

# Developing regulations to improve the energy efficiency of buildings in Arabian Gulf countries

S. Awawdeh and C. Tweed

*School of Planning, Architecture and Civil Engineering, Queen's University Belfast,  
2 Lennoxvale, Belfast BT9 5BY, Northern Ireland*

## ABSTRACT

As in other parts of the world, building legislation has been used since the 1980s by government bodies in the Arabian Gulf countries. These countries sought to reduce rising electrical consumption (6.7% per year) during the construction boom following the discovery of oil. Generally, however, these early regulations are limited in scope and have been implemented in a piecemeal manner across the different countries. This paper outlines the research strategy needed to develop the regulations further to improve the energy efficiency of buildings in this region according to their specific requirements and contextual conditions. The process of issuing regulations is complicated because of the number of parties involved and affected. It must consider carefully the targeted society, in addition to a meticulous selection of type and component of regulations, which must be based on scientific research and study. The paper also discusses the implementation process for regulations, which plays a key issue in assuring proper application by all parties.

## KEYWORDS

Gulf Countries, building regulations, energy conservation, context.

## INTRODUCTION

The Arabian Gulf countries<sup>1</sup> are among the fastest developing countries in the world mainly because of the discovery of oil within their territories. Their need to conserve energy in buildings has not been a major priority over the past two decades. However, there are signs this is beginning to change for two main reasons. First, for some of these countries, the end of a reliable supply of inexpensive oil to cool and power buildings is now acknowledged as a possibility, and even a certainty in the long term. Second, the cost of building additional electricity generating plants to cope with spiralling demand is now considered unsustainable. This paper considers how building legislation might be introduced to curb the excessive consumption of energy to cool buildings in the region. The main aim here is to describe the background context in which the legislation must operate and to consider the main areas that need to be addressed if new legislation is to succeed.

The Arab countries in the Middle East are united by a shared history, traditions, language, religion and similarities in geographical features and climate. Many are also united by the wealth they have gained through the discovery of oil within their

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<sup>1</sup> These countries include the United Arab Emirates (UAE), the Kingdom of Bahrain, the Kingdom of Saudi Arabia, the Sultanate of Oman, the State of Qatar and the State of Kuwait.

territories. The main problems facing building designers in the region are posed by the extreme climate, which ranges between hot-dry desert and hot-dry maritime desert. The latter is considered to be amongst the least favourable climates on earth and is characterised by high intensities of solar radiation, high humidity, low precipitation, small diurnal variations, and alternating land and sea breezes (Koenigsberger, 1974: Fry, 1982). The main energy requirement in buildings, therefore, is for air-conditioning to dehumidify and to cool.

## **THE IMPACT OF OIL ON THE GULF COUNTRIES**

The discovery of oil in the region has had a major impact. On 25th May 1981 the leaders of the above mentioned Gulf Countries met in Abu Dhabi, United Arab Emirates, and established a cooperative framework joining the six states. This framework aimed to effect coordination, integration and inter-connection among them in all fields to achieve unity, according to Article 4 of the GCC Charter (GCC, 1981). The GCC began the process of establishing legislation that would seek to curb excessive energy consumption in buildings, but this was only the first step towards reduction. The legislation was implemented differently in different countries and the scope of the legislation was generally limited. To make significant savings it will be necessary to consider more comprehensive legislation.

### **Development in the Gulf Countries**

Since the discovery of oil, the population of the region has grown exponentially. In 1970 the population of the GCC States was approximately 5 million. By 1980 this had doubled to 10 million, and by 2000 this had passed the 25 million mark (GCC, 2004). Much of the increase is due to the immigration of specialists and workers in different fields. As a result, the construction industry experienced a marked boom. Architects from different parts of the world compete in this region to use the latest construction technology and materials. As in other parts of the world, vernacular architectural techniques have been neglected and replaced by the mechanical equipment to provide a comfortable indoor climate in a very harsh climate.

The increased number of buildings relying on the air-conditioned systems has caused a continuous increase in electrical consumption, peaking during summer (Al-Rabghi et al, 1999). Air-conditioning is responsible for roughly 70% of peak load demand in Kuwait and 45% of the annual electrical consumption (Al-Marafie et al, 1989). Furthermore the electrical consumption per capita in the Gulf countries is within the world's highest.

## **CONSERVING ENERGY IN THE GULF COUNTRIES**

Much of the world became concerned about the possibility of unreliable energy supply in 1973. However, for the Gulf countries the issue of conserving energy was not addressed then because the procedures for promoting economic development provided a long planning agenda, and the discovery of oil was recent to the Gulf

countries. But it did not take them much time to realise the importance of conserving their main source of revenue for the coming generations.

### **The role of the Gulf Countries Council in conserving energy**

The Supreme Council of the GCC in their periodic meetings repeatedly note the importance of conserving energy for two main reasons: first the oil is their main national wealth, and so they must aim to save it for the longest possible period; and secondly, the high cost of establishing the electrical plants which increase their development budgets. These two issues directed the Electricity Ministers towards the role the building sector could play in reducing the consumption of electricity. The Electricity Administration in the General Secretariat prepared The Thermal Insulation bylaw in 1984 and it was issued as a recommendation at that time. It was based on other countries' experience, where building regulations proved to be an effective policy instruments used since 1970s to reduce the consumption of energy in buildings (OECD/EPOC/WPNEP, 2002; Petersen and Togeby, 2001). In addition to the developed countries experience and studies which assured the effectiveness of the use of thermal insulation in saving energy in buildings.

Due to rapid increases in electricity consumption in the Gulf countries the Electricity and Water Ministers decided in 1999 on the importance of the use of thermal insulation in all new buildings and asked the General Secretariat to address this issue to all competent authorities. However, insufficient reduction of electricity consumption led the Supreme Council on December 2002 to decide "the application of thermal insulation on all buildings and charged the ministerial committee in municipalities affairs to determine the levels of the insulation and to prepare the required control for the implementation." This decision was based on the Electricity Cooperation Committees' recommendations. It was the first mandatory action issued by the GCC, but it allows individual countries complete freedom to issue their regulations. This flexible decision led to various degrees of response by the Gulf countries as discussed below.

### **The role of individual government bodies**

Kuwait set the precedence for conserving energy. The Kuwait Institute for Scientific Research (KISR) began researching energy conservation in 1980. It was mainly directed towards energy conservation in air-conditioned (A/C) buildings (Al-Ajmi et al, 2003). The electricity ministers in the Kingdoms of Saudi, Qatar and Bahrain handled the responsibility of conserving energy in buildings. The federal state that joins the seven emirates in the United Arab Emirates explains the variance in the regulation between Abu Dhabi and Dubai the two main emirates, where Dubai started in 2003 with the mandatory application of thermal insulation while Abu Dhabi has yet to apply regulations and the same applies to Oman. Table 1 summarises the main aspects of legislation in different members of the GCC (ADMTP, 1994; DM, 2003; MMA, 1989; GCC, 1998; MMRA, 2001; MHME, 1999).

TABLE 1

Summary of the implementation of energy performance of buildings legislation in the Gulf Countries.

	GCC	Kuwait	Saudi	Qatar	Bahrain	UAE Dubai
	Date of introduction	1984, 2002	1983	1984 - 2001	1981 - 1989	1999
Mandatory/ Voluntary	voluntary	mandatory	mandatory	mandatory	mandatory	mandatory
Authority in charge	Electricity Administration in the General Secretariat	Ministry of Electricity, and KISR	Ministry of Industrial & Electricity and Ministry of Municipal and Rural Affairs	Ministry of Electricity and Water & Ministry of Municipal Affairs	Ministry of Electricity and Water and Ministry of Housing, Municipalities and Environment	Dubai Municipality and Dubai Electricity Authority
Targeted buildings	New governmental buildings-1985 multi story Commercial building-1986 Private buildings-1987		New government buildings 1984 multi storey Commercial buildings 1985	All new A/C buildings	All new A/C buildings	All new A/C buildings
Type of regulation	Building envelope	Building envelope	Building envelope	Building envelope	Building envelope	Building envelope
Walls	0.741W/m <sup>2</sup> C	0.57W/m <sup>2</sup> C	No specific values	0.741W/m <sup>2</sup> C does not apply for private buildings.	0.75W/m <sup>2</sup> C	0.57W/m <sup>2</sup> C
Ceiling	0.57W/m <sup>2</sup> C	0.399W/m <sup>2</sup> C	No specific values	0.57W/m <sup>2</sup> C	0.6W/m <sup>2</sup> C	0.44W/m <sup>2</sup> C
Glazing	Restrictions on the type of glass.	Shading required.  Double or reflective glazing for large areas	No restrictions	Shading required. <sup>2</sup>  Restrictions on the type of glass. <sup>3</sup>	Restrictions on the type of glass <sup>4</sup>	Restrictions on window U values and window design. <sup>5</sup>
Government to test and approve the material	Mandatory condition	Mandatory condition		Mandatory condition		
Standard details	Exist		Exist			
Colours of external facades		Must Avoid dark colours		Use light colours if possible		Use light colours

<sup>1</sup> Double or reflective glazing for buildings with more than four floors. And other buildings if glazing area  $\geq 10\%$  of total wall area.

<sup>2</sup> Provide vertical and horizontal shading devices.

<sup>3</sup> Double or reflective glazing on Government buildings if the glazing area  $<20\%$ , on private and commercial buildings with  $>4$  floors or  $>16$  unit. Other buildings if glazing area  $<10\%$  single,  $11\%$ -

15% reflective, 16%-20% double. Double and reflective glazing on government and other buildings if the glazing area >20%.

<sup>4</sup> If glazing area 10%-20% then U is < 5W/m<sup>2</sup>C and SC <0.5. If area >20% then U is < 2.4W/m<sup>2</sup>C SC < 0.44. For curtain wall U is < 2.1W/m<sup>2</sup>C and SC <0.25. For sky light U is < 2 W/m<sup>2</sup>C and SC <0.25.

<sup>5</sup> If glazing area 10%-40% then maximum U is 3.28W/m<sup>2</sup>C and SC 0.4. If glazing area >40%, or for sky light the maximum U is 2.1W/m<sup>2</sup>C, SC 0.35 and provide thermal break in the sections.

The table above shows that the adoption of the GCC bylaw by member countries of the Council is piecemeal and somewhat haphazard. In addition, the regulations mainly target the building envelope, specifying maximum U values for walls and roofs. But the glazing is such an important factor it needs to be addressed more carefully because of its effect on the cooling load in very hot climates with a very high solar radiation. Still other important techniques are missing which might increase the energy efficiency of the buildings, such as the use of efficient A/C equipment, efficient lighting system with the use of the day lighting and a suitable control system. In addition, there is scope to revive forgotten older techniques such as the orientation and shading systems to reduce the amount of solar radiation entering buildings.

## **POSSIBLE APPROACHES TO LEGISLATION**

There are very few studies and research that evaluate the effectiveness of the existing regulations and their implementation process. To make progress on reducing the energy consumption in these countries it is necessary to consider how legislation might work from a wider perspective.

Enacting energy efficient legislation in the Gulf region poses three main challenges for government bodies : (a) indifferent or even negative attitudes to energy efficiency shaped by "social, political and commercial processes" (Guy and Shove, 2000: Lam and Hue, 1996: Levine et al, 1994); (b) the current availability of cheap energy; and (c) the rapid construction taking place which does not allow for any changes that might delay it. Measures to reduce energy consumption, therefore, must consider five main aspects to consider:

- (a) the attitudes and values of the people who will be involved in the design and operation of new buildings—including, developer, owner, design team, contractors, suppliers and manufacturers and the end-users of the buildings;
- (b) the political and economic context in which the legislation will operate, including its existing limitations and barriers;
- (c) the range of scientific and technical solutions to the problem of high energy consumption in the Gulf countries—for example, the siting and design of the building and its surroundings;
- (d) the design of the regulatory instruments—for example, whether to use performance-based or prescriptive regulations; and
- (e) implementation and enforcement of legislation and the cooperation between agencies (Lam and Hue, 1996: Janda and Busch, 1993).

The research aims to provide the related government bodies in the researched countries with a comprehensive list of the best techniques that would reduce the consumption of electricity for the new high-rise buildings, but which also takes

account of the social, political, economic and cultural context in which legislation and technical solutions are expected to operate.

## CONCLUSION

This short paper introduces the main aspects of a research study aimed at developing legislation and other measures to reduce the demand for energy in buildings in the Arabian Gulf. The current state of legislation in a range of these countries has been described and the paper also identifies the main areas that need to be addressed in the remaining research.

## References

- Abu Dhabi Municipality and Town Planning (ADMTP), (1994) "The act of regulating the building works and the related executive bylaw" (Arabic).
- Al-Ajmi, D., Al-Awadhi, N., and Maheshwari G.P (September, 2003). Energy Conservation in Kuwait: An Environmental and Economic Perspective, *Proceedings of the 3<sup>rd</sup> LASTED International Conference, Power and Energy Systems*: 217-222, Marbella, Spain.
- Al-Marafie, A.M., Sur, R.K., and Maheshwari, G.P. (1989). Energy and power management and air-conditioned buildings in Kuwait. *Energy* **14**:9, 557-562.
- Al-Rabgi, Omar, Al-Beiruty, Mohammed H. and Fathalah, Kadry A. (1999). Estimation and measurement of electric energy consumption due to air conditioning cooling load, *Energy Conservation and Management* **40**:14, 1527-1542.
- Dubai Municipality (DM), 2003, Administrative Resolution No. (66) Of 2003, approving regulations on the Technical Specifications for Thermal Insulation Systems and Control of Energy Consumption for Air-Conditioned Buildings in the Emirate of Dubai.
- Fry, M. & Drew, J. 1982, *Tropical architecture in the dry and humid zones*, 2d edition, R.E. Krieger Pub. Co., Malabar, Fla.
- GCC, Cooperation Council for the Arab States of the Gulf, the General Secretariat, (1998). Draft Thermal Insulation Law. Economic Affairs, Electrical and Water Administration. (Arabic).
- GCC, Cooperation Council for the Arab States of the Gulf, (1981). The Cooperation Council – Charter, <http://www.gcc-sg.org>
- GCC- Cooperation Council for the Arab States of the Gulf- Secretariat general- Information Centre – Statistical Department, (2004)
- Guy, S. and Shove, E. (2000). *A sociology of energy, buildings, and the environment: constructing knowledge, designing practice*. Routledge, London.
- Janda, K.B. & Busch, J.F. 1994, "Worldwide status of energy standards for buildings", *Energy* **19**:1, pp. 27-44.
- Joseph C. Lam and S.C. M. Hue 1996, "A review of building energy standards and implications for Hong Kong", *Building Research and Information* **24**:3, pp. 131-140.
- Koenigsberger, O.H. (1974). *Manual of tropical housing and building*, Longman, London.
- Leth-Petersen, S. and Togeby, M., 2001/7. Demand for space heating in apartment blocks: measuring effects of policy measures aiming at reducing energy consumption. *Energy Economics* **23**:4, pp. 387-403.
- Levine, M.D., Koomey, J.G., Price, L., Geller, H. & Nadel, S. 1995, "Electricity end-use efficiency: Experience with technologies, markets, and policies throughout the world", *Energy* **20**:1, pp. 37-61
- Ministry of Housing, Municipalities and Environment (MHME), Kingdom of Bahrain, (1999). Decree No. 8 for year 1999 regarding thermal insulation bylaw for buildings.
- Ministry of Municipal Affair (MMA), Qatar, (1989). Ministerial decree No. 6 for year 1989 regarding the technical specification for building to conserve electrical consumption. (Arabic)
- Ministry of Municipal and Rural Affair (MMRA), Kingdom of Saudi Arabia (2001). Thermal Insulation in Buildings.
- OECD/EPOC/Working Party on National Environmental Policy 13-Jun-2002, Case Studies on Policy Instruments for Environmentally Sustainable Buildings, OECD, 2002, France.