The Iraqi Grid Electrical Demand: Questionable Forecast

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Abstract:

Electricity sector in Iraq has faced many problems and obstacles which have a great effect on the development and upgrading of the sector. Such problems involve the uncertainty of the load forecast which is partly due to the sudden rise in the consumer buying power after 2003 coupled with the electricity generation deficit. Various factors have led to this situation, such as the international blockade on Iraq, limited investments, fossil fuel delivery, successive wars, security issues and many others.

The present work focuses on the load forecast for the Iraqi power network for the period (2016-2030). Two forecasting methods are dealt with here, viz. the averaging method and the maximum–minimum both proposed and implemented. Both methods produced a fairly matching load growth profile with the load forecast has been done under load shedding circumstances. The results obtained were close to the adopted load forecasts for the years 2015 and 2016.

Microsoft Excel program was used to conduct the load forecast study. Data implemented were obtained from the National Dispatch Center (NDC) and the Planning and Studies Office (P&SO) / Ministry of Electricity.

Keywords: National Dispatch Center, Planning and Studies Office, Ministry of Electricity, load forecast, load shedding, load supply, extrapolation.

حمل منظومة القدرة العراقية : توقع الاحمال

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المستخلص :

واجه قطاع الكهرباء في العراق الكثير من المشاكل والعقبات المتعلقة بتطوير وتحسين القطاع, من هذه المشاكل عدم معرفة الحمل المستقبلي المتوقع, الارتفاع المفاجئ في القوة الشرائية للمستهلك بعد عام ٢٠٠٣ والذي تزامن مع عجز في إنتاج الطاقة الكهربائية لعدة أسباب منها الحصار الدولي المفروض على العراق, محدودية الاستثمار, مشاكل تجهيز الوقود للمحطات الجديدة, الحروب المتتالية, الأوضاع الأمنية وعوامل أخرى.

في هذا العمل تم التركيز على كيفية حساب الحمل المتوقع لمنظومة القدرة الكهربائية العراقية للفترة (٢٠١٦-٢٠٣٠). تم اقتراح وتنفيذ طريقة لتنبؤ الحمل خاصة بمعالجة البيانات العظمى والصغرى للحمل المجهز حيث كانت نتائج هذه الطريقة مطابقة وقريبة من منحنى الحمل المتوقع للأعوام ٢٠١٥ و ٢٠١٦ المعلنة من وزارة الكهرباء.

تم استخدام برنامج معالج البيانات (Microsoft Excel) في حسابات الأحمال المتوقعة. البيانات المستخدمة في هذا العمل تم جمعها من مركز السيطرة الوطني ودائرة التخطيط والدراسات / وزارة الكهرباء.

Introduction:

The electric load forecasting is the backbone for any power system planning process. The outcome of the load forecast gives the guidelines to predict the future load demand to be implemented for a workable plan to satisfy the power network requirements. In this paper, the long-term load forecast is considered; the span of the load forecast period is (2016 – 2030). It corresponds to the load demand forecast with enough lead-time to plan for long-term construction scheduling for developing new generation facilities, purchasing of generating units, developing transmission, distribution systems and maintenance. The accuracy of the long-term demand load forecast has a significant effect on developing future generation and distribution planning. Overestimation of load demand will result in substantial unnecessary investment for the construction of excess power facilities, while underestimation will result in customer discontentment [1]. Unfortunately, it is difficult to forecast load demand accurately over a planning period of several years. This fact is due to the uncertain nature of the forecasting process, especially for Iraq situation.

Load forecast process may be divided into three categories, namely:

- Short-term load forecast predicts the load demand for one day to several weeks, it is used for offline power flow studies in order to specify the active and reactive power flow, overloading, magnitude, and phase angle of bus voltage [2].
- Medium-term load forecast predicts the load demand from several weeks to about five years. The information obtained are used for power system operation and control [2].

- Long-term load forecast predicts the load demand from five years up to about twenty years, the outcome of this study is used for power system expansion planning [2].

Load Forecast Methods: There are numerous mathematical methods available to conduct a load forecast study, Figure (1) gives a summary of these methods, each method has its own merits [3], and all these methods are suitable for load forecasting studies. There are other new methods to predict the actual load forecast, but all methods needed to actual load demand i.e. without load shedding**.**

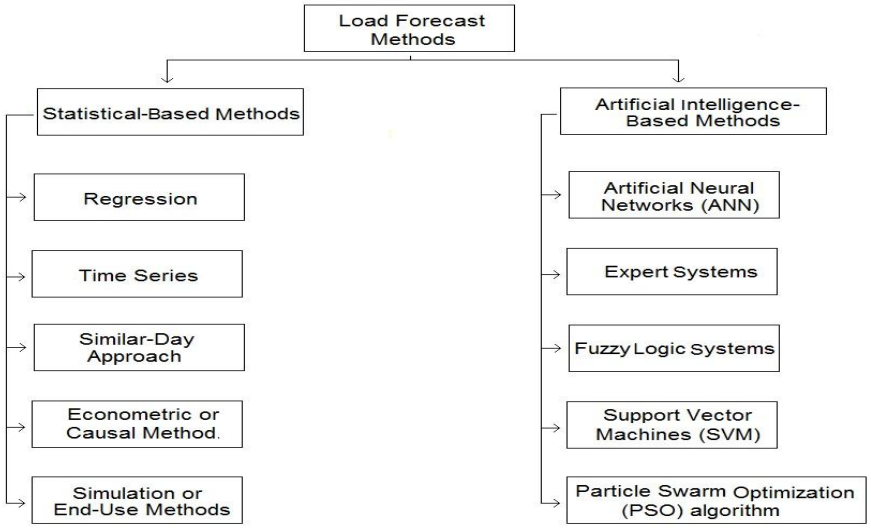

Figure (1) Load forecast methods

Any load forecast method depends primarily on the historical data gathered from the network. The data needed for the load forecast for the Iraqi power network are obtained from two sources:

- The National Dispatch Center (NDC), and
- The Planning and Studies Office (P&SO)

The NDC predict the short-term load profile using measured readings from governorates' annual load test. The data

collected from the NDC was for the period (2009-2015) [4]. The P&SO conducted a long-term load profile forecast; it was for the period (2012-2030) [5]. In both forecasts, factors of ambient temperature, holidays, and other factors were taken into consideration with the individual analyst experience playing a significant role in the final load decision.

Data collected from the two sources is plotted in Figure (2). Figure (2) shows that there is a difference of about 3000 MW for the year 2015, and which represent around 20% discrepancy between the data of the two sources.

The aim of the present work is realizing the electric load forecast of the Iraqi power network based on the historical data obtained from the two sources. A detailed load forecast study is required for the period (2016 - 2030).

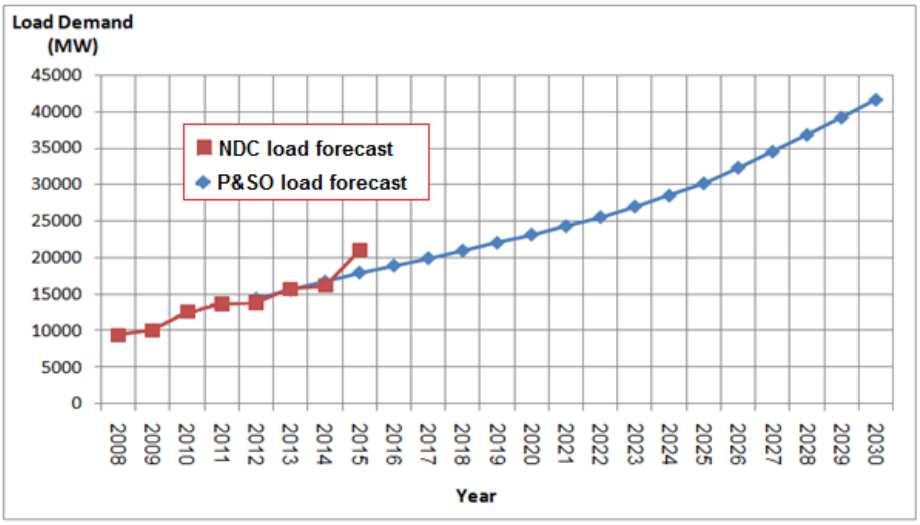

Figure (2) NDC and P&SO load forecast data

The Work Methodology: In this work, two methods are proposed and used to treat the data collected from M.o.E for the load forecast study for the Iraqi power network, these methods are used as they are capable of dealing with data under load shedding conditions, namely they are;

1- The averaging method.
2- The maximum and minimum (Max.-Min.) load supply method.

Fitting the collected data of Figure (2) to a first, second, third and fourth order equations, the second order one give more realistic results because it has less percentage error as compared with years from (2012 to 2015) for the two sources. Figure (3) shows the extrapolated NDC load data and the P&SO data fitted to the second order curve fit equation.
In the averaging method, the fitted data of the NDC and P&SO are averaged to result in the middle curve of Figure (3)

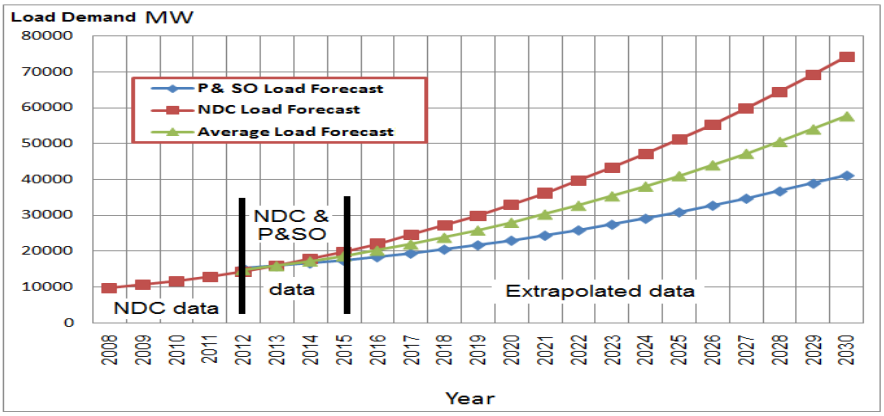

Figure (3) NDC, P&SO, and the extrapolated load forecast

The maximum and minimum load supply method is based on the maximum and minimum supplied load (P_{max} and P_{min}) during a year. Figure (4) shows a sample data of the hourly load supply of the year 2013.

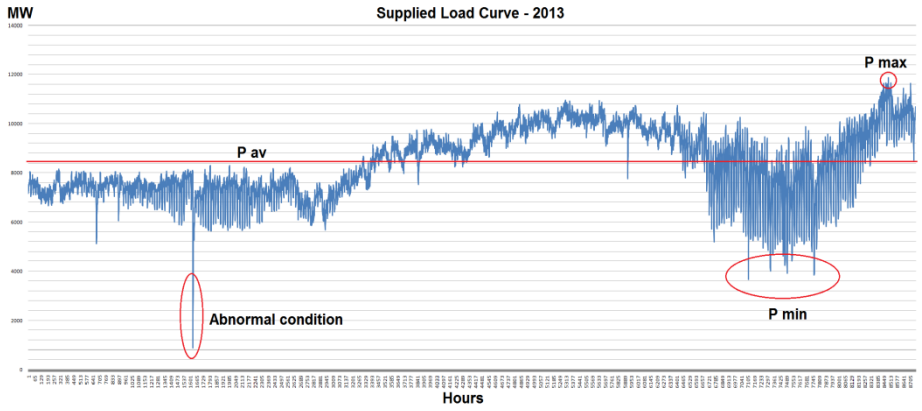

Figure (4) Hourly supplied load for the year 2013

The following procedure was followed to estimate the load forecast under load shedding conditions:

1. The average load supply (P_{av}) per year is given as:

$$P_{av} = \frac{\text{Sum of all hourly loads}}{8760\ (\text{hours})} \quad \ldots . (1)$$

2. An index factor representing the divergence between (P_{av} and P_{min}), is given as:

$$D_F = \frac{P_{av} + P_{min}}{P_{av}} \quad \ldots . (2)$$

3. Two other factors are taken into consideration:

- Res: reserve margin, estimated to be (10%).
- D: demand factor, estimated to be (85%) of the forecasted load demand, this figure is taken from M.o.E.

$$D = \frac{\text{Maximum demand}}{\text{Total connected load}} \quad \ldots . (3)$$

4. The forecasted load demand (P_d), can be calculated using the following equation:

$$P_d = D_F \text{ x } P_{max} \text{ x Res x D} \quad \ldots. (4)$$

5. For the period (2009-2011), the NDC data including Kurdistan-Iraq grid (Erbil, Sulimanyah and Dhouk), from mid-2014 until 2015, there was not enough information about the load of the governorates (Nineveh, Anbar and part of Saladin). A factor (G) is introduced in equation (4) as a weight of the supplied load for these governorates. This is needed to modify the NDC data for example; the percentage weight of the Kurdistan-Iraq governorates for the period (2009-2011) was about 20% from total load. Therefore, the factor (G) is (80%) to estimate the load demand without Kurdistan-Iraq. For the year 2015, the weight of governorates Nineveh, Anbar and part of Saladin, gave a value for the factor (G) about (19%). This factor is approximately equal to (9.5%) of the total load demand for year 2014 for these governorates, as there are no loads supplied to these governorates during the second half of 2014, hence equation (4) is modified as follows:

$$P_d = D_F \text{ x } P_{max} \text{ x Res x Dx G} \quad \ldots. (5)$$

Equation (5) is used to calculate the load forecast for the period (2009-2015), the results obtained are given in Table (1).

Table (1) Forecasted load demand for the period (2009-2015)

Year	Pmax (MW)	Pmin (MW)	Pav (MW)	Res	D	G	(P_d) Forecasted Load (MW)	NDC Forecasted Load (MW)
2009	7702	4615	6405	1.1	0.85	0.8	9912	10028
2010	8321	5143	6801	1.1	0.85	0.8	10930	12612
2011	9651	5380	7110	1.1	0.85	0.8	12681	13681
2012	8838	4820	6911	1.1	0.85	1	14026	13834
2013	11882	4630	8425	1.1	0.85	1	17215	15709
2014	12051	5500	9533	1.1	0.85	1.095	19456	16186
2015	13313	4550	9531	1.1	0.85	1.19	21884	20988

To extend the calculation up to the year 2030, the power demands (Pd) in table (1) are fitted to a linear first order equation, and extrapolated from year 2016 to year 2030, using the following equation (6):

$$Pd\ (MW) = 2053(Y) + 21314 \quad \ldots. (6)$$

where (Y) = (Y'-2015), (Y') years starting 2016 to 2030,
2053 = amount of the annual increase in load demand in MW,
21314 = estimated power demand at 2015 in MW,
the load forecast results obtained for the years (2015 and 2016) are close to NDC load forecast with less than 5% error. It is worth mentioning here, that the maximum – minimum load supply method results are closer to the NDC than for the P&SO, for example, the NDC load forecasted for year 2016 is about 23000 MW and the extrapolated data in results about

23367 MW, with a mean error less than 3%. The extrapolated load forecast data are shown in Figure (5).

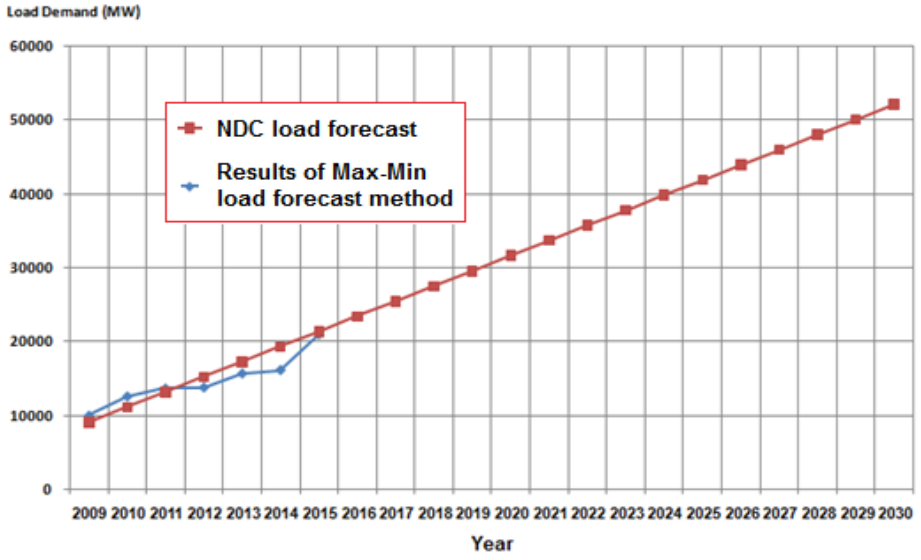

Figure (5) Load forecast result using Max. - Min. method

Figure (6) shows the two methods results for the period (2016-2030). It is clear in Figure (6) that the maximum and minimum load supply method produced a more conservative load forecast results in the last two years as compared to the averaging method. The pecentage error between the two methods is about 13% for the year 2016 and less than 10% for the year 2030. These errors are resonable and can be accepted, as the NDC data are not measured but estimated as mentioned earlier.

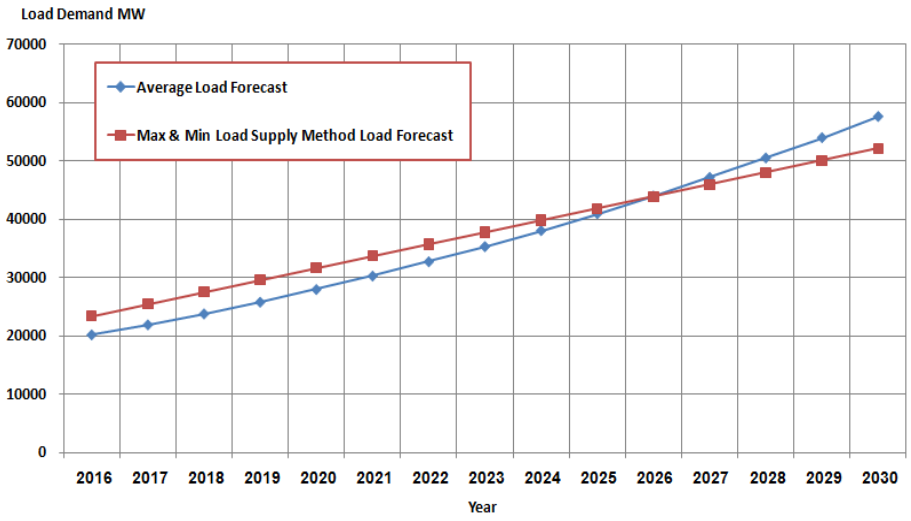

Figure (6) Results comparison

Conclusions :

The load forecast process is very important for generation and transmission planning expansions due to its economic and social impacts. Load shedding impact on the data input to the forecasting process for both the NDC and P&SO was not taken into consideration in their future load forecasts.

In the present work, the proposed and adopted methods for the load forecast study produced relatively similar results. However, the maximum and minimum load supply method results were favorably comparable with that of the NDC load forecast. Therefore, a better load forecast can be obtained recommending the maximum and minimum load supply method for adoption by the M.o.E. Moreover, the adoption of maximum and minimum load supply method takes into consideration the process of the load shedding controls and hence produce more realistic results.

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