



**Faculty of Manufacturing Engineering**

**IMPROVE THE EFFICIENCY OF ENERGY BY ADOPTING ISO  
50001 IN THE IRAQI MINISTRY OF ELECTRICITY.**

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**IMPROVE THE PERFORMANCE OF ELECTRICITY POWER PRODUCTION  
BY ADOPTING ISO 50001 IN THE IRAQI MINISTRY OF ELECTRICITY.**

**NOOR SHAKIR MAHMOOD**

**A thesis submitted  
in fulfillment of the requirements for the degree of Master of Science  
in Manufacturing Engineering**

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## **DECLARATION**

I declare that this thesis entitled “Improve the Performance of Electricity Power Production by Adopting ISO 50001 in the Iraq Ministry of Electricity. Case study from Al- Dora power station / Iraq is result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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## **APPROVAL**

I hereby declare that I have read this report and in my opinion this report is sufficient in terms of scope and quality as a partial fulfillment of Master of Manufacturing Engineering (Industrial Engineering).

Signature :  
Supervisor Name : Dr.Seri Rahayu bint Kamat  
Date : 05/ 07 / 2016

## **DEDICATION**

To the sake of Allah my Creator .This thesis work is dedicated to my husband, Ahmed Ali, who has been a constant source of support and encouragement during the challenges of graduate and life. I am truly thankful for having you in my life. This thesis work is dedicated to my parents, for their endless love, support and encouragement along my life. To my beloved kids: Mohammed, Lina and Rzan. To my beloved sisters, whom I cannot force myself to stop their love. To all my family, the symbol of love and giving. My friends who encourage and support me. I dedicate this thesis.

## ABSTRACT

Today, energy efficiency issues are becoming more and more important within organizations. The international standard ISO 50001 defines general requirements for the operational and organizational structure for companies. ISO 50001 provides benefits for organizations large and small, in both public and private sectors, in manufacturing and services, in all regions of the world. ISO 50001 will establish a framework for industrial plants; commercial, institutional, and governmental facilities; and entire organizations to manage energy. The main problem that facing the power production in Iraq is the decline in the amount of energy produced because of a set of problems, one of them not- adopting ISO 50001. The main objective of this study is to identify the factors that help the Ministry of Electricity in Iraq to adoption ISO 50001 in the power stations and then analyze these factors to the suggestion adoption ISO 50001 in AL-Dora power station in Iraq. The sample for this research includes the (managers and engineers) who work in AL-Dora power station are 163 (13 Managers and 150 Engineers), who have the decision to adopt ISO 50001 in the power station at the ministry of electricity of Iraq. The data were used for this study that was generated through structured questionnaires with close-ended questions by the survey in Iraqi Ministry of Electricity at AL- Dora power station. Statistical Package for the Social Sciences (SPSS) was used to test the research hypotheses. This study has been used two methods to check the adoption ISO 50001 first method was through survey and analysis by SPSS software this method used the tools of SPSS software of parametric test like the correlations, mean, standard deviation, regression analysis, histograms and P–P plot. The second method was by conducting experiments at the workplace to prove the validity of the results that have been obtained by the SPSS software. This is the first study of its kind in the Iraqi Ministry of Electricity is studying the effect of application of ISO50001 on improving the efficiency of energy management, reduce costs, quality improvement , environmental performance and economic sustainability in power stations and considered very important and has economic feasibility. Therefore, this study it will help the Iraqi Ministry of Electricity by providing new ideas about the loss of the cost and time due to the loss of productivity. The results of this study to prove the adoption ISO 50001 Leads to an efficiency in energy management, reduce costs, create a sustainable environment in the field of energy production in the ministry of electricity especially in electric power plants in Iraq.

## ABSTRAK

*Pada hari ini, isu-isu kecekapan tenaga menjadi lebih penting dalam sesebuah organisasi. Standard Antarabangsa ISO 50001 mentakrifkan keperluan umum bagi struktur operasi dan organisasi bagi syarikat-syarikat. ISO 50001 menyediakan manfaat yang baik untuk organisasi kecil dan besar, dalam sektor awam dan swasta, pembuatan dan perkhidmatan, di semua rantau di dunia. ISO 50001 akan menubuhkan rangka kerja untuk kilang industri; kemudahan komersial, institusi dan kerajaan; dan seluruh organisasi untuk menguruskan tenaga. Pensasarnya tidaknya luas di seluruh sektor ekonomi negara, adalah dianggarkan bahawa standard yang boleh mempengaruhi. Masalah utama adalah pengeluaran kuasa di Stesen Jana Kuasa di Iraq yang menghadapi penurunan yang berterusan dalam jumlah tenaga yang dihasilkan. Keadaan ini adalah disebabkan sebahagian dari perkerja tidak mahu menggunakan sistem ISO 50001 disarankan. Keadaan ini boleh melemahkan keberkesanan dan kecekapan prestasi perkerja di bahagian masing-masing, dan kerugian dalam sumber manusia dan bahan, dan ini akan melibatkan kenaikan kos, kerosakan kepada kesihatan pekerja dan kelemahan dalam prestasi kerja. Objektif utama kajian ini adalah untuk mengenal pasti isu kualiti dan penerimaan faktor ISO 50001 di AL-Dora stesen janakuasa gas di Iraq. Seterusnya menganalisis prestasi dan kecekapan Stesen Janakuasa Elektrik di Iraq dengan mengamalkan ISO 50001. Sampel kajian ini termasuk pengurus dan jurutera yang bekerja stesen kuasa AL-Dora adalah 163 (13 Pengurus dan 150 Engineers), Yang mempunyai kuasa untuk mengambil keputusan untuk melaksanakan ISO 50001 di loji janakuasa. Data yang digunakan dalam kajian ini yang telah dijana melalui soal selidik berstruktur dengan hampir - tertutup oleh kaji selidik itu di Iraq Kementerian Elektrik (stesen kuasa AL- Dora). Pakej Statistik untuk Sains Sosial (SPSS) digunakan untuk menguji hipotesis Kajian ini telah menggunakan dua kaedah untuk memeriksa penggunaan ISO 50001 Kaedah pertama adalah melalui kajian dan analisis oleh perisian SPSS kaedah ini menggunakan dua jenis alat perisian SPSS Jenis pertama ujian parametrik seperti korelasi, min, sisihan piawai, analisis regresi, histogram dan P-P plot. Kaedah kedua adalah dengan menjalankan eksperimen di tempat kerja untuk membuktikan kesahihan keputusan yang telah diperolehi oleh SPSS. Ini adalah kajian pertama ISO50001 yang dijalankan di Kementerian Iraq Elektrik yang sedang mengkaji kesan menggunakan system ISO50001 dalam meningkatkan kecekapan pengurusan tenaga, mengurangkan kos, peningkatan Kualiti, Prestasi Alam Sekitar dan Kelestarian Ekonomi di stesen-stesen kuasa dan dianggap sangat penting dan mempunyai ekonomi yang berdaya saing dan maju. Oleh itu kajian ini akan membantu Kementerian Iraq Elektrik dengan memberikan idea-idea baru tentang kehilangan kos dan pengurangan produktiviti dikalangan perkerja dan syarikat. Hasil yang diharapkan daripada kajian ini untuk meningkatkan kecekapan pengurusan tenaga, mengurangkan kos, Mewujudkan persekitaran yang mampan dalam bidang pengeluaran tenaga di Kementerian Tenaga Elektrik terutama di loji kuasa elektrik di Iraq.*

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## TABLE OF CONTENTS

	PAGE
<b>DECLARATION</b>	
<b>APPROVAL</b>	
<b>DEDICATION</b>	
<b>ABSTRACT</b>	i
<b>ABSTRAK</b>	ii
<b>ACKNOWLEDGEMENTS</b>	iii
<b>TABLE OF CONTENTS</b>	iv
<b>LIST OF TABLES</b>	vii
<b>LIST OF FIGURES</b>	ix
<b>LIST OF APPENDICES</b>	xi
<b>LIST OF ABBREVIATIONS</b>	xii
<b>LIST OF PUBLICATIONS</b>	xiii
<b>CHAPTER</b>	
<b>1. INTRODUCTION</b>	<b>1</b>
1.1 Background of Study	1
1.1.1 Need of Energy Conservation	3
1.1.2 Power down: Iraq's electricity shortages	5
1.2 Research Motivation	8
1.3 Problem Statement	9
1.4 The Research Questions	10
1.5 Research Objectives	10
1.6 Contributions of the Research	11
1.7 Scope of Research	12
1.8 Study Outline	12
<b>2. LITERATURE REVIEW</b>	<b>14</b>
2.1 Introduction	14
2.2 Definition of terms used in ISO 50001	16
2.3 Cycle of PDCA	18
2.4 Benefits of Adoption ISO 50001	19
2.5 Comparison between ISO 50001 and Other Standards	21
2.6 Energy Management System	23
2.6.1 The role of industrial EnMS	23
2.7 Governmental Energy Management Programs	25
2.8 The global energy challenge and the importance of energy efficiency	27
2.9 Previous studies	27
2.10 Country and Sector Background	38
2.10.1 Ministry of Electricity in Iraq	39
2.10.2 AL-Dora Power Station	40
2.11 Conceptual Framework Model of Adoption ISO 50001	42
2.11.1 Cost Reduction	43
2.11.2 Quality Improvement	44
2.11.3 Environmental Performance	44
2.11.4 Economic Sustainability	45
2.11.5 Energy Reduction	46
2.12 Chapter Summary	50

<b>3.</b>	<b>METHODOLOGY</b>	<b>51</b>
3.1	Introduction	51
3.2	Process Flow of the Study	52
3.3	Proposed Research Hypotheses	55
3.3.1	Cost Reduction	55
3.3.2	Quality Improvement	55
3.3.3	Environmental Performance	55
3.3.4	Economic Sustainability	56
3.3.5	Energy Reduction	56
3.4	Sample, Unit of Analysis and Respondents	58
3.5	Qualitative Versus Quantitative Method	59
3.5.1	Questionnaire Development	60
3.5.2	Formulation of Questionnaire	60
3.6	Data Collection Method	63
3.6.1	Data Statistical Analysis	64
3.6.2	Statistical Approach	64
3.6.3	Demographic Participant Profile Analysis	65
3.7	Descriptive Analysis	65
3.7.1	Reliability Analysis	65
3.7.2	Regression Analysis	68
3.7.3	ONEWAY ANOVA Analysis	69
3.7.4	Correlation Analysis	70
3.8	Chapter Summary	71
<b>4.</b>	<b>RESULT AND DISCUSSION</b>	<b>72</b>
4.1	Introduction	72
4.2	Questionnaire for Data Collection	72
4.3	Data Analysis	73
4.3.1	Analysis of Demographic Profile	73
4.3.2	Correlations, Mean and Standard Deviation	87
4.3.3	Control Variable	89
4.4	Analysis and Compare (Ordinal VS Ordinal)	90
4.4.1	Hypotheses Analysis	90
4.4.2	Research Model and Summary of Hypotheses Tested	112
4.5	Experiments Adoption ISO 50001	113
4.5.1	First Experiment	114
4.5.2	Second Experiment	120
4.6	Chapter Summery	127
<b>5.</b>	<b>DISCUSSION</b>	<b>128</b>
5.1	Introduction	128
5.2	Hypothesis Discussion	128
5.2.1	Cost Reduction	129
5.2.2	Quality Improvement	129
5.2.3	Organization's Environmental Performance	130
5.2.4	Economic Sustainability	131
5.2.5	Energy Reduction	131
5.3	Experiments Discussion	132
5.4	Chapter Summery	133

<b>6.</b>	<b>CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE WORK</b>	<b>134</b>
6.1	Summary of the Study	134
6.2	Attainment of Research Objectives	135
6.2.1	Attainment Objective 1	135
6.2.2	Attainment Objective 2	136
6.2.3	Attainment Objective 3	137
6.3	Conclusions	138
6.4	Future Research	139
6.5	Recommendations	141
	<b>REFERENCES</b>	<b>143</b>
	<b>APPENDICES</b>	<b>151</b>
	<b>APPENDIX A</b>	<b>151</b>
	<b>APPENDIX B</b>	<b>165</b>
	<b>APPENDIX C</b>	<b>169</b>
	<b>APPENDIX D</b>	<b>173</b>

## LIST OF TABLES

<b>TABLE</b>	<b>TITLE</b>	<b>PAGE</b>
2.1	Comparison between ISO 50001 and other standards	22
2.2	Details the Number of ISO 50001 Certified	25
2.3	Previous studies	28
2.4	Details of AL-Dora power station Installed capacity	41
2.5	Review of influence factors for adoption ISO 50001	49
3.1	Relationship between Methodology and Objectives	54
3.2	Gant Chart of Entire Study	57
3.3	Reliability Analysis	66
4.1	Demographic Profile – Gender	73
4.2	Demographic Profile - Respondents by Age Group	75
4.3	Demographic Profile - Respondents by Education	76
4.4	Employers Working in the Iraqi Ministry of Electricity	78
4.5	Current job position	79
4.6	Working Experience in AL-Dora power station	80
4.7	Prospects of using ISO 50001	82
4.8	Obtain a certificate of ISO 50001 in the short-term	83
4.9	Easy to adapt to the requirements of the standard ISO 50001	84
4.10	Implementing ISO 50001 is a long term process	85
4.11	ISO 50001 implementation costs	86
4.12	Correlations, Mean and Standard Deviation	88

4.13	ONEWAY ANOVA analysis	89
4.14	The Relation between Research Hypotheses Variables	90
4.15	Summary Results of Regression Analysis: CR and ISO 50001 standard	92
4.16	Details results of Regression Analysis: Cost Reduction and ISO 50001	92
4.17	Details Analysis ANOVAa	93
4.18	Details Coefficientsa	93
4.19	Summary Results of Regression Analysis QI and ISO 50001 standard	96
4.20	Details Results of Regression Analysis: Q I and ISO 50001	97
4.21	Details Analysis ANOVAa	97
4.22	Details Coefficientsa	97
4.23	Summary Results of Regression Analysis: OEP and ISO 50001	101
4.24	Details Results of Regression Analysis OEP and ISO 50001 standard	101
4.25	Details ANOVAa	101
4.26	Details Coefficientsa	102
4.27	Summary Results of Regression Analysis: ES and ISO 50001 standard	105
4.28	Details Results of Regression Analysis: ES and ISO 50001 standard	105
4.29	Details Analysis ANOVAa	105
4.30	Details Coefficientsa	106
4.31	Summary Results of Regression Analysis: ER and ISO 50001	108
4.32	Details Results of Regression Analysis: ER and ISO 50001	109
4.33	Details ANOVAa	109
4.34	Details Coefficientsa	109
4.35	Summary of Hypotheses testing	112
4.36	Summary of fuel pump savings	116
4.37	Summary of compressor air savings	125

## LIST OF FIGURES

<b>FIGURE</b>	<b>TITLE</b>	<b>PAGE</b>
1.1	World Energy Usage and Future Projections	4
1.2	Electricity Demand peak and forecast in Iraq	6
1.3	Iraq Electricity Generation Profil	7
2.1	Energy Management System Model for ISO 5000	17
2.2	Cycle of PDC	19
2.3	Number of ISO 50001 Certified Sites Worldwide	26
2.4	AL-Dora power station installed capacity	41
2.5	The Conceptual Framework to Adoption ISO 50001	48
3.1	Study development Planning and Relationship	53
3.2	The Percentages of the Samples in AL-Dora gas power station	58
4.1	Pie Chart for Gender	74
4.2	Respondents by Age Group	75
4.3	Demographic Profile - Respondents by Education	77
4.4	Working Experience in the Iraqi Ministry of Electricity	78
4.5	Current job position	79
4.6	Working Experience in AL-Dora power station	81
4.7	Prospects of using ISO 50001	82
4.8	Obtain a certificate of ISO 50001 in the short-term	83
4.9	Easy to adapt to the requirements of the standard ISO 50001	84
4.10	Implementing ISO 50001 is a long term process	85

4.11	ISO 50001 implementation costs	86
4.12	Relationships between Cost Reduction and ISO 50001 standard	94
4.13	Histogram of Cost Reduction	94
4.14	P-Plot of Cost Reduction	95
4.15	Relationships between Quality Improvement and ISO 50001 standard	98
4.16	Histogram of Quality Improvement	99
4.17	P-Plot of Quality Improvement	99
4.18	Relationships between OEP and ISO 50001 standard	102
4.19	Histogram of Organization's Environmental Performance	103
4.20	P-Plot of Organization's Environmental Performance	103
4.21	Relationship between Economic sustainability and ISO 50001	106
4.22	Histogram of Economic sustainability	107
4.23	P-Plot of Economic sustainability	107
4.24	Relationship between Energy Reductions and ISO 50001 standard	110
4.25	Histogram of Energy Reduction	111
4.26	P-Plot of Energy Reduction	111
4.27	Pipes of fuel pumps before Configuration	117
4.28	Pipes of fuel pumps after configuration	117
4.29	Fuel Pump	118
4.30	Compressor before change setting	122
4.31	Compressor after change setting	122
4.32	PLC Control for Compressor	123
4.33	New pressure switch to control after configuration	123
4.34	Main air tank to compressor air	124

## LIST OF APPENDICES

<b>APPENDIX</b>	<b>TITLE</b>	<b>PAGE</b>
<b>APPENDIX A</b>		<b>151</b>
A1	Demographic Variables	154
A2	Reasons Applying the Standard ISO 50001	156
A3	Factors Affecting of ISO 50001, Independent variables	158
A4	Adoption ISO 50001 standard as Dependent variables	163
<b>APPENDIX B</b>		<b>165</b>
B1	Data Input of Demographic	165
B2	Data Input for applying ISO 50001	166
B3	Data Input for independent variables	167
B4	Data Input for ISO 50001 as a dependent variable	168
<b>APPENDIX C</b>		<b>169</b>
C1	First Page of Publishing Paper 1	169
C2	First Page of Publishing Paper 2	170
C3	First Page of Publishing Paper 3	171
C4	First Page of Publishing Paper 4	172
<b>APPENDIX D</b>		<b>173</b>
D1	Certification of Analysis Accuracy	173



## LIST OF ABBREVIATIONS

SPSS	Statistical Package for the Social Sciences
MW	Megawatt
KW	Kilowatts
ISO	International Organization for Standardization
EnMs	Energy management systems
EnPIs	Energy Performance Indicators
MOE	Ministry of Electricity
CO <sub>2</sub>	Carbon Dioxide
CR	Cost Reduction
QI	Quality Improvement
EPO	Environmental Performance Organization
ES	Economic Sustainability
ER	Energy Reduction
Btu	British thermal unit
NO <sub>2</sub>	Nitrogen Dioxide
PDCA	Plan - Do - Check – Act
IV	Independent Variables
DV	Dependent variables

## LIST OF PUBLICATIONS

The following publications have been achieved by this research work:

### Journals:

1. **Noor Shakir Mahmood**, Seri Rahayu Kamat, Ahmed Ali Ajmi, (2016), "Increase the Performance of Power Station: Results and Analysis of an Empirical Study of the ISO 50001 Energy Management Systems in the Iraqi Ministry of Electricity", *MAGNT RESEARCH REPORT* (ISSN. 1444-8939), Vol.4 (2). PP. 75-86. **(ISI)**.
2. Seri Rahayu Kamat, **Noor Shakir Mahmood**, Ahmed Ali Ajmi "REVIEW AND ESTABLISHING FRAMEWORK MODEL TO ADOPTION ISO 50001 ENERGY MANAGEMENT SYSTEM IN POWER STATIONS", *Journal of Advanced Manufacturing Technology* (ISSN: 1985-3157) (2016).
3. Ahmed Ali Ajmi, Seri Rahayu Kamat, **Noor Shakir Mahmood**, (2016), "Analysis of the Effects of Temp in the Turbine Rooms on the Performance of Workers in the Power Stations", *MAGNT RESEARCH REPORT* (ISSN. 1444-8939), Vol.4 (2). PP. 65-74. **(ISI)**.
4. Seri Rahayu Kamat, Ahmed Ali Ajmi, **Noor Shakir Mahmood** " THERMAL COMFORT AT THE TURBINE ROOM IN THE POWER STATION: A SYSTEMATIC REVIEW", *Journal of Advanced Manufacturing Technology* (ISSN: 1985-3157) (2016).

# CHAPTER 1

## INTRODUCTION

### 1.1 Background of Study

With ever increasing and constant environmental pollution, the level of concern among the people regarding this issue increased as well. However, the level of awareness increases only when the consequences become very clear and irreversible. With the eco-unfriendly behavior of the population and the presence of large manufacturing plants, the planet is fast being polluted and slowly being destroyed. One of the factors that significantly affect the parametric environment is energy, its use, consumption, and its conservation. It is well known that using environmental awareness campaign to encourage people is inadequate to realize the effect of actions that will decrease environmental pollution. However, there is a universal driver for the implementation of proper measures and proper treatment of energy and environment, which is money. Most managers speak the language of profit. From the management in the organization and their commitment to improvements in energy efficiency, the success of any project in energy efficiency depends on money. Managers and owners are interested in cost savings and increased profits. If the language of money is used in environmental campaigns, it might result in significant developments. One of the good examples of adoption of savings and environmental effects is the international standard ISO 50001:2011, which will be discussed in this study (Wulandari et al., 2015).

The International Organization for Standardization (ISO) develops a new set of standards that addresses the use of energy in businesses, which is called the ISO50001:2011. It is an energy management system standard, published by ISO on 9<sup>th</sup> June 2011, and is an international framework that can be utilized by companies for the efficient management of energy, encompassing its procurement and use. ISO 50001 proposes technical and management strategies for companies to follow so that energy use can be maximized and costs reduced, with minimal stress on the environment. Experts estimate that this standard influences up to 60% of the world's energy demand. It is important for a company to conform to the energy management standards. Managing our world's energy supply is becoming ever more important, with the demand for energy in the world far outstripping supply. Conserving energy and using energy in the most efficient and effective manner is becoming more important around the globe (Karcher and Jochem, 2015). ISO 50001 is derived from the usual elements present in ISO's management systems, which practically guarantee miscibility with ISO 9001 (quality management) and ISO 14001 (environmental management). The standard works by combining energy efficiency and management practices via the utilization of the current energy-consuming processes. The standard is mostly predicated on the Plan-Do-Check-Act (PDCA) cycle, combining technical and managerial perspectives. The objectives of the standard are:

- i. Assist organizations in improving the current energy-consuming assets.
- ii. Create transparency and facilitate communication between the management of energy resources and the promotion of energy efficiency throughout the supply chain.
- iii. Reduce energy cost, greenhouse gas (GHG) emissions, and other environmental effects. Industries that adopted an Energy management systems used 10-20 % less energy within the first half decade.

- iv. Implement superior practices related to energy management and complement excellent energy management behaviors.
- v. Help facilities assess the implementation of state-of-the energy-efficient technologies.
- vi. Combine other organizational management systems, such as environmental, and health and safety, in the event it is miscible with other performance improvement approaches.

### **1.1.1 Need of Energy Conservation**

The consumption of energy sources has been increasing drastically over the past 30 years. It is estimated that the world's energy consumption would increase by 49% from 2007-2035 (Golden et al., 2014). According to the latest International Energy Outlook report, by Larson (2013) it expects the total world energy usage for 2010 was 524 quadrillions British thermal unit (Btu), and it is projected to increase to 630 Btu by 2020, and 820 quadrillions Btu by 2040. Much of this growth will occur in emerging economies, with energy use in China and India alone expected to account for nearly half of the increase in total energy use. Within OECD countries Organization for Economic Co-operation and Development, energy use will rise by 17 per cent. Outside, it will grow by 90 % (Larson, 2013). Figure 1.1 shows the energy consumption from 1990 and projections through 2040.

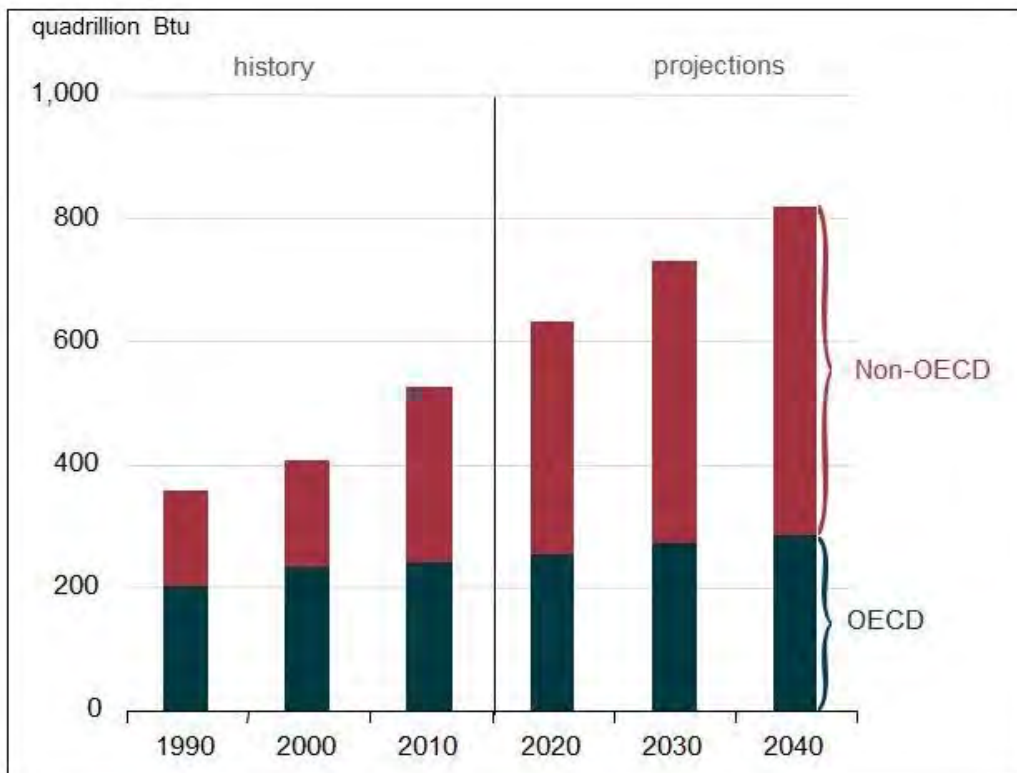


Figure 1.1: World Energy Usage and Future Projections (Larson, 2013).

Energy conservation refers to the reduction of energy consumption via the usage of less energy service, whereas energy efficiency refers to the usage of less energy for a constant service. There is a significant growth in the energy consumption around the globe with respect to time. The by-product of this growth in energy consumption is the increased emissions of greenhouse gasses (GHG's), causing global warming. Hence, many nations have started focusing on energy conservation and energy efficiency as a way to reduce these greenhouse emissions. The energy conservation through the reduction of energy costs is also one of the pillars of sustainability and sustainable development. Many of studies show that if the world continues to consume fossil fuels at a rate similar to 2006, the reserves of oil, coal, and gas will last (Pinheiro and Bianchini, 2014).

### **1.1.2 Power down: Iraq's electricity shortages**

The Gulf War (1991) was a source of misery to Iraq, and it suffered many calamities. One of the infrastructures that were most effected was the power infrastructure, and even now, it suffers from non-existent investment and poor equipment. This is exacerbated by the US-led invasion of Iraq in 2003, where despite increased electricity supply; it could not keep up with demands. Based on data collected from the Ministry of Electricity, Iraq generates 8000 MW of power, which is short of the required 13000-15000 MW that is requirments. There are also many problems that plague the power sector in Iraq, such as aging power plants and the lack of fuel or water. These problems are compounded by the presence of illegal connections and the lack of funding for improved infrastructure, which is projected to affect generation as well.

The period beginning 2003 up till now see Iraqi households getting, on average, only 8 hours of electricity per day via the established public network. A further quarter of the households lacks access to even basic forms of electricity. Despite the availability of expensive communal and private generators, households receive, at most, 18 hours of power per day. Electricity supply has since been decreasing in certain areas, especially in Baghdad, poor distribution systems and unsustainable networks are not only creating power problems, they are also slowing the local economy. The businesses based in these areas are forced to fork out a significant amount of their respective revenue just to obtain power from costly private generators. This results in reduced profits, investments, economic growth, diversification, and job creation. This is reflected by the fact that even at times of low demands, the public's positive perception of the electricity supply has never exceeded 39% since 2003. In 2006-2007, only 8% of the people being positive about electricity supply and distribution. However, by February 2009, this percentage has recovered somewhat to 38%.

This enhanced opinion agrees with the slight increase in demand being fulfilled. Figure 1.2 shows the peak of electricity demand that have been forecasting until the end of 2030

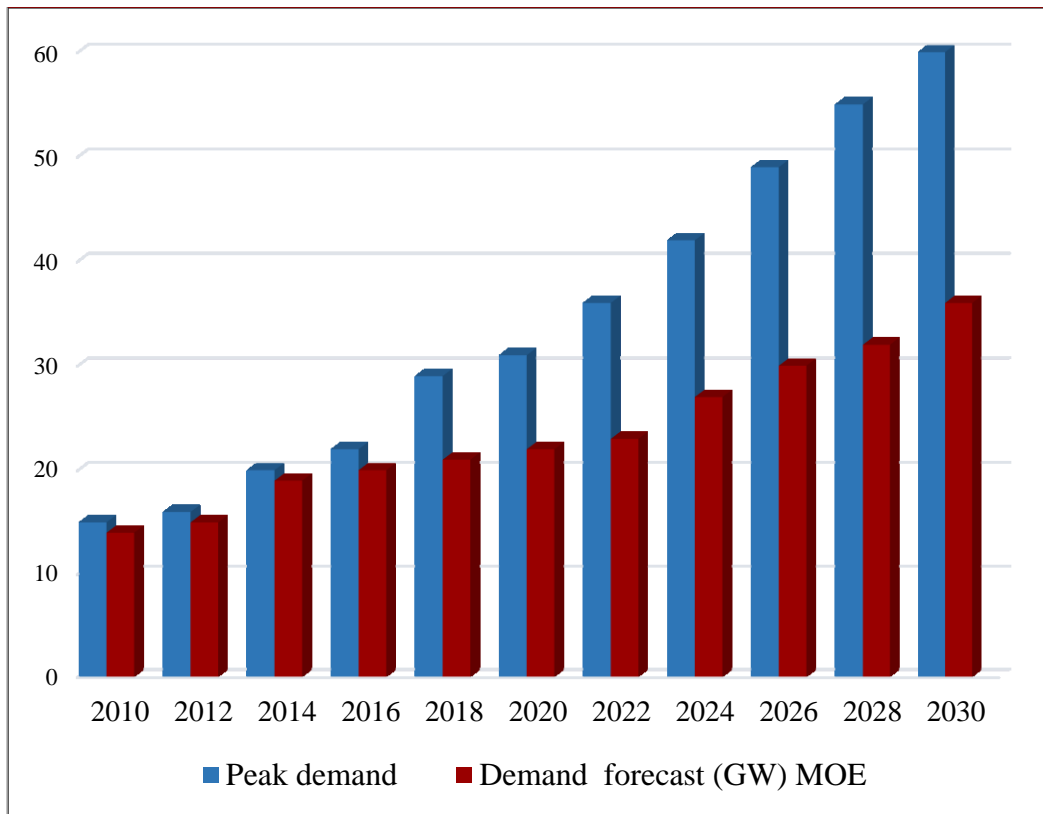


Figure 1.2: Electricity Demand peak and forecast in Iraq (Istepanian, 2014).

The core dynamic of Iraq's electricity crisis is simple: an ever-widening gap between supply and demand. There is no accurate estimate of the actual demand, due to its suppression by institutional and economic constraints on consumption, and the lack of accurate historical data since the 1990s. In a previous study conducted by the Ministry, demand was estimated to fall between 50 and 70 % higher than originally anticipated by the Ministry's Master Plan, taking into account factors such as shifting demographics and suppressed demand. The total peak demand is likely to reach anywhere between 50,000 to 60,000 MW by 2030 while the Ministry forecasted peak demand as a mere 35,000 MW. In