

Israel Wind Energy — History and Future

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As a small country, Israel had to cope with obstacles, arising from the shortage of resources, such as water and fossil fuels for its independence and resilience.

From these shortages and the resulting challenges, a highly innovative and knowledgeable community of scientists, engineers and companies, specializing in different CleanTech industries such as Renewable energy, water supply & safety, energy production and optimal usage of limited resources arose to support its need of growth and sustainability over the years.

The Cleantech Group and the World Wildlife Fund (WWF) publish an annual Global Cleantech Index, based on innovation and the ability to commercialize, published their last report of 2014, where Israel topped, followed by Finland and USA.

According to the report: Israel is the cleantech innovation archetype for both embedding entrepreneurial spirit into its educational system and into its society's everyday norms as well as for predisposing its start-ups to resource innovation – as a survival mechanism to overcome resource constraints

and energy dependency. Relative to the size of its economy, Israel has had a disproportionate number of cleantech companies (19 in total) voted by the cleantech community into the

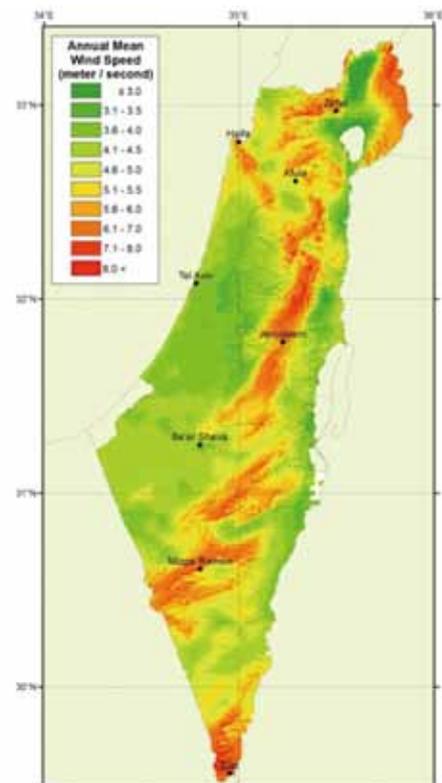


Fig.1 IMS wind speed map of Israel at 100m

shortlist of the Global Cleantech 100 index over the past 3 years

Wind energy is no exception in the amount of different related initiatives, start-ups and established companies, despite practical and regulatory constraints, which have so far limited the local implementation of wind energy production. This however, is changing nowadays as obstacles are removed and regulations are set in place.

During January 2014, 4 wind farms got their conditional 461MW permits, following the 21MW projects expected to start construction shortly. These however are not the only signs of the conceptual change after over 22 years with only a single wind farm of 10X600KW Wind Turbines(WTs)- which will also be repowered using new, up-to-date turbines.

As the ministry of energy has set the goals of reaching 10% of renewable energy by 2020,

third of which is allocated for wind, the public utility authority has set the feed-in-tariff, with separate FIT for small (up to 50KW) and large WTs.

The ministry of energy also initiated a project of mapping wind energy potential in Israel – an ongoing project carried out by the Israeli Meteorological Service - IMS, and consultancy of the Finnish Meteorological Institute – FMI, for which the first phase has been released to the public, including data for heights of 30, 60, 100 and 150m at a 100m resolution.

Next steps are to incorporate the data onto the GIS online mapping services open to the public, where other layers of relevant information are integrated with the wind power data, and some dedicated features for wind energy development.

A significant outcome of the study performed by the IMS the evaluation of the on-shore wind energy potential, which is claimed to be in the range of 3,000MW.

In parallel, for the last three years, the ministry of interior in cooperation with the other ministries and in cooperation with public organizations conducted two parallel activities – Preparation of a National Master Plan – which has been released August 2014 – a plan which provides all provisions and guidance to the construction of wind farms and a separate activity of a request for proposals from wind farm developers to submit their requests for a preliminary provisional inspection and approval.

The RFI process resulted in responses for over 2,000MW, and those did not include some of the projects mentioned earlier.

The RFI responses were evaluated by nature conservation organizations, the public utility authority, the Israeli Electric company, Ministry of energy, ministry of environment

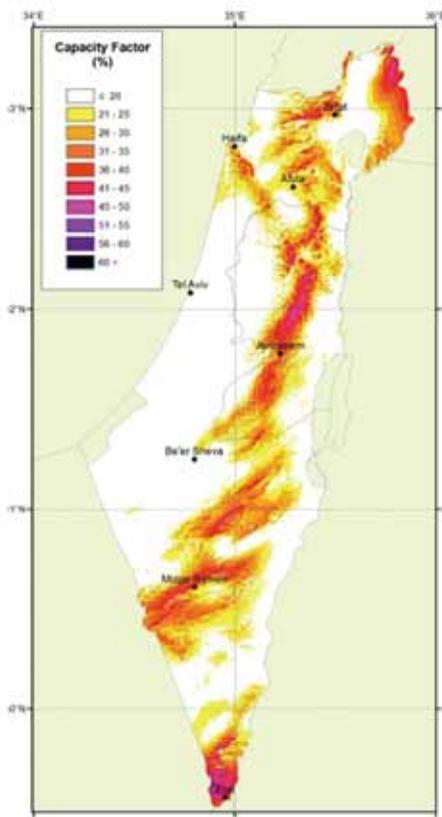


Fig.2 Capacity Factor (%) at 100m

protection, IDF, aviation authority – practically all relevant authorities.

As result of the process, another amount of roughly 500MW wind farms also got their preliminary approval to move forward with the development process.

Work of the Israel Energy Forum released its "Zero Carbon Israel" research, which was also published on WWEA bulletin, showing that Israel could reach by 2040 80% power from Renewable energy at the same cost of a fossil based electricity sector.

Technology innovation

Multiple companies at different stages of development and maturity, some in stealth mode, other mature exist in the Israeli landscape. A small sample of some of these companies includes:

Pentalum, the leading LIDAR equipment provider, has already delivered hundreds of units world-wide, with investments from ABB and GE. Following their successful wind assessment product, a second generation of nacelle installed LIDAR is planned to increase productivity by integrating into the turbine for early YAW control that would direct the blades in the direction of the wind and reduce blade gust damages.

Meteo-Logic, which provides sophisticated forecasting of wind farm power production, energy price forecasting as well as regional forecasting, ramp forecasting in case of extreme variations in short time-frames, interday real-time forecasting and up to 14 days ahead forecasting

BIRDVISION–provides potential collision detection of birds with turbine blades. The product is also available for collision prevention

with power lines. The product is relying on bird zoology and behavior

WINFLEX–Manufactures Inflatable rotor turbine, Using light weight, flexible and inexpensive composite materials, in turn allows using Simple, durable and low cost structure, this turbine presents an innovative Safe solution that is easy to transport, install and provide maintenance at much reduced costs.

Winflex is one of five top award winners in the 2010 General Electric Ecomagination Challenge competition.

EVR-MOTORS – Developing lightweight, high efficiency direct-drive, permanent-magnet generators for wind turbines. The lower weight per KW drastically reduces the engineering requirements from other turbine components, such as tower, thus reducing the total cost of the wind turbine that uses the EVR generator. ALSTOM S.A. is a partner to EVR-Motors.

RSL Electronics- –provider of wind turbines Vibration Condition Monitoring System (CMS) – the WT-HUMS™ (Wind Turbine Health & Usage Monitoring System)

Synergy Cables- a leading provider of high quality cables, used in on-shore and off-shore wind farms internationally.

WindWells – A unique methodology of finding those areas with wind wells – a high wind energy concentration, stable in space and time.

ENSTORAGE - develops large scale energy storage solutions based on a cost effective flow battery technology. which provides long duration discharge at high power levels, Low

capital and operating costs and easy integration with a modular, scalable architecture. SIEMENS is one of the investors in the company.

Chakratec- develops a flywheel that provides a stationary green energy storage solution with low capital cost and a disruptive low cost per cycle, with unlimited charge / discharge cycles

All the above was but a short sample of the multiple approaches and solutions available within the Israeli scene for the global wind industry.

The upcoming world wind energy conference, which would take place in Israel next October, is part of the positive trend of the build-up of the viable, vibrant and active field to be deployed for the local, as well as international markets and industries.

History and academic research

The history and academic research of wind energy in Israel is nearly as old as the country itself. Wind energy gained attention as a source of energy already during the late 1950's, when Israel lacked fossil fuel sources.

This shortage of energy was the drive for research activities. One of the universities involved in the research was the Technion – Israel Institute of Technology in Haifa, and the then new Department of Aeronautical Engineering.

One of this new Faculty members - Prof. Avraham Kogan was looking for ways of applying aeronautical know how to help the young state of Israel. Prof. Kogan identified wind energy as a potential alternative source.

In a valley between the Dead Sea to the Red Sea, where wind was uni-directional, he developed efficient shrouded (ducted) wind turbine, a research that continued during the 1960's.

Examples of other works during the 60's also included:

- Professor Eliahu Nissim (M.Sc. 1961) "Investigation of Aerodynamic Envelopes for an Aerogenerator for Wind Energy Utilization".
- Professor Arnan Seginer (M.Sc. 1963) "Investigation of Aerodynamic Envelopes for an Aerogenerator for Wind Energy Utilization (the axisymmetric case)".
- Professor Ozer Igra (M.Sc. 1967) "Design of a Turbine and Investigation of its Performance for an Aerogenerator for Wind Energy Utilization".

During the mid-1970's, Dr. Aviv Rosen - a Post-Doctorate student at UCLA, who returned to the Technion, formed a research group that since then was involved in teaching and research of wind energy, covering aerodynamics, structural mechanics, dynamics, performance, control and other topics.

The group published international papers, participated the EU framework research project MEXICO (Measurements and Experiments In Controlled conditions). A model of a three bladed HAWT designed and built by a Technion team, tested in the DNW wind tunnel in the Netherlands- The results of which have been used by various research groups all over the world.

Research during the 80's included amongst others, topics such as "A Model of the Aeroelastic Behavior of Darrieus Wind Turbine Blades" (Abramovich, H. and Rosen, A. 1988), "The Behaviour of the Blade of a Darrieus Wind Turbine" (Abramovich Haim, D.Sc. 1983), "Wind Turbine for Communication

Towers" (Sheinman Yhoshua, M.Sc. 1986) and "Numerical Analysis of Tip Vane Influence on Wind Turbines" (Lavi Isaac, M.Sc. 1989)

At the School of mechanical Engineering, faculty of engineering, in Tel Aviv University, there is also vast activity related to renewable and specifically wind energy, including an Energy lab and the Energy track of studies, headed by Prof. Avi Kribus. A few new experiments were established, among which one can find a wind tunnel experiment on small wind turbines.

In the meadow aerodynamics lab of Tel-Aviv University, under the leadership of Prof. Avi Seifert, a few research projects are being conducted. These experiments, deal with the application of active flow control for improved efficiency of small, medium and large wind turbines.

In the school of EE of TAU, Prof. George Weiss has been working on stabilizing wind-induced vibrations of wind-turbine towers, in order to increase their reliability and life-span using torques obtained by modulating the generator torque and the pitch angle, while the recent investigation is on installing a tuned mass damper in the nacelle. Prof. Weiss has also investigated the optimal control of power converters used to transfer the non-synchronized AC voltage collected from the generator, to the power grid.

Professor Asher Yahalom and Prof. Alon

Kuperman from Ariel university have also performed research, such as a Generalized Approach to Estimating Capacity Factor of Fixed Speed Wind Turbines of any type, approach based on wind probability distribution and manufacturer power curve, where Instead of choosing a particular model for approximating the power curve, commonly used polynomial fitting is employed.

At the university of Haifa, Economical-Environmental Assessment of Wind Turbines work by Orna Raviv with Prof. Ofira Ayalon and Dr. R. Palatnik evaluates the social cost of wind power generation, focusing on the externalities of wind turbines caused by the effect on birds and agricultural-landscape.

The many activities, within the Academy and industry, as well as the significant governmental assistance in the development of new technologies and the global challenges the world is facing on its way to 100% renewable energies are yet to be explored, and the upcoming WWEC2015 hosted by WWEA and the Israeli Wind energy Association could serve as an excellent platform for the exchange of knowhow and ideas, a platform for technology cooperation.

The Israeli Wind Energy Association would like to welcome you to the coming World Wind Energy Conference - Let us all meet at the WWEC2015. 