Electric Vehicles
Implications for the Israeli Electricity Market

Executive Summary

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Background

The transition to electric vehicles (EV) is one of the most significant changes expected over the next decade. This paper examines the effect of electric vehicles on the annual energy consumption, on the generation capacity required in the electricity sector, on the development of the transmission system, on the development of the distribution network, and the desired structure of the electricity tariff.

The challenge of designing the electricity sector to integrate EV is particularly complex because it is characterized by uncertainty as to the technical characteristics and the behavioral patterns of the population. First, the growth rate of the number of electric vehicles is unknown. Second, the characteristics of the charging demand profile are also unknown yet. Moreover, the transportation sector may change substantially, due to the transition to autonomous vehicles ("robotics"), which will lead to a change in the structure of vehicle ownership and the traveling distance. As a result, charging patterns might change too. In addition, in the coming years, changes in the patterns of travel by private vehicles are expected, because of the expansion of the scope of work from home, economic incentives to avoid traveling by private vehicles, and a possible improvement in public transportation in Israel.

This paper is intended to shed light on the implications of EV transitions on the electricity sector, and to offer a basic model that will allow policymakers to assess the possible impact on the annual electricity demand, the generation capacity, the planning of transmission network, and the planning of the distribution networks in residential areas.

The paper focuses on private cars, buses, and minibusses. We did not include in this analysis heavy vehicles, such as trucks, because it appears that for heavy vehicles fuel cells would be more cost-effective (IEA, 2021). Also, we did not include taxis in the work, because the unique travel characteristics of the taxis around the clock may delay their electrification.

Given the uncertainty, we constructed a possible range of reasonable scenarios related to penetration rates (diagram 1) and possible charging patterns (diagram 2). Our model enables a sensitivity analysis of the effect of each assumption on the required development of the electricity sector, thus considering the feasibility of incentives that will encourage the implementation of controlled charging.

Diagram 1 – EV penetration scenarios
Conclusions

The penetration of the electric vehicle will lead to a further increase\(^1\) of 0.2% -0.7% in the annual power consumption. This demand will be added to the base annual demand growth of 2.2%. Diagram 3 depicts the annual demand for charging at the medium penetration rate scenario.

Diagram 3 – Annual consumption for EV charging

The peak demand in Israel is shifting to the evening, due to increasing solar generation at noon. As a result, uncontrolled charging in the evening will require additional capacity. While, controlled charging which will shift some of the charging load to nighttime or daytime, will significantly reduce the additional required capacity.

Diagram 4 depicts the additional capacity required to meet the charging demand of the electric vehicle according to the penetration scenario of the electric vehicle and the charging management policy. As seen, without controlled charging, an additional capacity of ~ 2000 megawatts may be required to meet the charging demand. Partially controlled charging will reduce the required capacity to ~ 1000 megawatts. Fully controlled charging will reduce the required additional capacity to only 200 megawatts.

\[^1\] In addition to a base growth rate of 2.2%
In the distribution network, high variance is expected between different areas in the country: In areas characterized by a high socio-economic profile, faster penetration of electric vehicles is expected, because households in this area are characterized, according to CBS data, by a higher number of vehicles per household (1.5 cars on average) and at a higher turnover rate of vehicles (40% of the cars less than 3 years old).

The additional load on a typical 630 KW distribution transformer, in an unmanaged charging scenario, may be as high as 95 kilowatts at peak demand, in a scenario where 50% of the vehicles of the families are powered by the distribution transformer are electric. I.e., unmanaged charging may ass ~20% extra demand to the peak of the transformer's typical charging load.

**Policy recommendations**

Considering the findings, it is advisable to consider the policy recommendations listed below:

It is recommended to encourage daytime charging at public charging stations - to reduce the need for additional generation capacity:

A. Charging during the daytime will help address the surplus of solar generation in the winter and at the spring and fall seasons and will reduce the need for additional capacity that will be required for evening capacity.

B. Encouragement of charging in public stations can be done by stipulating an obligation to install charging stations in commercial areas, public buildings, and workplaces, as well as by subsidizing public stations. The cost of subsidizing public positions is expected to be significantly lower compared to the cost of additional capacity needed to meet the demand for charging during the evening.

C. It is proposed to encourage competition between different suppliers at public charging locations, to avoid local charging monopoly actions, which will lead to a high
charging rate and will be a negative incentive for charging at public locations: this competition can be achieved through tenders, or by having multiple charging providers in each area, so that there is continued competition for the charging price between the providers. In this context, it should be noted that the regulator has determined an exemption from the need for a license to establish charging stations for 8 years, so the activity is not supervised, and the charging rate is not supervised.

D. Obligation to set up charging stations in workplace parking lots - corporations have a significant weight in the penetration of the electric vehicle because they currently purchase ~ 20% of the private vehicles and finance the cost of fuel and maintenance of the vehicles. However, from the corporations’ point of view, it is preferable that the charging take place in the evening at home rather than at work. In doing so, the corporations may contribute to the diversion of charging into the evening hours, contrary to the public interest. Hence the importance of encouraging and/or imposing a duty to allow charging in the corporate parking lots to enable daytime charging.

The distribution network should be planned by the regional forecast for electric vehicle growth, focusing on areas with a high socio-economic profile, where faster penetration is expected.

We recommend 1-2 connection points at the residential building for charging electric vehicles and to avoid installing a private meter for each charging station by the distribution license holder:

A. Installing 2 connection points will allow the building to contract with more than one charging provider and thus allow competition on the price of charging.
B. Controlled Charging implies offsetting some of the charging load to later hours. To do so, the charging load should be distinguished from another residential load, and the supplier should be allowed to offer tariff incentives for load shifting. If the EV charging is integrated with the residential load at the residential meter, the charging load would not be distinguished, the tariff will be regulated and therefore it would not be possible to offer incentives for load shifting.
C. Given the importance of controlled charging, it is advisable to separate the connection intended for EV charging from the connection intended for other residential uses.

It is recommended to consider a designated tariff for connections established for electric vehicle charging:

In general, the electricity demand is considered inflexible, i.e. - consumers’ response to price signals is limited. However, the demand for EV charging is expected to be flexible. That is, consumers may respond to a price signal and agree to defer charging time if charging is completed by the next morning. This is especially true when the average driving range is limited compared to the battery potential and therefore the tolerance for delayed charging is higher.

A preliminary survey shows that California and some regions in Europe have already adopted this policy and set a designated tariff for charging.
In deciding whether to combine charging with the apartment meter it must be considered that combining the charging load with the residential load will prevent the application of a designated tariff for EV charging.

In conclusion, the transition to an electric vehicle is a welcome trend with far-reaching effects on the electricity sector. It is proposed that government ministries, with an emphasis on the Ministry of Energy, the Ministry of Transport, the PUA, the System Operation Company (Noga), and the Israel Electric Company formulate practical policies that will enable the transition to electric vehicles. We hope that this paper and our simulation tool will assist policymakers in formulating the policy.