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Energy Generation Management for Energy Demand of Electrical Car in Turkey

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Abstract: In next two decade duration the electric car will participate a significant role in auto marketing. The electrical car use electric that is supported by current electrical network. Indeed the current electrical network cannot support the hole system in specific time in the case of loading electric car to it that will increase the demand in that specific time duration. To support the electric car energy requirement you have to manage both energy generation and energy consumption. The solution to that problem is intelligent grid system and management of the energy. In addition it is important to spread energy generation and consumption. Consequently that study is shown a significant energy management method for energy demand in Turkey's tomorrow for electric car.

Keywords: Energy Production Management, Smart Grid Management, Electric Vehicles

1. Introduction

Human inventions have brought to facilitate for life in globalized world. Perhaps one of the most important invention of the products are motor vehicles.

Motor vehicles have provided the transportation of people for decades and it has become an indispensable part of human life. The motor vehicle fuel sources are gasoline, diesel and gas such as use of fossil resources that are depleted in developed and developing countries due to the increase of transport intensity has brought about environmental pollution [1].

Global warming causes which led to oil, natural gas and coal fossil fuels formation of greenhouse gases such as the majority of fossil fuels have been used by motor vehicles. Turkey's State Institute of Statistics (DİE) in 2013, according to a survey by the total number of motor vehicles were found to be over 18 million in Turkey [2]. This number rises to higher levels in other developed countries. In addition, it shows statistics, 17% of annual greenhouse gas emissions occurs as a result of transport [3,4].

All the world as electricity consumption has been increasing each passing day in Turkey. Electricity was used for the first time in our country in 1902, so far last time during the history of the Ottoman Empire and the Turkish Republic are primarily to population growth, electrical equipment and technology products more commonly used today, the growth of the industry, fast train, subway such as the spread of electric motors with transport, on days with high temperatures of air conditioning use year after year more home and in the workplace as a cooling method using with as much electricity consumption for irrigation due to many factors electricity consumption is increasing almost every year [5].

The Gross Domestic Product (GDP) increased by 3.3% per year on average in the 2008-2013 period of Turkey, whereas primary energy supply has increased by 4.26% per year over the same period. Between GDP and primary energy supply is known to be strongly correlated. Referring to Figure 1 and Figure 2, as shown by the projected GDP growth is estimated Turkey's primary energy consumption; for respectively 110 million tons of oil equivalent (Mtoe) the year 2014, and there are 112 Mtoe in 2015 and 2016 to 113.5 Mtoe [6-8].

Based on the correlation between GDP estimates based on the above-mentioned trend analysis shows that both are very close to the estimated value.

The spread of electric cars the energy needs of these vehicles ensuring the sockets will be encountered with the case parking lots, homes, in offices, shopping centers and on the road.

Electricity demand will create this situation would cause a

large increase in the load power plants, over all electrical power system components (power plants, lines, transformers, etc.) Capacity may lead to strain [4].
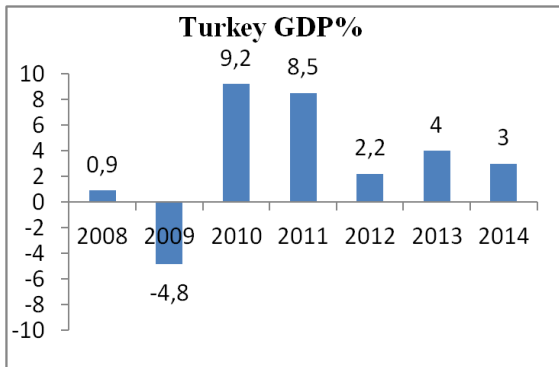

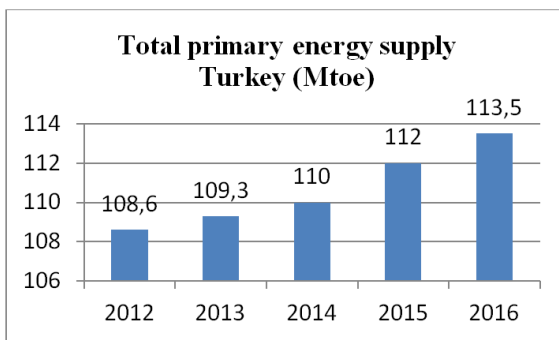**Figure 1.** *Turkey GDP Ratio.*

Figure 2. *Total primary energy supply Turkey.*

Quality and the continuous provision of an energy supply services, charging stations for electric vehicles, the integration of renewable energy sources to the grid and consumer issues such as the ability to produce its own electricity are trying to resolve issues through research today. To overcome the problems that may arise in this context there is a need of a fast and reliable network infrastructure.

Although electrical systems is influenced by the growing demand for all levels subject of research in Table 1 in the demand for energy, as seen at certain times (Peak and Energy Demand) increase and to investigate the impact that creates the electricity production of this growing demand.

Table 1. *Energy Demand Forecast (Low Demand).*

YEAR	Peak Demand		Energy Demand	
	MW	Increase (%)	GWs	Increase (%)
2013	40130	5.6	257060	6.6
2014	42360	5.6	273900	6.6
2015	44955	6.1	391790	6.5
2016	47870	6.5	310730	6.5
2017	50965	6.5	330800	6.5
2018	54230	6.4	352010	6.4
2019	57685	6.4	374730	6.4
2020	61340	6.3	398160	6.3

2. Electric Cars

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Electric cars are automobiles that are propelled by one or more direct current (because DC is rechargeable) electric motors, using electrical energy stored in batteries or other energy storage devices. Electric motors have instant torque potential. Quietness and strong and smooth acceleration provide a comfortable drive [9].

Electric cars can get between 32km and 210km without recharging, depending on the size of their batteries [10]. The most important problem of the electric vehicle technology is the batteries and charge. Solution to these problems is linked to the development of battery technology. A model released in 2013 by Renault which is one of the pioneers in electric vehicle technology, Renault Zoe has a 22 kWh lithium-ion battery pack and 65 kW (88bg) motor. Its charging time is between 6-10 hours using 220V AC voltage. It is a known fact that car users, car manufacturers and governments are quite optimistic about the electric cars. It can be inferred here that market share of the electric cars will increase soon after electric cars are released for customers. In one study, electric cars is expected to reach 25% of the shares in the automobile market in the next ten years [4,11].

For instance, it can be accepted that Renault Zoe model draws 3kwh energy from the network during charging. This electricity demand is dependent on the use and distance. The average energy demand can be calculated by taking battery characteristics into consideration. As an example, Table 2 presents characteristics of the battery belonging to a Renault Zoe-type electric car.

Table 1. *Characteristics of the Renault Zoe electric car battery.*

Characteristics	Values
Battery Type	Lithium - ion
Energy Capacity	22 kWh
Voltage	400 V
Charging Time at 220 V (3 kWh)	3-10 Hours
Electric Range	210 km

Even if power a battery will demand from the network is definite and constant, the load characteristics per consumer may not be stable since electric car owners cannot start charging their batteries all simultaneously because of their daily use in everyday life [12]. Therefore, consumer demand scenarios can be created keeping battery characteristics and behavior of car users in mind.

3. Change in Electricity Demand

Consumer demand for electricity generation at present varies depending on seasonal effects. Widespread use of electric cars will change maximum electricity demand (Peak

hours) and daily demand. In order to investigate the effects of electric cars on the network, It is needed to determine how charging these cars impacts the daily load curve and to manage the situation [4].

For the purpose to evaluate the future impact of electric cars was used the load measurement results of Turkey Electricity Transmission Company (TEIAS). As Figure 3 displays, change based on annual measurement data increases over the years. Ineffective management of energy demand factor will result in power outages and have adverse effect on the power stability as well.
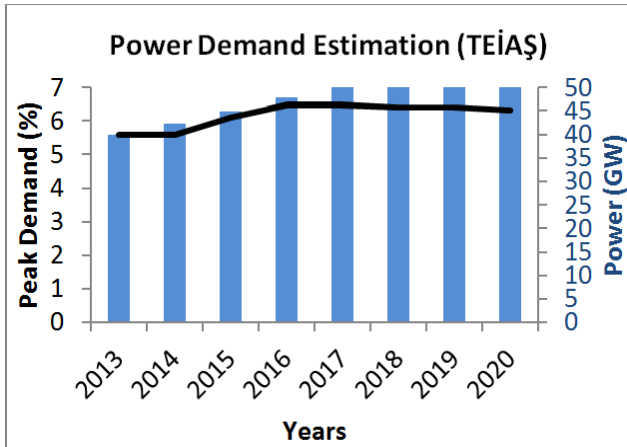

Figure 3. *Power and Peak Demand Estimation in Turkey.*

Charging of electric cars will cause a huge energy demand at different times in a day. The proportion of the total number of the cars and the number of cars on the road should be determined by hours in a day in order to have information about the battery charge rate. A sample study results are given in Figure 4 [13, 14]. It is observed that the time period when cars are mostly used is between 7:00 AM and 18:00 PM. Battery charge rate will be inverse and less since cars are widely used on the way during this period. Charging periods at different times will occur during the day. The figure 5 shows three different charging periods. The first of these periods is Peak1 which includes timeframe between 22:00 to 02:00, when most cars at home. In Peak1 timeframe, after they get home after work, people charge the batteries for the next day. The second period is Peak2 which includes timeframe between 18:00 to 22:00. This timeframe coincides with the current peak timeframe which indicates maximum power demand during the day. However, the number of cars being charged in Peak2 timeframe is expected to be less when compared to Peak1. The third period is Peak3 which includes timeframe between 8:00 in the morning to 12:00 at noon. For Peak3, charging conditions in multistory car parks under business centers, public offices, and in the streets where there exist workplaces around in major cities should be considered [4].
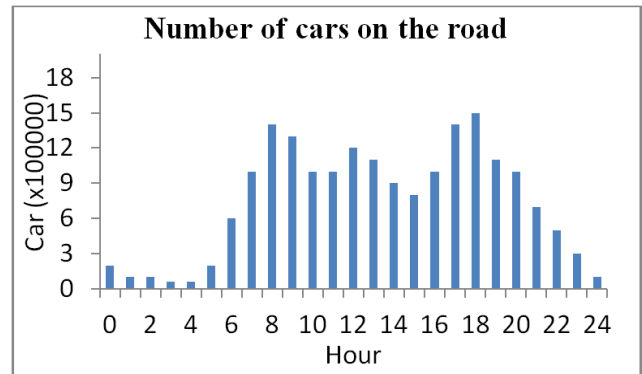

Figure 4. *The number of vehicles per hour in Turkey traffic system.*

According to the statistics obtained from SIS (State Institute of Statistics, DIE) it is reported that approximately one out of every four households has cars in Turkey [15]. By adapting these statistics to the number of electric vehicles will be in Turkey, we determine the estimated number of the vehicle for example energy demand. Considering the projections that the share of electric vehicles in the car market will raise to 30% over the next 10-15 years, we can examine the impact on the daily load demand. For this purpose, studies were carried out for cases which electric vehicles have 30% of the share of the car market and results are presented in Figure 5. Owing to the demand increase in production created taking TEIAŞ Peak Demand factor (Table 1) and the sample electric vehicle battery characteristics (Table 2) into account, and three peak hours are created for three distinct charge possibilities in Figure 5.

In the first case, cars were considered to be charged between 22:00 and 02:00. Because this timeframe coincides with hours when power demand is low, it is not observed an increase in peak value of the demand. However, when electric vehicles have 30% of the share in the market, a second peak demand at night may be created. In case of a further increase in the share of vehicles, it will create a positive impact if the highest peak demand is shifted to this period.
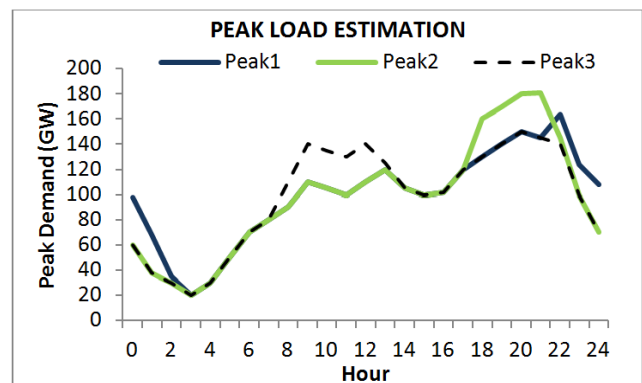

Figure 5. *Peak Load Estimation for Turkey.*

As for the second case, Peak2, cars were considered to be charged between 22:00 and 02:00. Results obtained are presented in Figure 5. Since the batteries are started charging at six in the evening, additional loads imposed by electric cars

and peak point of the daily load curve are overlapped, so there appears increase in maximum power demand in the second charge period. This is not desirable situation. Production in Turkey is very close to the maximum in this period and it is necessary to operate additional units at the power plants for meeting this demand factor. This action requires to activate imported fuel and natural gas operated power plants instead of thermal and hydroelectric power plants running at full capacity. This is the most negative scenario and it should be managed. Hence, it would be better to shift the charge time in this period to Peak1. A second solution is to keep energy pricing high using smart meters in this period.
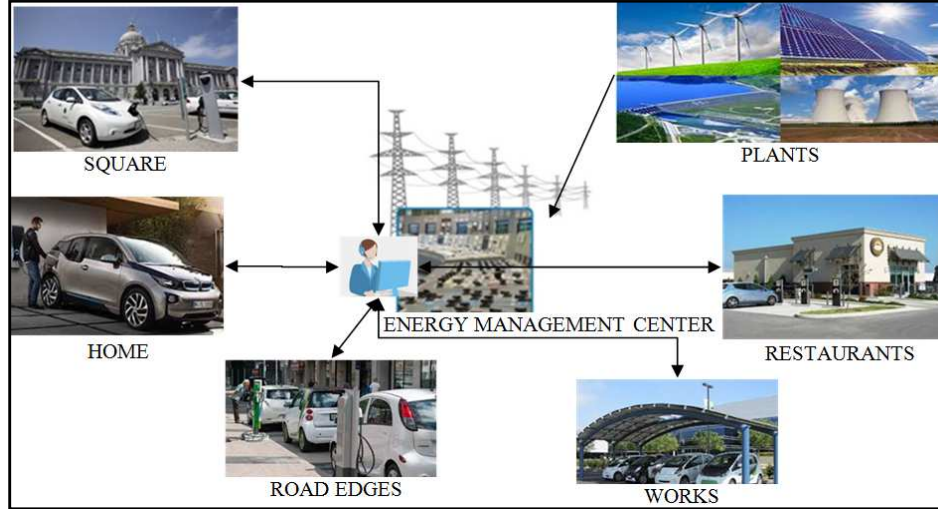

Figure 6. Energy Generation Management for Energy Demand of Electrical Car.

Figure 5 also presents additional loads caused by electric cars and daily load curve occurs in Peak3 charge period including time between 08:00 and 12:00. Since batteries are charged in the early hours of the day, when energy demand is average, in Peak3, this will not cause any problems in the production. In case there appears a need to shift charge time to other periods because of excessive load demand in Peak2, this load can be transferred to Peak3.

Because of the fact that the demand for electricity in periods taken into account increases approximately 20-30%, this situation requires management. Peak1 and Peak2 does not appear to be affected in terms of shortage will occur under the influence of electric vehicles charging periods. However, it is predicted smart grid and an increase in price for Peak2, which is also managed today, as mentioned above. Nevertheless, when electric cars are widespread, it is also observed that 30% increase in the number of the cars will result in about 20% auxiliary load on the network load. This auxiliary loading will make necessary to activate additional units for plants which run 90% efficient under normal circumstances. In order to minimize additional installation expenses of power plants, it is essential to spread the load over the day (Figure 7).

In Figure 6, the demand for electricity that can occur as a result of increase in the number of electric cars in the near future can be met by means of the automation control from a center. Adverse effects on the distribution system can be reduced by shifting the charging periods of the electric cars to hours characterized by low demand rate. In this case, additional loads electric cars will cause fill the lower levels of the daily load curve and so the system capacity can be used more effectively [4].

There exist various methods, as presented in Figure 7, need to be taken into consideration in order to prevent capacity challenges in the production system and increase in the peak value of demand. Various solutions are foreseen against the demand factor. The use of smart grid system is a prominent solution. It will also create a more stable load balance to use electronic meter triple tariffs system (day, peak, night) applied by *Turkish Electricity Distribution Corporation* (TEDAS). According to these tariffs, as a result of high pricing at the early hours of the night, when the power demand is the highest, it is expected that demand tends to lower and shift to late hours when the price is lower. In this way, the power demand increased because electric cars added to the network will shift to late hours at night and overburden on the distribution system will be prevented [16].
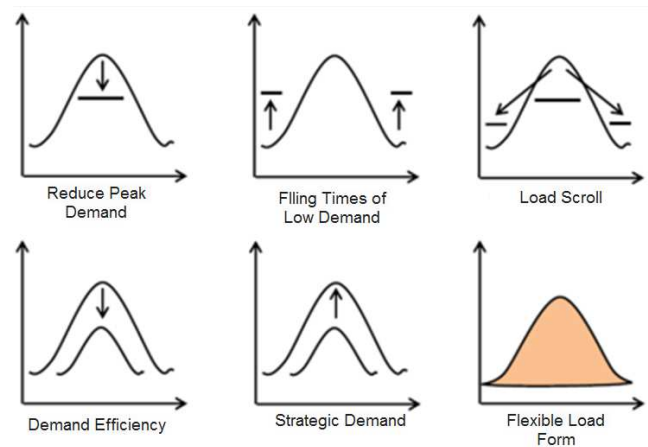

Figure 7. Peak Demand Management Strategies.

In addition to this increase in demand for electrical energy,

there are some other various problems encountered such as fluctuations in demand in the system and generators inefficiently operated for short periods due to peak load Consumption habits of users varies according to time through daily, monthly and annual processes. Due to these differences, the power demand sometimes falls well below average (Peak1) and sometimes (Peak2) can reach to highest value to overburden the network [17].

4. Conclusion

According to studies carried out, electric cars are expected to have a major share of the car market due to their use, energy costs, protection of the environment and dependence on foreign sources of energy in near future. Energy for these cars will be supplied by means of power outlets in workplaces, shopping centers, parking lots, houses and on highways. But, this will challenge for all elements of the energy system (power plants, lines, transformers, etc.) because there will result in a huge load demand in the production system [4].

Because each country has different network structures, system analysis should be sustained and optimal conditions should be sought during the integration of both smart systems and other renewable energy sources. The infrastructure of dynamic analysis of the existing network should be established and renewable energy systems such as wind and solar should provide support to meet this power demand.

In designing remote energy monitoring and measuring structures, it should be considered to be modern and fast. Appropriate points of the network and different scenarios should also be scrutinized for systems capable of active and reactive power control.

It is essential to do grid integration of electric vehicles and equipment using wireless communication methods and power flow analysis in coordination in a center. Thus; it is ensured that the charging time of electric vehicles is organized, the impact of devices on the network is reduced and a continuous and stable energy is provided [18].

In this study, we aimed to possible effects of electric cars that can occur on a daily load distribution of electricity generation system. As a result of our research, it was observed that the peak power demand in the evenings (Peak2) will increase when additional load caused by the widespread use of electric cars are added to the system. In case the market share of electric cars goes above a certain rate, it was also found out that it will lead to different peaks at different charging schedules and may result in strain in production capacity. The results of the analysis carried out on daily load curves, in cases where customers starts charging battery at night, electric cars doesn't reveal infrastructure problems in the production system in the short term; however, in the long term it is necessary to invest in the necessary infrastructure.

By means of methods such as smart grid, smart metering technologies, equal distribution of power demand and household load control, it is intended to charge electric car batteries when the power demand is low during the day (Peak1) and to prevent potential strain in capacity. The amount of peak demand in GW is observed for short periods, and power plants allocated to meet this demand remain inactive at other times [16].

For this purpose, our electricity system should be strengthened by including new energy production centers to the system. Accordingly; electrical system should be made more intelligent through the integration of smart metering and data transmission technologies to power generation, transmission and especially distribution systems. Thus, the energy demand of the electric car will not negatively affect production, and power outages and failures will not increase, either. Considering their positive impact on the environment the investments made in this context are expected to be welcomed by society.

References

[1] Korkmaz M., Yerli Otomobil Projesinde Son Nokta: Elektrikli Otomobil, AR&GE Bülten 2014 Aralık – Sektörel

[2] www.tuik.gov.tr/PreHaberBultenleri.do?id=158951

[3] TÜİK, "Sera gazı emisyon envanteri", Ankara, 2007

[4] Bostan, F.Ö., Bağrıyanık F.G., Bağrıyanık M., Elektrikli Otomobillerin Dağıtım Sistemleri Üzerindeki Olası Etkilerinin İncelenmesi İstanbul Teknik Üniversitesi, Elektrik-Elektronik Fakültesi, Elektrik Mühendisliği Bölümü, İstanbul, Türkiye

[5] http://www.enerjiatlasi.com/elektrik-tuketimi/gunluk-rekor

[6] Birol, F., (2012) World Energy Outlook. International Energy Agency, 2012 report.

[7] Kentli, F., Yılmaz, M., (2013). Fotovoltaik Panellerin Güç Arttırımında Kullanılan Yöntemler. 2. Anadolu Enerji Sempozyumu, 2-3 Mayıs 2013, Diyarbakır.

[8] DPT, DEK-TMK Raporu, http://www.dpt.gov.tr, 17 Şubat 2013.

[9] www.vikipedia.com

[10] Hadley, S. W., Tsvetkova, A. A. "Potential Impacts of Plug-in Hybrid Electric Vehicles on Regional Power Generation," The Electricity journal, 2009.

[11] Taylor J., Maitra A., Alexander M., Brooks D. "Evaluation of the Impact of Plug-in Electric Vehicle Loading on Distribution System Operations", IEEE Power & Energy Society General Meeting, 2009.

[12] Michael Kintner-Meyer , Kevin Schneider , Robert Pratt, "Impacts assessment of plug-in hybrid vehicles on electric utilities and regional u.s. power grids", Part 1: technical analysis , Pacific Northwest National Laboratory(a), November, 2007.

[13] Clement-Nyns, K. and Haesen E. "The Impact of Charging Plug-In Hybrid Electric Vehicles on a Residential Distribution Grid," IEEE Transactions on Power Systems, VOL.25,NO.1, 2010.

[14] M. Yılmaz, "Determination of methods deriving electrical energy from solar energy and optimum efficiency by solar tracking system", Ph.D. thesis, Dept. Electrical Education, Marmara Univ., Istanbul, Turkey, 2013.

[15] TÜİK Motorlu Kara "Kullanım amacına gore sayısı", Ankara, 2008.

[16] Zehir M. Alparslan Akıllı Şebekelerde Gelişmiş Yerel Talep Yönetimi İstanbul Teknik Üniversitesi, Elektrik-Elektronik Fakültesi, Elektrik Mühendisliği Bölümü,İstanbul, Türkiye

[17] Dortolina, C.A. ve Nadira, R. (2005). Estimating future demand a top down/bottom up approach for forecasting annual growths, in Power Engineering Society General Meeting, Houston, USA, Haziran 2005.

[18] F. Kentli and M. Yılmaz, "Obtaining the optimum efficiency electrical energy under Diyarbakır conditions using solar tracking system involving PV panel", Energy Education Science and Technology Part A, Special Issue, pp.613-620, Dec. 2012.

[19] Akcanca Muhammet Ali, Taşkın Sezai Akıllı Şebeke Uygulanabilirliği Açısından Türkiye Elektrik Enerji Sisteminin İncelenmesi Elektrik-Elektronik Mühendisliği Bölümü, Celal Bayar Üniversitesi, Manisa.