932

The maintenance and function of Montefiore's windmill had ceased by about 1876; a steam-powered mill not dependent on the vagaries of wind began operations in the nearby German Colony (at 6 Emek Refaim Street) in 1873, ending the commercial viability of wind-powered milling in Jerusalem. Two nearby windmills, built by the Greek Orthodox Church in the 1850s to supply Christian pilgrims with flour, also apparently ceased operating in the 1870s. The stone tower that housed one of those mills is now part of a commercial complex on Ramban Street in the Rehavia neighbourhood.

Cap blown off by British, 1948

Without a cap 1955

For most of the first two thirds of the 20th century, Montefiore's windmill tower was a derelict yet picturesque Jerusalem landmark. In 1948, however, just before the British withdrawal from what was then British administered Palestine, the Hagana, the main Jewish defence force of the period, built a military post on the tower's roof.

The story goes that the British High Commissioner, emerging from a nearby church on a Sunday, noticed the addition and ordered the whole tower blown up. However, the sappers assigned the task happened to be from Ramsgate, the English town where Montefiore had lived for almost 50 years, and, seeing a plaque on the tower with the name Montefiore and the name of their town, reinterpreted their instructions to destroy the tower and simply blew off the tower's rooftop extension.

In 1967, after the Six Day War and Jerusalem's reunification, the Jerusalem Foundation gave the neglected windmill tower an initial makeover, repairing stonework and installing a new roof, copper cap and what looked like sails (although they did not move). In 1982, a small museum was opened within the structure. In the late 1990's cracks began to appear in the tower structure and the cupola and blades were crumbling, endangering visitors. In 2000 the structure was reinforced and the emblematic sails and dome were replaced. At that time, the Jerusalem Foundation envisaged a planning and fundraising campaign that would eventually see the windmill restored to its condition of 1857.

Before the 2012 renovation

In 2006, the Jerusalem Foundation and the Amsterdam-based Christians for Israel devised a plan to recreate Montefiore's working windmill within the old tower. The Jerusalem Foundation took upon itself the responsibility for implementing the restoration project and raised the needed funds from Christians for Israel, the Prime Minister's Office, the Ministry of Tourism and the Jerusalem Municipality.

A member of the Holman family, who had built the machinery for the 1857 mill, was contacted and the original designs were located in the National Library in London. New windmill machinery was manufactured in Holland, shipped to Israel and a new working mill was constructed under the supervision of Dutch engineers and mill constructors Arjen Lont and Willem Dijkstra. New cupola and blades for Montefiore's restored windmill were finally installed in the renewed stone tower on July 25, 2012.

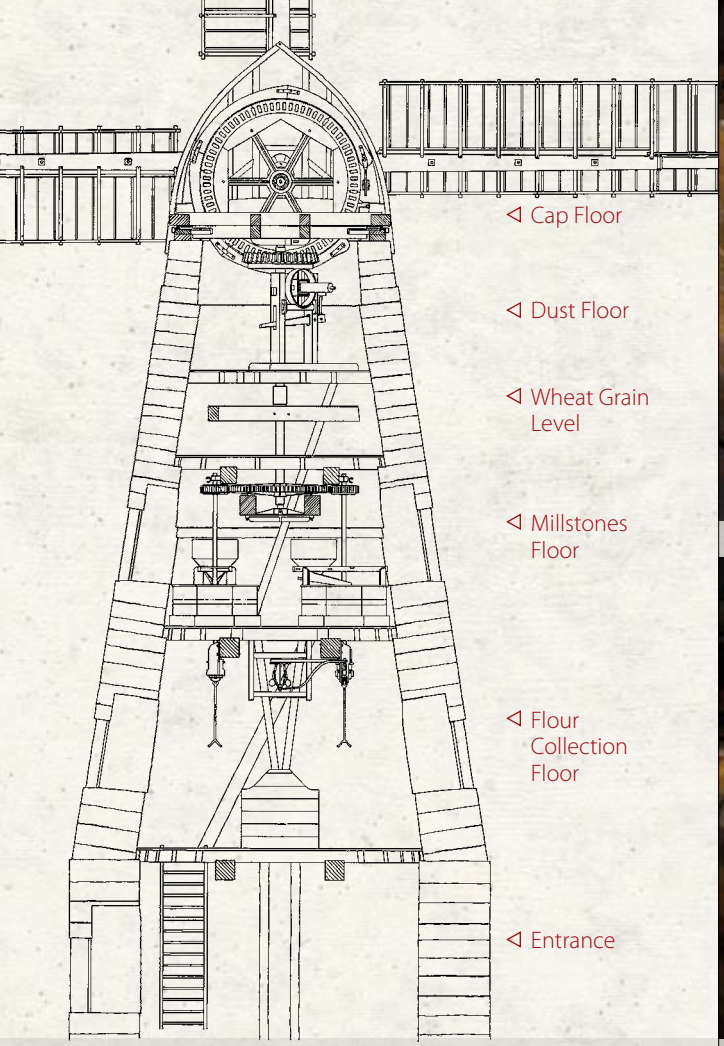
The five main stages to the milling process, from bottom to top and back again: raising, cleaning and grinding the wheat grain; and collecting and lowering the flour to be packed for sale or consumption.

The wheat grain is raised from the ground floor by a sack hoist system of wooden mechanical wheels and chains to the cap floor. There, the sacks are emptied into a large, funnel-shaped grain bin, from which the grain passes through a dust screen and grain shoot into a feeding bin called a hopper. The grain is then transferred onto a feeding platter (hopper horse) and ground into flour between millstones on the millstones floor.

Before being packed into sacks, the flour undergoes a mechanical bolting (sifting) process using a sieving cloth. This process separates the flour from the bran and any coarse, unground bits of grain.

Upon completion of the sifting process, the flour is transferred through a meal spout on the flour collection floor to a meal bin and into flour sacks on the ground floor.

Windmill entrance with the Montefiore Coat of Arms



The Montefiore Windmill

The new Montefiore mill, largely a reproduction of the 1857 mill, was dedicated in August 2012 and the first sack of flour was produced in May 2013. Montefiore's windmill, now restored to its former glory, operates on a regular basis, in the same manner in which it once worked, with the additional option of electrical backup for grinding, which at the time of this pamphlet's publication had not been deployed.

Visitors can enter the windmill and a short video explains the building of the windmill, which began the historic process of Jews leaving the walled city to establish modern day Jerusalem. On days when the windmill is grinding wheat, it will be possible to purchase flour on the premises.

Sir Moses' windmill at Mishkenot Sha'ananim is a famous, historic landmark and prominent feature of Jerusalem's skyline. Its restoration is a symbol of sustainability and of Jerusalem: old and new; a rich and glorious history and a stronger, even more glorious future.

For the windmill's opening hours, please call 02- 6230323.

Mishkenot Sha'ananim has a thriving international conference centre and guesthouse established by the Jerusalem Foundation.

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Mishkenot Sha'ananim Founded by The Jerusalem Foundation
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Windmills & Wind Turbine History

The First Wind Powered Machines: The first windmills for which we have clear evidence ground grain in 10th century Sistan, now eastern Iran. These Sistan windmills had sails attached to a vertical rotor, a relatively inefficient method of capturing wind energy. Windmills whose four sails are attached to the hub of a horizontal shaft first appeared in northwestern Europe around 1150, notably in areas without swift running streams and thus without access to water power. These first European windmills were post mills, that is the whole body of the mill together with its sails was supported on one post and the whole mill was rotated by muscle power to face the shifting wind. Fixed tower mills with rotating caps carrying four sails seemingly first appeared in the 14th century. (The Montefiore mill has a rotating cap.) The automatic fantail, a circle of small sails mounted behind and at right angles to the main sails aligning the main sails to the shifting wind, was patented in England in 1745. (The Montefiore mill has such a fantail.)

Wind Power Terminology: A windmill in its narrowest usage references a wind driven machine for grinding grain, but often references any machine that converts wind energy into rotational energy. A wind turbine normally refers to a machine that converts wind energy into electricity. And a wind farm is an array of wind turbines.

Dutch Wind Powered Machines: Living close to or below sea level on flat frequently windy land, the Dutch first employed wind power to drain land in 1408. By 1508, a few hundred drainage mills (poldermolens) employing scoop wheels operated in what is now Holland. In 1594, Cornelias Corneliszoon built Holland's first wind powered sawmill. The proliferation of such mills made possible the Dutch Golden Age -- the 17th century Dutch dominance of European shipbuilding, of the spice trade, and of herring fishing. (Socioeconomic details from that time: Amsterdam prohibited the import of wind sawn lumber until 1630; a Dutch sponsored wind powered sawmill was erected near London in 1663, but was wrecked by English hand sawyers of wood who feared low cost competition.) In 1730, in the Zaan region north of Amsterdam, arguably the first industrial region of Europe, some 250 windmills cut lumber for shipbuilding and construction. (Uncut logs were floated down the Rhine in rafts or shipped by sea from the Baltic.) In the mid 19th century, just before the ascendancy of coal fuelled steam power, the Dutch employed perhaps 9,000 windmills to grind grain, drain land, saw wood, press oilseeds, make pulp for paper, process tobacco, produce paint pigments and more.

The American Wind Pump: In 1854 in the United States, Daniel Halladay developed an inexpensive, comparatively light weight, self regulating wood bladed wind powered machine suitable for pumping water from wells on family farms, cattle ranches and alongside railways (for steam locomotives). The mass production of the successors of Halladay's wind pump made possible much of the late 19th century agricultural settlement of the drier areas of North America, South America, Australia, and South Africa. In 1900, literally millions of farmers depended on such pumps. In the 1930s electric pumps, powered cheaply and reliably after rural extensions of national electrical grids and increasingly reliable petroleum fuelled pumps began to displace American wind pumps. By the 1960s the few functioning technological descendants of the European 12th century post mills had marginal economic importance and human harvesting of wind power appeared to have no future. But today, thanks largely to Danish technology and enterprise, more wind energy is harvested weekly to generate electricity than was harvested annually for all purposes in any year prior to 1995. And more new wind powered capacity was installed in each of the years from 2008 through 2014 than existed in 2000.

Wind Turbines: The first attempts to efficiently generate electricity from the wind began within ten years of Edison's development of a practical light bulb. Charles Brush built a .012 megawatt capacity wind turbine in Ohio in 1888. Electricity was fed into batteries and the batteries powered the lighting and electric motors of Brush's mansion. In the 1890s and early 1900s the Dane Poul La Cour conducted wind tunnel tests, built four and five bladed wind turbines and trained "wind electricians." Until the end of World War I, when fuel prices fell, Poul la Cour inspired wind turbines supplied significant amounts of electricity to Danish farms. In the Soviet Union of the 1930s two small (.1 megawatt) wind turbines supplied electricity to electrical grids. In the USA of the 1930s, the Jacobs brothers manufactured and sold, notably to Midwest farmers, thousands of reliable three blade wind turbines. In 1941 in Vermont (USA) a very large, for the time, 1.250 megawatt turbine was connected to the grid. In 1945 a blade broke and repair was deemed uneconomic. In Denmark in 1957, an innovative experimental wind turbine of .2 megawatt capacity, designed by Johannes Juul, in 1904 a student of Poul la Cour, commenced electrical production. After ten years of trouble free operation a bearing failed. The bearing was replaced in 1975.

Interest in non-carbon generation of electricity, for many in nuclear generation, increased dramatically after the 1973 OPEC oil embargo and the tripling of world petroleum prices. Concerned that Denmark would build nuclear reactors, teachers at the Danish Tvind alternative school decided in late 1974 to attempt to build a large wind turbine to demonstrate that a non-nuclear future was practical. The Tvind wind turbine, constructed with largely volunteer

labour, started generating electricity in 1978 and continues to generate electricity today. The Tvind turbine was the largest in the world when built, received little government encouragement or institutional support and cost about half a million dollars. The Tvind initiative fostered a climate of Danish cooperative grass roots experimentation with wind turbines. In 1976, the Dane Christian Riisanger hooked up his homemade wind turbine to his home's electrical wiring and discovered that he could make his electrical meter run backwards.

In the United States of the late 1970s, significant government moneys were directed to wind turbine research. In 1979 the first large American wind turbine since the Vermont turbine of the 1940s went into operation. It cost millions of dollars and was dismantled after two years. In California in the early 1980s tax legislation and regulation incentivized the funding and construction of wind farms. Literally thousands of wind turbines were erected, perhaps half of Danish design. Tax incentives changed in 1986 and the short wind energy boom ended, but an international wind turbine manufacturing industry had been jumpstarted and Danish turbine design had been showcased and proved reliable.

Jumping to 2014, policies encouraging wind turbine construction are now primarily motivated by fear of catastrophic climate change. Prices for wind generated electricity have dropped significantly since the 1980s, but prices for solar generated electricity have dropped faster. The world's leading manufacture of wind turbines is a Danish company, Vestas. China has the world's largest installed wind turbine capacity and also the world's heaviest carbon footprint, a footprint that has quadrupled since the mid 1980s. The United States, the country with the world's second largest wind turbine capacity and the world's second largest carbon footprint, generates about 4% of its electricity with wind turbines. In Denmark, annual wind generated electricity is equivalent to about 33% of annual electrical consumption, the highest percentage of any country. Denmark also has the highest electrical rates in Europe -- when wind power is unavailable electricity has to be imported, often at high cost, and, conversely, during periods of high winds, Denmark is sometimes forced to literally give away electricity.

Renewables in Israel: Israel's first wind farm began operations in 1992 in the Golan. Plans announced in 2010 for additional Golan wind turbines and for a wind farm near Eilat have as yet not materialized. Israel has a goal of producing 10% of its electricity from renewables by 2020; in 2014 renewables, primarily solar, generated about 2% of Israel's electricity.

This pamphlet was produced in memory of Ernest Petrie (1917-2012), physician and mensch.