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# Evaluation of large scale building energy efficiency retrofit program in Kuwait



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## ABSTRACT

In this paper, an overview of the Kuwaiti energy sector characteristics is presented to include its generating capacity as well as its end-use consumption over the last two decades. Moreover, a detailed analysis of the total and end-use energy consumption attributed to various building types is provided. The paper presents the specific regulations of the building energy conservation code of practice using its original version of 1983 and its revised version of 2010. The code enforcement mechanism is also outlined. Based on a detailed review of the reported literature, the potential energy savings opportunities and their cost-effectiveness for Kuwaiti buildings are discussed. Using a comprehensive review for reported analyses, the paper summarizes the economical and environmental benefits of improving energy efficiency for both new and retrofitted buildings in Kuwait. It is found that the 2010 revised version of the energy conservation code of practice can provide an additional 23% savings compared to the original version of the code developed and implemented in 1983. The implementation of an energy efficiency program to achieve the energy savings level set by 2010 energy conservation code of practice can achieve.

It is found that without a gradual reduction of energy subsidies, the establishment of a mandatory energy efficiency retrofit program in Kuwait through implementation of basic energy efficiency measures and improved operating strategies for the existing building stock can provide significant economical and environmental benefits to Kuwait as well as the creation of significant job opportunities.

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## Contents

1. Background	1069
2. Energy sector characteristics	1070
3. Current building energy efficiency Policies	1071
4. Potential of energy efficiency in buildings	1073
4.1. Potential for commercial buildings	1073
4.2. Potential for residential buildings	1074
5. Assessment analysis methodology	1074
5.1. Analysis approach	1074
6. Energy savings, economic, and environmental analysis	1076
6.1. Energy savings analysis	1076
6.2. Economical and environmental analysis	1077
7. Program implementation considerations	1077
7.1. Cost-effectiveness analysis	1078
7.2. Job creation analysis	1079
8. Summary and conclusions	1079
Acknowledgment	1080
References	1080

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## Nomenclature

A/C	air conditioning
CFL	compact fluorescent lamp
COAG	Council of Australian Government
COP	coefficient of performance for air conditioning systems
EEMs	energy efficiency measures
GCC	gulf cooperation countries
GWh	giga kilo watt-hour ( $10^6$ kW h)
HVAC	Heating, Ventilating, and Air Conditioning
IEA	International Energy Agency

KD	Kuwaiti dinars (1 KD=\$3.33)
LCC	life cycle cost analysis
LED	lighting emitting diode
MENA	Middle East and North African countries
MEW	Ministry of Electricity and Water for Kuwait
MW	mega watts ( $10^3$ kW)
RT	refrigeration ton
UAE	United Arab Emirates
UN	United Nations
WBCSD	World Building Council for Sustainable Development
WWR	window to wall ratio

## 1. Background

Worldwide, buildings account for about 40% of the primary energy consumption [13]. In the Middle East and North Africa (MENA) region, buildings consumes even higher fraction of the primary energy consumption. For instance, 70% of energy consumption in Kuwait is attributed to buildings. Considering all the sectors (i.e., buildings, industry, and transportation), Qatar and Kuwait have the highest per capita carbon emissions in the world as depicted in Fig. 1 [29].

In the MENA region, Qatar and Kuwait have the highest per capita electricity consumption with 16,000 kW h/year/person and 15,000 kW h/year/person, respectively. It is should be noted that for several MENA countries including Kuwait, the majority of the electrical energy is consumed to operate buildings [11]. The trend for high energy demand for buildings in the Arab region is expected to continue over the next decade due to high population growth and significant urbanization. Indeed, the annual urban population growth rates in Arab countries range between 2% and

6% with an average for the region of 3.8% according to a UN-Habitat report [27]. As a result, the building sector is one of the fastest growing sectors in the Arab region. Specifically, according to a recent report, a total of \$4.3 trillion is forecasted to be spent on construction in the MENA region over the next decade, representing a cumulative growth of 80% [23].

Moreover, several MENA countries provide significant energy subsidies in order to reduce the electricity and fuel prices to their citizens. In particular, United Arab of Emirates (UAE) and Kuwait are the top two countries in the world for energy consumption subsidies per person with respectively, \$4172/person and \$3729/person. It is reported that for its 2012/2013 budget, Kuwait allocates KD 3.1 billion of the 6.3 billion subsidization for the consumer services to the electricity subsidization [9]. It is also reported that the actual costs during for generating and distributing electricity in Kuwait during 2011 is 37 fils/kW h (i.e., \$0.134/kW h) but it sold to the customers for only 2 fils (i.e., \$0.006/kW h), resulting in 95% subsidies from the government [21].

Carbon Emissions In Ton per Capita

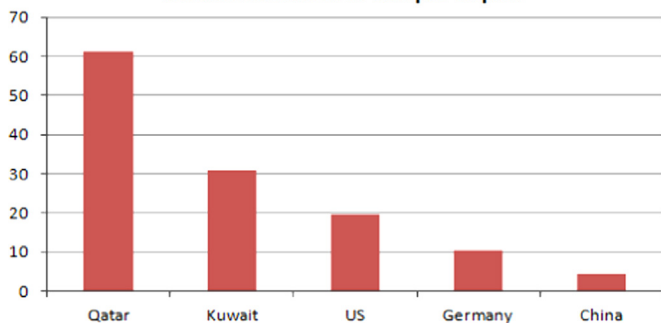


Fig. 1. Per capita carbon emissions for selected countries (Source of Data: WBCDS [29]).

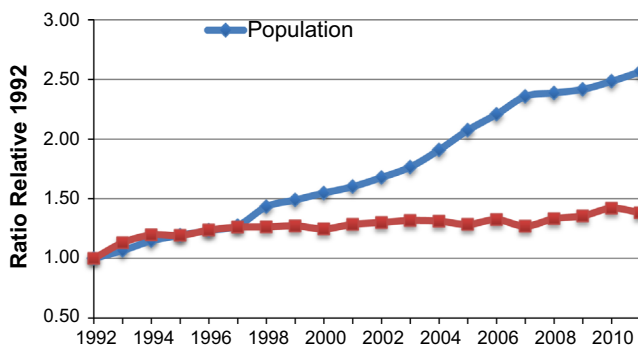


Fig. 2. Annual per capita energy use and population levels for Kuwait.

## 2. Energy sector characteristics

The Ministry of Electricity and Water (MEW) is the sole supplier of electricity and water resources in Kuwait. The increasing population in Kuwait and the scarce water resources is forcing MEW to increase its generating capacities with higher investments in new power plants. Indeed, over the last decade, Kuwait has seen its population as well as its per capita energy consumption increase steadily as shown in Fig. 2. The data obtained from MEW indicate that the energy use per person has more than doubled between 1980 and 2005 [22]. Moreover, the population has doubled from 1992 to 2005 due to high demand in labor force after the Iraq invasion of 1990–1991. The growth in the population combined with high energy use per person has significantly increased the requirements for electrical power generation to meet the national needs especially in the growing residential sector. In 2011, Kuwait has 8 electrical power stations with a combined capacity of 13,115 MW serving a peak load of 11,220 MW [22].

According to an IEA study [12], Kuwait has one of the highest carbon emissions intensity in the MENA region due to its high reliance on oil to produce electricity and desalinate water. Table 1 summarizes the CO<sub>2</sub> emissions intensity expressed in gCO<sub>2</sub>/kW h for select MENA countries during 2009. Kuwait generates 870 of gCO<sub>2</sub> for each kW h of electricity, significantly higher than the world average of 573 gCO<sub>2</sub>/kW h. It should be noted that countries that utilize natural gas to generate a significant portion of its electricity have low carbon emissions intensity. For instance, the share of natural gas in the total electricity generated in Qatar is over 85% [12].

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