ENERGY EFFICIENCY IN THE BUILDING SECTOR IN THE MIDDLE EAST AND NORTH AFRICAN REGION

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ABSTRACT

As global warming is a major threat for each country worldwide, in particular however for the Middle East and North African (MENA) region, it comes not as a surprise, that seven out of the twenty MENA countries have already developed energy efficiency (EE) policies. The present paper is based on a literature research on the green building standards of these countries and outlines that Israel and Egypt present the most advanced examples for this policy. This research then proceeds a qualitative evaluation and a quantitative analysis, providing proposals related to EE measures upon the building sector of Israel and Egypt. Besides their similarities from a macroscopic point of view, Israel and Egypt have to adjust the proposed common strategies to their local needs and characteristics, because there are some stark differences: Egypt is expecting high annual economic growth rates and a significant growth of population, while in the case of Israel the energy refurbishment of existing building stock is necessary. The EE measures target mainly in electricity consumption and related CO_2 emissions reduction, because of the high cooling needs of the region. If full implementation of the Israeli green building regulations is established, then the residential building stock can achieve a reduction of up to 30% in the electricity consumption. The corresponding value for Egyptian would be 20%.

Keywords: MENA, EE, energy efficiency, green building, energy code, energy consumption reduction, Israel, Egypt.

1. Introduction

The objective of the paper is the solid understanding of the current situation in MENA region. The paper focuses on the two most developed MENA countries, considering EE in the building sector, Egypt and Israel, and proposes a roadmap for the implementation of EE in buildings through an evaluation of the potential and the elaboration of a strategy.

The MENA designation refers to 20 countries, namely Algeria, Bahrain, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Palestinian Authority, Qatar, Saudi Arabia, Syria, Tunisia, Turkey, UAE and Yemen (Meir *et al*., 2012). Along the lines of the actions of global community, MENA region has already developed a strong interest in energy saving measures. Due to the warm climate of the region, EE measures target mainly in electricity consumption, as the majority of buildings use air-conditioning units to meet their high cooling needs. Israel and Egypt have quite some differences and discrepancies: Israel has less than 10% of Egypt's population and nearly 1/50th of Egypt's area; yet it has almost 1,5 times higher GDP annual growth and almost 3 times higher GDP per capita (World Bank). However, the larger Cairo area alone has a population of almost 20 million and is amongst the ten most rapidly growing mega-cities. Furthermore, Egypt has oil and even more significant natural gas reserves and also an important respective industry, whereas Israel only recently discovered some more modest natural gas reserves and is now building the infrastructure for its utilization (OECD, 2011). As far as the building sector is concerned, Israel is a predominantly an urbanized country, while Egypt is still undergoing urbanization. In the buildings of both countries, there are significant indoor

environmental quality (IEQ) problems and consequently they have developed green building standards in order to achieve an improvement in IEQ and to ensure future energy savings. Both standards are applied on a voluntary basis and have not been widespread yet among developers and construction companies, despite that both countries have already signed the Kyoto Protocol. Finally, Israel has a leasing system for predominantly state owned land which affects development plans implemented by entrepreneurs, whereas Egypt is developing state funded residential projects, e.g. villages for university students, graduates and staff (Meir, 2015).

2. Qualitative statistical analysis

Green building codes and tools are examined and discussed over a range of issues such as their transformation into an integrated model, market reaction, economic incentive mechanisms for both constructors and end-users, enhancement of regulatory control, technological and scientific background and public awareness on this field. Consequently, a qualitative evaluation has been carried out, based on seven criteria that have been elaborated: tools' context, economic barriers, market reaction, institutional factors, technological sector, scientific education and public awareness.

As far as Israel is concerned, it came out that its tool, named SI 5281, does not consider social and economic aspects of sustainability; institutional assistance is provided upon the mandatory compliance of the tool, as it is a rather isolated document, not incorporated in the general building law. Moreover, there are no economic incentives for EE measures due to subsidized, low electricity prices with simultaneous high GDP and GNI levels. In addition, SI 5281 is being applied mainly for residential units, but without sufficient recording of the applications. Commercial and public sector prefer the internationally well recognized LEED. Finally, despite the high technological development of Israel, both in absolute terms and in comparison with the other MENA countries, it still lacks appropriate educated technical staff and awareness of end-users.

The qualitative evaluation of Egypt and its tool named GPRS pointed out similar constraints. The main difference is the absence of technological innovations in the Egyptian market, meaning that all the related sectors are in a weaker situation, compared to those in Israel. In addition, the absence of economic incentives for EE in Egypt, combined with extremely high subsidies on electricity and natural gas, at least until 2013, has a very unfavorable impact on EE measures. Still, since 2014 there are changes taking place, with energy subsidies being gradually reduced.

As a result a common policy pathway is proposed for both countries upon four fields, plan, implement, monitor and evaluate with corresponding actions in each field such as the mandatory implementation of the green building codes, the constant monitoring of the assessment stages, the adaptation of the evaluation tools to local needs and the raise of awareness and willingness-to-pay of all stakeholders, meaning developers and end-users. In turn, each action corresponds to specific measures aiming at specific goals. It is important to mention that besides the similarities of Israel and Egypt from a macroscopic point of view, there also stark differences between them and the proposed policy pathway has to be adjusted to the particular needs and characteristics of each one, meaning in particular to their socio-economic conditions and to their regulatory system.

3. Quantitative statistical analysis

3.1. Methodology

A quantitative statistical analysis of Israel and Egypt has been carried out, considering the EE in residential sector up to 2030. A medium term situation is presented for 2020, which is the target of the Kyoto Protocol. Both of these scenarios are compared to the business-as-usual (BAU) scenario using 2005 circumstances as a base line, the year of the official enforcement of Kyoto Protocol.

Reported data from well-known organizations have been collected and taken for granted about the national growth of each country. The rest of the data are estimations based on the above researches following the detailed procedure as follows:

- The annual change in population is recorded in the study of the United Nations (2013) for both countries. In case of Israel, it was added in total population of 2013 that has been recorded by

the World Bank so as to estimate the population in 2030, while in case of Egypt, the period 2014 to 2030 is covered by the study of the United Nations as well.

- GDP growth is recorded until 2013 in the World Bank official site for both countries, while the United Nations' study presents a forecast about Egypt for the next 3 years as. For the remaining years up to 2030 a 3% growth annually was assumed about Israel and a 3,5% annual growth was assumed about Egypt, values that are thought to be a representative one for the countries based on previous records.
- GDP values were taken for granted till 2013 based on the World Bank's indications. The annual GDP growth of 3% that it was referred above was added to the last recording in 2013 so as to estimate GDP values up to 2030.
- The Central Bureau of Statistics in Israel refers the number of dwellings constructed annually till 2013 (CBS, 2014). Following the trends of 2013, annual constructions up to 2030 were weighted on the total population of each year. To increase the reliability of measures, these estimations comprise the mean annual growth of 3% that was assumed for Israel. The total amount of dwellings in each year was approximated according to the population growth rates. In parallel, The African Development Bank Group through the web site *Open Data for Egypt* ($CAPMAS_1$) refers the number of residential units in 2006. Also, a value of 2012 is recorded ($CAPMAS_2$) The annual growth rate of residential constructions was estimated based on the growth rate between the years 2006 and 2012 in comparison with the corresponding population growth rates.
- As far as BAU (Business-As-Usual) scenario concerned based on electricity consumption by households until 2010 that has been recorded by the United Nations (2013), next years' consumption were estimated based on the trends of 2011, year of last recording, including the mean annual growth of 3% in Israel and an annual growth of 9.4% as it is referred in literature review (Georgy *et al*., 2007). CO_2 emissions from residential buildings up to 2011 are recorded (World Bank). Projections for the following years' emissions relied on the growth of electricity consumption in each corresponding year.
- Regarding the first abatement scenario, the change in electricity consumption was examined and consequently in CO_2 emissions, for the case that only the new dwellings after 2015 would be built along the lines of SI 5281 in Israel and of GPRS in Egypt. This would lead to respectively 30% and 20% reduction in electric power consumption in a building that would be "green", built according to their instructions.
- A long-term abatement scenario up to 2030 is presented later on. According to this scenario, not only new dwellings from 2015 and on are considered to be low-energy, but also the existing building stock is meant to be energy retrofitted. The rate of applying energy-efficiency improvements in the existing dwellings is suggested as follows: 4% of the existing building stock would be improved within 2015 and every year after that an increase of 5,7% in the number of retrofits would occur annually, leading to no buildings without energy-efficiency improvements in 2030.

3.2. Results

Israel: In the first abatement scenario, electricity consumption would be reduced by 5,77%, but they remain 46,43% above 2005 levels. In the second scenario, the corresponding percentage of reduction is 30% as all residential buildings would apply SI 5281 measures and electric power consumption remain only 8.78% above 2005 levels, meaning that within the following decade they will be less than 2005 values.

Egypt: In the first scenario, electricity consumption would be reduced by 15.25%, but they remain high above (680,87%) 2005 levels. In the second scenario, the corresponding percentage is 20% as all residential buildings would apply GPRS measures. However, electric power consumption and emissions still remain 637.10% above 2005 levels.

Based on the elaboration of all these indicators and assumptions, the main conclusion drawn is that as new buildings comprise just a tiny proportion of the Israeli building stock annually, approximately 1.6% (Parad, 2014), energy improvement measures should definitely be applied in existing building developments so as Israel to be able to fulfill its international obligations about climate change mitigation. As far as Egypt is concerned, given the annual growth in residential

sector of 9.4% of the previous years, it needs years to reduce consumption and emissions below 2005 levels, as constructions of residential buildings grow at a faster rate compared to population growth rate, due to high national growth that Egypt would like to have according to literature review. Hence, a scenario of 3.5% growth in residential sector (as GDP growth in the region) was examined and estimated the corresponding levels at 157,08%, that is thought to be more achievable in a few decades.

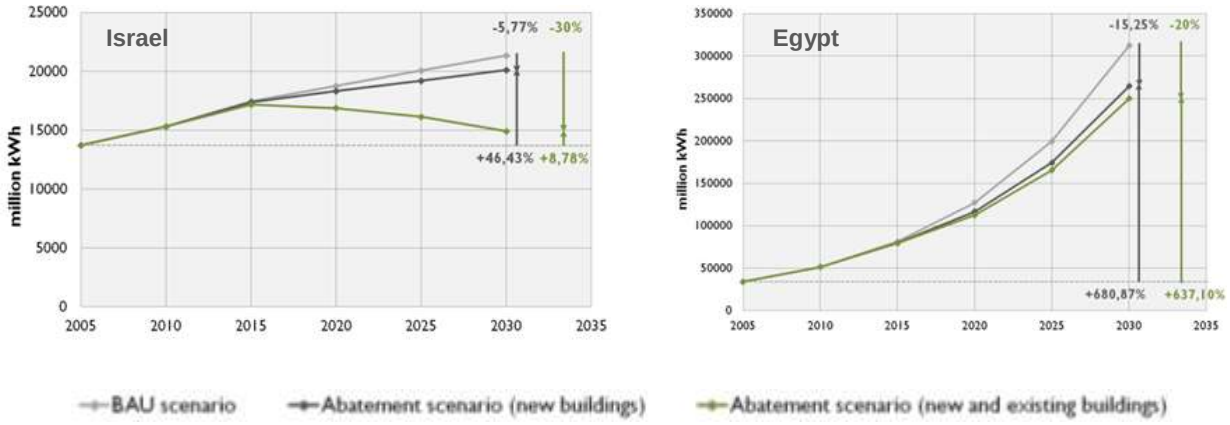

Figure 1: Residential building sector abatement scenarios in Israel and Egypt.

4. Conclusions

Ostensibly, the socioeconomic constrains that MENA countries currently face, indicate that EE measures are not a prime thought of their governments. However, a detailed analysis suggests that green buildings in the region can be considered as an imperative priority, as the MENA climate leads to increased energy consumption and hence costs.

Israel and Egypt have developed voluntary green building standards, but they still do not find a broad popularity. If barriers are lifted and full compliance is ensured, the Israeli regulation can lead to 30% reduction of electricity consumption, while the corresponding value in Egypt is 20%. It is worth to mention that in Israel the energy retrofit of the existing residential units seems to be the most effective way to change the consumption pattern, while the new constructions in Egypt sufficiently affects its pattern due to the high predicted construction growth, although simultaneously this growth leads to increased total energy consumption, compared to 2005. However, readers should bear in mind that the quantitative statistical methodology used is based on a top-down approach that needs constant revisions and updating of data in order to eliminate parameters of uncertainty.

To sum up, both case studies should be reviewed so as to ensure full implementation of the standards from the supply and the consumption side as well, so as to provide higher percentages of energy savings. As a result, a conceptual theoretical framework of common measures should be applied upon planning, implementation, monitoring and evaluation. This common policy seems to be representative for other MENA countries as well. Liu *et al*. (2010) point out that a green building code that shares structures and contents within a region enhances its adoption. In that sense, a future in-depth research in technology transfer of green building policies would be the key element for progress.

ACKNOWLEDGEMENTS

This paper is conducted in terms of the Master of Science in Energy Systems, funded by the State Scholarship Foundation, Programme IKY-Siemens 2013-2014.

REFERENCES

1. Meir I., Peeters A., Pearlmutter D. Halasah S., Garb Y., Davis J.M. (2012), Green Building Standards in MENA - An assessment of regional constraints, needs and trends, *Renewable and Sustainable Reviews*, **30**, 271-281.
2. World Bank Group (last access at November 2014), URL: http://data.worldbank.org/indicator.
3. OECD (2011), OECD Environmental Performance Reviews: Israel 2011 - Highlights, OECD Publishing, URL: http://www.oecd.org/env/country-reviews/48962516.pdf.
4. Personal contact with Professor I. Meir (2015), Ben-Gurion University of the Negev, Department of Man in the Desert, Desert Architecture & Urban Planning Unit.
5. United Nations, Department of Economic and Social Affairs, Population Division (2013), URL: http://esa.un.org/unpd/wpp/Documentation/pdf/WPP2012_ Volume-I_Comprehensive-Tables.pdf.
6. Central Bureau of Statistics of Israel (2014), Statistical Abstract of Israel 2014, Summary Table 22.1, 929-932, URL: http://www1.cbs.gov.il/shnaton65/st22_01.pdf.
7. Central Agency for Public Mobilization and Statistics of Egypt$_1$, (last access at November 2014) URL: http://egypt.opendataforafrica.org/mydmjdd/population-and-housing-census-2006-egypt.
8. Central Agency for Public Mobilization and Statistics of Egypt$_2$, (last access at November 2014) URL: http://egypt.opendataforafrica.org/hvgwdde/buildings-and-residential-units-1943-2012-egypt.
9. United Nations, Energy Statistics Database (2013), URL: http://knoema.com/UNSDESD2013/ un-statistics-division-energy-statistics-database2013? location=1001070.
10. Georgy R. Y., Soliman A. T. (2007), Mediterranean and National Strategies for Sustainable Development - Priority Field of Action 2: Energy and Climate Change, Energy Efficiency and Renewable Energy - Egypt: National Study, Plan Bleu, Regional Activity Centre.
11. Parad M. (2014), The Global Cleantech Innovation Index 2014, WWF and Cleantech Group.
12. Liu F., Meyer A. S., Hogan J. F. (2010), Mainstreaming Building Energy Efficiency Codes in Developing Countries – Global Experiences and Lessons from Early Adopters, *World Bank Working Paper*, No. **204**.