Energy Independent Residential Development for Dhaka City, Bangladesh

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Abstract

Dhaka, the capital of Bangladesh, has been predicted to be the 6th largest megacity in the world by 2030 with about 10 million additional people compared with the current population. This rapid urbanization is accompanied by a fast growing energy demand. On the contrary, the country is far behind in energy sufficiency thus the new developments are unlikely to be supported with adequate energy supply. Moreover, in the face of increasing greenhouse emission and resource depletion, traditional fossil fuel based energy is no longer an option. This research, therefore, is aimed at exploring the possibilities for energy independent residential developments in Dhaka in order to respond to these many challenges.

The research has been conducted by adopting a multimethod approach, which include different quantitative research strategies and techniques supported with a limited qualitative approach. The final outcomes of this research are based on experiments conducted through building performance simulations; however, the simulations are grounded on rigorous monitored data, which included different urban, building, micro-climatic and household parameters that influence household energy consumption. To investigate the urban and building contexts, 70 typical apartment buildings and 93 apartment unit plans were studied. Interviews have also been conducted with representatives from relevant professionals: real estate developers, practicing architects and academicians to understand the background to apartment developments. Micro-climatic conditions were investigated including by using air temperature data loggers. Household contexts were investigated through a questionnaire survey of around 400 residents. The information obtained from the existing situations studied were then analysed and used for the simulations to test various scenarios in order to derive the final outcomes of this research.

The research has identified several existing urban, building and household practices, alterations of which will result in substantial household energy consumption reduction. Best practice modifications of present ways are proposed and the findings indicate that applying these best practices can reduce the current energy consumption by at least thirty-nine percent. It is possible for residential developments in Dhaka to achieve energy independence, after reducing the consumption, by the installation of roof mounted solar photovoltaic systems and battery storage for each household; however, shifting to energy efficient appliances is vital in achieving this. Furthermore, the results indicated that not only the future buildings but also the existing buildings with minor retrofitting and utilizing energy efficient appliances and equipment can achieve energy independence.

The results of this research are expected to have an important impact on the future residential developments of Dhaka as the energy consequences of the current urban and building practices are now known. This will help the professionals to take more informed decisions towards building energy efficient developments in Dhaka. The results also provide a basis for the policy makers to update the existing building construction regulations as well as to develop energy policies to promote energy independent developments.

Although focusing on Dhaka, results from the research will also be useful for other cities in Bangladesh and elsewhere in the world facing similar socio-economic challenges.

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List of Acronyms and Abbreviations

BBS	Bangladesh Bureau of Statistics
BPDB	Bangladesh Power Development Board
BPS	Building performance simulations
BNBC	Bangladesh National Building Code
CR	Canyon ratio
CIA	Central Intelligence Agency
DCC	Dhaka City Corporation
DMA	Dhaka Metropolitan Area
DMDP	Dhaka Metropolitan Development Plan
DESCO	Dhaka Electric Supply Company Limited
DOHS	Defence Officer Housing Society
DPDC	Dhaka Power Development Company Limited
EEA	European Environment Agency
EIA	Energy Information Administration
EPA	US Environmental Protection Agency
FAR	Floor area ratio
GOB	Bangladesh Government
GDP	Gross domestic production
HDI	Human Development Index
GHG	Greenhouse gas
IDCOL	Infrastructural Development Company Limited
IEA	International Energy Agency
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
IPHA	International Passive House Association
IPS	Instant Power Supply

LC-ZEB	Life cycle zero-energy building
MPEMR	Ministry of Power, Energy and Mineral Resources
ZEB	Zero-energy building
PSMP	Power System Master Plan
PV	Solar Photovoltaic
PWD	Public Works Department
RAJUK	Rajdhani Unnayan Kartripakkha
REHAB	Real Estate & Housing Association of Bangladesh
RH	Relative Humidity
SHGC	Solar Heat Gain Coefficient
SHS	Solar Home Systems
SVF	Sky View Factor
SREDA	Sustainable and Renewable Energy Development Authority
TMY	Typical Meteorological Year
UHI	Urban Heat Island
UN	United Nations
UNB	United News of Bangladesh
UNEP	United Nations Environment Programme
UNDP	United Nations Development Programme
WB	The World Bank
WWR	Window to wall ratio

Publications

Publications arising from this research are listed below.

Parveen, R., Soebarto, V. & Williamson, T. (2015, September). *Investigating Urban Heat Island to derive alternative options for energy efficient residential developments, case study: Dhaka, Bangladesh.* Paper presented at the Architecture in (R)Evolution: 31st Passive and Low Energy Architecture (PLEA) Conference, Bologna, Italy.

Parveen, R. (2012, November). *Potentiality of energy-plus urban developments in developing countries. Case study: Dhaka, Bangladesh.* Paper presented at the 46th Architectural Science Association (ASA) Conference, Gold Coast, Australia. Available at http://anzasca.net/wp-content/uploads/2014/02/p60.pdf

Declaration

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Rehnuma Parveen

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***In the Far East**, there is a tree called the Chinese bamboo tree. This remarkable tree is different from most trees in that it doesn't grow in the usual fashion. While most trees grow steadily over a period of years, the Chinese bamboo tree doesn't break through the ground for the first four years. Then, in the fifth year, an amazing thing happens – the tree begins to grow at an astonishing rate. In fact, in a period of just five weeks, a Chinese bamboo tree can grow to a height of 90 feet. It's almost as if you can actually see the tree growing before your very eyes.*

… pursuing your dream is a sure thing if you just don't give up. So long as you keep watering and fertilizing your dream, it will come to fruition. It may take weeks. It may take months. It may even take years, but eventually, the roots will take hold and your tree will grow. And when it does, it will grow in remarkable ways. ***- Eric Aronson**, Para-1 and 7, 2009.*

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