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Vulnerability of the Emirati Energy Sector for Disaster: A Critical Review

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Abstract

Infrastructure in all its forms is a valuable asset and vulnerable to any natural or manmade hazard. The protection of infrastructure is thus one of the most important and difficult tasks for any government. The energy sector dominates in the UAE and consists of various assets - electricity, oil and natural gas that are geographically dispersed and connected by systems and networks. The protection of these systems and assets and within the energy sector especially, the safeguarding of oil and gas infrastructure from any and all internal and external threats should become top priority in the UAE. Threats to geopolitical and economic stability that need to be considered and prepared for include tectonic activity, climate change, nuclear energy, terrorism and war. This paper explores the disaster vulnerability of the Emirati energy sector with specific focus on Abu Dhabi and Dubai cities. It is based on secondary data, taken from various academic and professional sources, and primary data from a questionnaire survey administered on site at two electricity-generating plants in Abu Dhabi and Dubai. Forty questionnaires were distributed and 35 were returned back- 20 Abu Dhabi and 15 Dubai. Oil and gas sectors were identified as the most vulnerable energy sources in both Abu-Dhabi and Dubai. Risk from terrorism was thought to be the greatest hazard with every single respondent choosing it. This was despite the fact that respondents believe it to be one of the threats that the energy sector is prepared for.

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1. Introduction

Hazards, either natural or anthropogenic in origin, are converted into disasters by a complex mix of the overall environment and other interacting external factors. In the last decade (2000-2011) 2.7 billion people have been affected by hazards, 1.1 million of which were killed at the cost of \$1.3 trillion (UNISDR, 2012). The cost in 2011 was the highest on record and since 1973 disaster statistics have seen a rising trend (UNISDR, 2012; Guha-Sapir et al, 2003). Developing nations in particular are vulnerable to natural hazards and ill prepared for terrorist based threats and activity. Any disaster they experience is likely to have grievous consequences from both a loss of life and infrastructural perspective (Petley et al., 2012). Infrastructure in all its form is a valuable target to any kind of attacker and vulnerable to any natural hazard. One of the highest priorities for state authorities is to shield them from any such occurrences and minimise serious impacts on the health, safety, security or economic wellbeing of citizens (Wuchte, 2012).

This research specifically looks at the disasters that have frequented the United Arab Emirates (UAE), or at least have the potential to do so. A special emphasis is placed on and the effect disasters have on the energy sector, its personnel and infrastructure. The range of disasters that the UAE could face is appreciable given that they could stem from tectonic activity, climatic change and even terrorism. These threats are as complex and diverse in origin as they are in effect. Energy dominates the UAE especially in terms of energy production and supply. Indeed, future energy requirements are expected to grow at a rate of 9 per cent per year - three times the global average (Gulfnews, 2013). Unlike other countries it does not need to be overly concerned about where its energy comes from given its substantial oil reserves. Rising natural gas demand nationally, has however, turned the UAE into a net gas importer, despite its relatively plentiful reserves. Furthermore, the country does need to consider the wider issues that could threaten or damage energy security and subsequently its financial recovery and growth.

Preparations for any potential disaster have been slow and have featured on a national scene at an appropriate scale only recently. In short, it has only been part of the UAE political focus and policy within the last few years. It is important that preparations and planning are made that are in proportion to any potential threat. This is particularly advantageous given the natural and man-made disasters that potentially threaten the nation, its stability and its energy. This paper explores the disaster vulnerability of the Emirati energy sector and specific focus is given on Abu Dhabi and Dubai.

2. Critical Infrastructure and Energy Facilities

Undoubtedly, national security, economic prosperity and the quality of life for most people in modern society depends on the continuous and reliable national of public infrastructures – most of which are interdependent. Infrastructure in all its forms is a valuable target to any kind of attacker and vulnerable to any natural or manmade hazard. The protection of infrastructure is thus one of the most important and difficult tasks for any government and national security. This is because infrastructure is so large that it is logistically and economically impossible to protect absolutely everything from a potential attack or natural event. Therefore one of the highest priorities for state authorities is to shield critical infrastructure and not just infrastructure per se from any detrimental occurrences and minimise serious impacts on the health, safety, security or economic wellbeing of citizens (Wuchte, 2012). Critical infrastructure, as adapted from the U.S Patriot Act, is considered to be not only physical assets but also virtual systems so vital to the state that the incapacity or destruction of such systems would have a debilitating impact on security, national economic security, national and/or public health or safety. It is thus taken to embody components that contribute to the wellbeing of a nation and which are essential to the chemical sector, transportation network, defence security, telecommunications, banking and finance, water utilities, public health system, emergency services and the energy sector (i.e. electricity network, power plants etc.).

The energy sector of any given developed or emerging country consists of various assets - electricity, oil and natural gas that are geographically dispersed and connected by systems and networks. A nation's (or region's) energy infrastructure provides fuel for and to the people, which in turn depends on the existing transportation, communications, finance and infrastructures (Kolevan, 2007). Critical energy infrastructure includes physical facilities, supply chains, information technologies and communication networks which, if destroyed, degraded or rendered unavailable for an extended period, would significantly impact on the nation or affect its ability to ensure

national security. For that reason one should not look at critical infrastructure as a collection of geographically defined objects but rather see it as something – a network, which goes beyond and is not confined by the boundaries sketched out. Neither is critical infrastructure necessarily confined to one particular sector, as there are in fact many potential overlaps. When critical energy infrastructure is down, transport may also be affected for example, with electricity lines possibly blocking roads and cutting access, making transportation difficult if not dangerous.

The need to face the challenges of critical infrastructure is recognised in the 2003 U.S. National Strategy for the Physical Protection of Critical Infrastructure and Key Asset. The first objective of this strategy centres on the identification and protection of assets, systems and functions that deem to be critical for public health, governance, economic security, national security and public confidence.

That said and according to Flammini (2012): *Little progress has been made towards a unified approach to critical infrastructure protection even though more than 250 tools and methods currently exist for evaluating criticality in infrastructure. Identification and prioritisation of the most critical components of critical infrastructure remains a challenging intellectual problem-* (p 4)

It is believed that assigning criticality levels, despite the lack of consensus can be said to be associated with the contribution (real or even perceived) that a given infrastructure has in maintaining the dependent society at a minimal level of national, regional and international law and order. This level will in turn relate to aspects of public safety and health, the state of the economy and the environment.

According to Critical Infrastructural Directive 2008/114/EC, there are three cross-examined aspects involved in any assignation of criticality:

- The number of casualties
- The economic impact (including potential environmental effects)
- Public impact (psychological and political)

All infrastructures particularly that of the highest criticality needs to become more resilient through vulnerability assessments, continuity of operations planning, and deliberate investment in cost-effective technologies, which improve the capacity of service providers and public authorities to maintain those critical functions (Auerswald et al., 2005). The protection of these systems and assets and within the energy sector especially, the safeguarding of oil and gas infrastructure from any and all internal and external threats should become the top priority (Bi, 2006). One important issue to the long-security of a national or even a regional energy system is the failure of international supply, whether on technical or political grounds. Any resilient energy network requires cooperation and the shared interests of all involved to work towards protection from “shocks”. This is especially the case if long-term resilience is regarded as a secure supply. Resilient critical infrastructure, based on Olinsky-Paul (2013) is defined by the author as that which has the self-sustaining ability to supply emergency electricity provision during outages where normal operations are absent or disrupted.

3. United Arab Emirates in Context

The UAE is located between latitudes 22.0° and 26.5° N and 51° and 56.5° E. Collectively the Emirates and its archipelago that extends over the Arabian Gulf cover 83,600 sq km. The Emirati coastline extends approximately 700 kms. The country shares land borders with Qatar to the west, Saudi Arabia to the south and west and Oman to the east and south. Four-fifths of the UAE’s land mass is desert. The highest altitude is 1,500 m in the Hajar Mountain range that extends into the northeast region and into Oman. Other landforms occur along the extremely shallow and gently sloping continental shelf of the Arabian Gulf where there are various offshore islands, salt marshes and coral reefs. The littoral zone of the UAE is characterised by active coastal sabkhas, or salt flats (Doherty, 2009). In 1980 the total population was 1 million. It increased to 8.4 million only 30 years later. By 2050 the UN expects this figure to reach 15.5 million (EUAWEW, 2011). In 2004 the three most populous Emirates were Abu Dhabi, Dubai, and Sharjah. Collectively they accounted for roughly 85% per cent of total population. The overwhelming majority of the population lives in urban areas in coastal zones, which is also prone to a vast number of natural hazards and manmade threats.

The climate is arid and subject to ocean effects due to the proximity of the Arabian Gulf and that of Oman. The coast brings humidity along with very high temperatures during the summer months. The Al Hajar al Gharbi Mountains due to the high altitudes create generally cooler weather conditions. There are two seasons: winter, from

November through to March and summer, which is from April to September. In the former temperatures are generally mild, given that it is rare that they ever fall below 6°C. In summer, conditions can be extreme reaching 48°C and 90% humidity at the coast but normally oscillating between 50-60%. Inland humidity is lower at around 45% but temperatures are known to climb to 50°C. As one might expect rainfall is few and far between. Any abnormally high rainfall, which is usually tied to the combination of winter Shamal and atmospheric depressions, makes for headline news. In November 2013 heavy flooding caused a number of minor injuries and one fatality when a man was swept from his vehicle. Medical staff stated the need for careful and considerate driving (Hasan 2013). Likewise, in February 2014 heavy rainfall and unusually cold conditions made headlines with traffic generated and drivers urged to exercise caution (Kazmi 2014). Summer rainfall is infrequent outside of the mountainous and south-eastern regions (which experience 140- 200 mm/yr). Whilst rainfall is typically low, even in the wettest months of February and March, evaporation is considerable averaging 8 mm daily (Ministry of Energy 2006).

4. Critical Energy Infrastructure in the UAE

The Arabian Gulf is shallow, about 200 meters or less in most areas. The gulf water moves slowly and has limited tidal waves. That said and as observed by Hafez and Halim (2007), the terrain is flat, most of the oil installations are either on the shore or in shallow water areas, major oil fields are either in the shallow area of the gulf or in the desert adjacent to the gulf shores. Severe weather is not likely but can include large tidal waves or sea storms. Terrorism presents a key issue, which could easily affect the geopolitical stability of the region, if not the entire globe (given the number of energy installations), global trade, economy and operations.

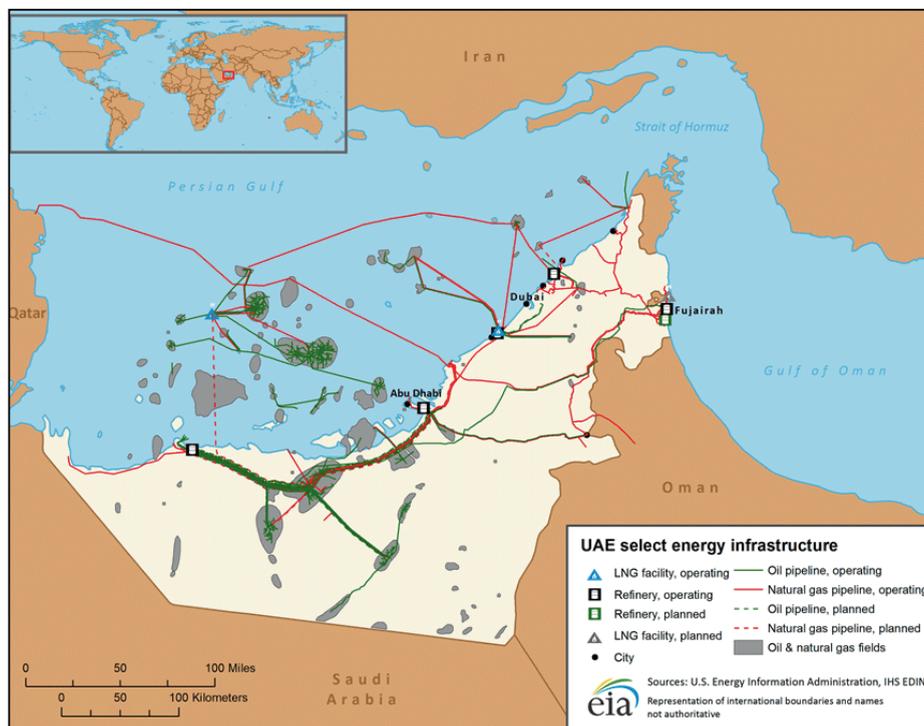


Figure 1: Key energy infrastructure in UAE. Source: U.S. Energy Information Administration (2013)

The energy sector dominates in the UAE and the gulf region generally (please refer to Figure 1). The Emirati economy is the second biggest regionally after Saudi Arabia and remains on course for five per cent growth protection within the next four years –largely due to rising oil prices (Kazmi 2014). Added to this, 2010 saw the

total value of construction contracts awarded in the UAE in the energy sector almost triple to \$8.8 billion (Dh32.32bn) for the period of January to May, from \$3bn against the same period in 2009 (Nambier, 2010). The energy sector is therefore very much an economic powerhouse responsible for the positive development of the nation. Some OPEC nations and many non-OPEC nations have seen production decline over the last five years, but the UAE has increased its total production of crude oil by approximately 31 percent and thus plays a highly significant role in global energy markets (EUAEW, 2011). Energy security and supply are equally a priority for a country that has built its reputation as the region's most stable country, both politically and economically with attractive business opportunities that are not found elsewhere (Dalli and Wilcox, 2006). The new development of nuclear power at Braqa, 33 miles from the coast provides another prime reason for comprehensive strategic planning in the mitigation of disaster. The technological choice of Generation III "APR1400", which has enhanced safety features such as longer plant life (normally 60 yr), enhanced user-friendliness, and higher burn-up rates and reduced fuel consumption and waste production (Al Farra and Abu-Jijleh, 2012) is a good example of man-made prevention (as opposed to hazard preparation).

It is irresponsible to ignore the UAE's vulnerability to various natural and man-made hazards. As development continues, the country and its people become even more vulnerable to the effects of those hazards. The issue of disaster is particularly acute on the coast where the highest population densities, the large number of high-rise buildings and commercial/residential structures are located. Ill-planned urban development has, rather than abated disaster, intensified it. Preparations for any impending disaster have been slow and in fact, due to the country's recent establishment, large-scale disaster preparation has featured on a national scene at an appropriate scale only recently. Every year brings more encompassing disaster management legislation and initiatives (Al Ghanim, 2010). In 2007, for example, a national emergency strategy was set-up to ensure a prompt coordinated and efficient response to any potential disaster (Al Kindi, 2007). This is particularly important because of the four-fold nuclear reactor development at the coast of Barakah and the crippling effect of the Japanese Tsunami, which bought one of the world's best-prepared nations to its knees. The UAE must act in a proactive manner and must subsequently develop an appropriate disaster management strategy before any disaster event occurs.

5. Research Methodology

The primary research of this study involved questionnaires consisting of both qualitative and quantitative style questions, in order to examine the disaster vulnerability and preparedness of the UAE energy sector. They were conducted in the official language of the UAE, Arabic. The location was at two electricity generating plants, one in Abu Dhabi and one in Dubai.

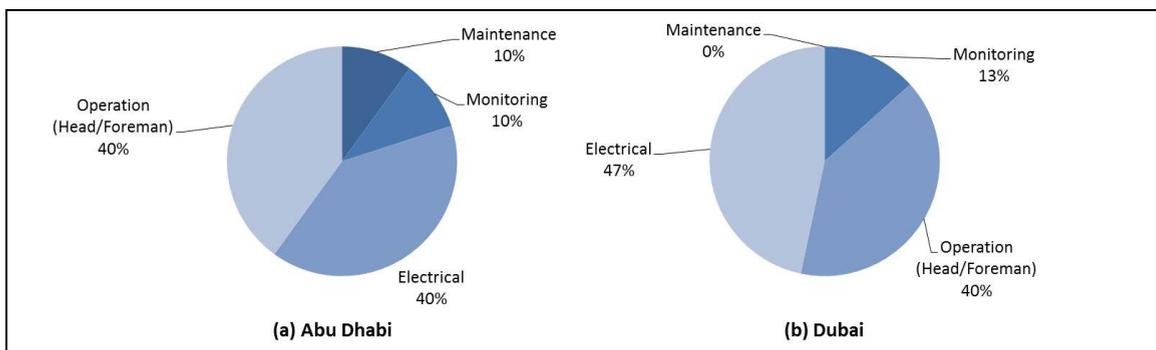


Figure 2: Work area distribution of the respondents (a) Abu Dhabi (b) Dubai

Forty questionnaires were distributed and 35 were returned back (20 Abu Dhabi and 15 Dubai) with 5 refusals. All were male and most aged between 30-40. The mean number of years employed at the Abu Dhabi plant was 4.5, a figure slightly higher than the years of experience in the current position at 4.4. In Dubai the mean of the years employed was lower 4.2 and likewise the years of experience in the current position was 3.8. Figure 3 shows the

work area distribution of the respondents. All respondents belong to either the operational or technical area, who have the most direct contact with any threats in the field.

The questionnaires contained both qualitative and quantitative questions and most were multiple choices or structured in a matrix. In the latter the respondent was given a scale of 1 to 10 with which to make his choice. In addition, yes/no answer options were often used. In order to ensure a collective understanding of the questionnaire and the purpose behind it, an information session and introduction by the researcher was given.

- The questionnaire contained questions on the following topics:
- Vulnerabilities of Emirati Energy Infrastructure
- Hazards that threat Emirati Energy Sector

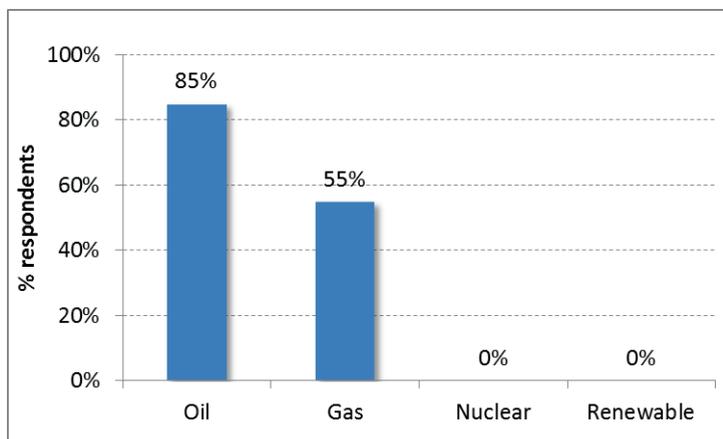
Steps in data analysis included: (i) editing and coding survey data, (ii) processing them in proper software, (iii) providing a descriptive statistical analysis for all the questions to generate insights. There are three basic measures of central tendency—mean, median and mode. In order to give some quantitative indication of the results, such as relative preparation for example, an index using the mean was constructed for each situation. Following section presents the findings from the questionnaires survey on preparedness of Emirati Energy Sector.

6. Results

6.1. Vulnerabilities of Emirati Energy Infrastructure

One of the questions broke down the Emirati energy sector into its constituting components- Oil, Gas, Nuclear and Renewable, and asked respondent to identify which are the most vulnerable sectors. All selected fuel exploration and supply (Oil, gas) as the most vulnerable and attributed to the higher risk on the followings:

- Mechanical or electrical risk (up to 80% of respondents)- which is related to the complexity of the equipment and techniques, high voltage, probability, of failure etc. ;
- Chemical risk (up to 60%) - mainly associated with the use of substances, flammability and the risk of leakages;
- Explosions;
- Oceanic exploration risk (up to 27%)- as operations out to sea are more complicated and riskier than their terrestrial counterparts; and
- Social risk (up to 20%)- due to the potential of the energy sector forming a terrorism target.



(a) Abu Dhabi

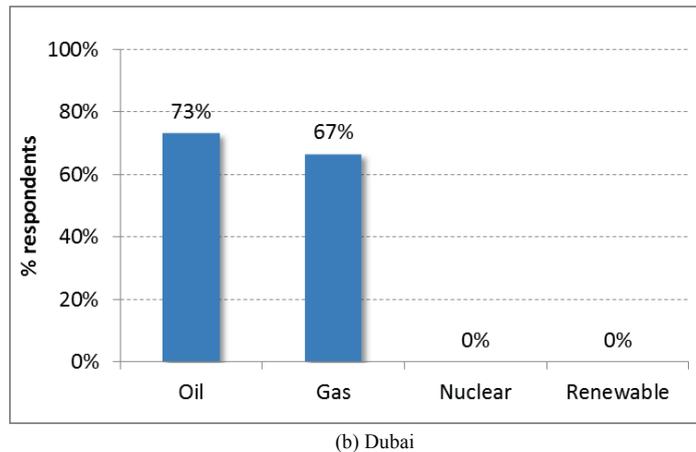


Figure 3: Most resilient energy source to natural and man-made hazard (a) Abu Dhabi (b) Dubai

As it can be seen from Figure 3, oil and gas sectors were identified as the most vulnerable energy sources in both Abu-Dhabi and Dubai. Renewables energies along with nuclear were chosen as the least vulnerable energy sources to natural, social or technological hazards. This may be due to their limited influence in the current energy provision. The nuclear plant at Brakah is still being built and is not expected to produce electricity until 2017. Likewise no wind power is established and remains in the planning stage (Al Mazrouei, 2013). Limited strength in renewable provision may also relate to the limited attention on renewable policy until after the undertaking of the questionnaire. Indeed, following the appointment of Al Mazrouei as Energy Minister and the subsequent commitment to renewable option there has been increased interest in renewable energy solutions. Under Al Mazrouei, Abu Dhabi, with its investments in Masdar aims to get 7 percent of its power from renewable sources by 2030. Neighbouring Dubai meanwhile is building a massive, 1 GW concentrated solar array that will be the largest in the world helping Dubai reach account for 5 % of renewable supply by 2030 (Dreazen and Belogolova, 2013).

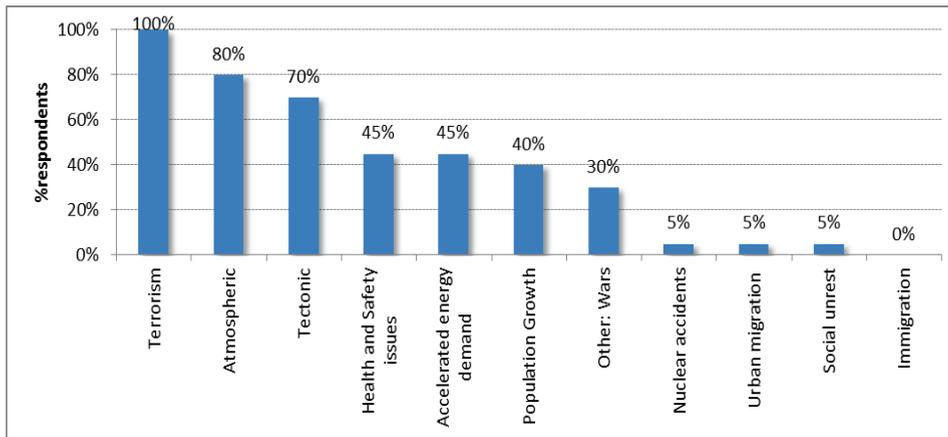
Should coverage of renewable energy be increased further it is likely that renewable energy will become the less vulnerable option for the energy sector given that there is widespread recognition from the respondents regarding the benefits of renewable energy sources:

- Clean energy (85% of the respondents), meaning no physico-chemical risk of flammability or explosions.
- Renewables energies at the moment are not currently considered to be a terrorist target (55%)
- The operation is less risky mechanically and electrically and because they consider renewable land options on land they feel that any negative issues would be less severe (50%)
- Consequently the operation and equipment is perceived as less complex (35%)

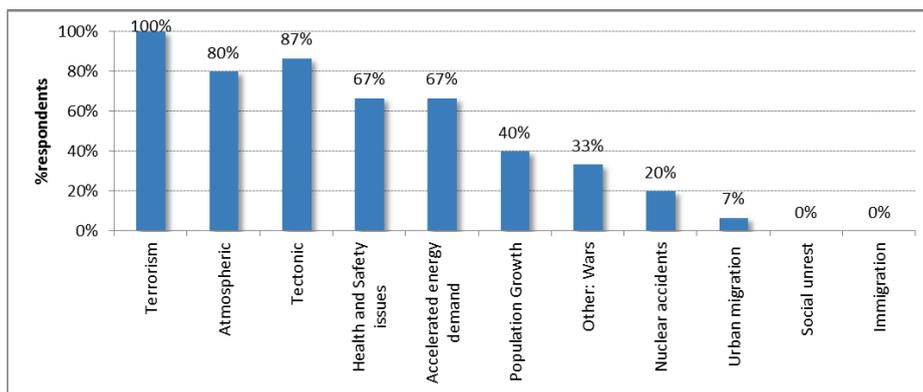
Subsequently, 100% of respondents said that renewables were safer and more environmental friendly than the other categories such as oil, gas or nuclear. Many do see it, however as a simple technology from an economic and technical point of view. However their opinion is not supported by literature on the subject. Whilst it is true, compared with conventional options, that the impact of renewables is negligible the extent of renewable impact on the environment is still far from certain (Moriarty and Honnery, 2012), others argue. Furthermore, despite 35% stating the simplicity of renewable energy, it is by no means a “simple” technology (Kunze and Busch, 2011; Outhred et al, 2007).

6.2. Hazards that threat Emirati Energy Sector

As part of the questionnaire, another question examined the main hazards that cause vulnerability within the energy sector apart from climate change. Risk from terrorism was thought to be the greatest hazard with every single respondent choosing it. This was despite the fact that respondents believe it to be one of the threats that the energy sector is prepared for. The other hazards included primarily the cause of wars as the most concern. The respondents consider risk from “wars”, which is likewise related to threats of a social origin, even though it was not part of the questionnaire (it was placed under “other”).



(a) Abu Dhabi



(b) Dubai

Figure 4: Coverage of the causes of vulnerability in energy sector (a) Abu Dhabi (b) Dubai

War and terrorism are seen as key threats to the Emirati energy sector. In fact more than 50% of respondents stated “terrorism” as the greatest risk. This is, in some respects, unusual because of the lack of geopolitical instability in the country. There have been regional issues such as historical problems with Iran or the political climate in Arab regions following the Arab Spring. Climate change is also recognised as an issue.

7. Conclusions

Despite the fact that only the UAE and Oman have been terrorist incident free, man-made threats remain a possibility. The cause for concern is increased in light of the lack of national preparation for man-made disasters. The UK Foreign and Commonwealth Office state (October 2012) that the threat of terrorism is “high” and that

“terrorists may be planning to carry out attacks. The US also remains concerned about the close proximity of Iran for both nuclear and terrorist activity. Potential threats to national stability stemming from regional uprising since the Arab Spring 2011, terrorist activity and nuclear associated issues are also a national concern. The latter two are particularly important in light of the new nuclear development at Braqa which according to Al Farra and Abu-Jijleh (2012) is planned to consist of four APR1400 reactor units designed to produce up to 1400 MWe each for a total capacity of 5600 MWe. It is believed that this study should be extended across the entire energy sector to see whether the results of this questionnaire survey could be validated. Such results could then form the basis of the UAE’s future energy sector strategies for the development of resilience in the face of both man-made and natural disasters.

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