Case Study Report

Food, Energy, Water and Waste management innovation in an urban context: a Qatar University Campus approach

Theodora KARANISA, Qatar University, Qatar
Imen SAADAOUI, Qatar University, Qatar
Helmi HAMDI, Qatar University, Qatar
Noora FETAIS, Qatar University, Doha, Qatar
Sami SAYADI, Qatar University, Qatar

Abstract

Climate change, population growth, and economic development are the drivers that make the need for a sustainable Food, Energy, Water and Waste Nexus more urgent than ever since the demand for food, energy and water is increasing together with the waste generation worldwide. University Campuses are urban communities that can be regarded as mini-cities since there is a big need for food, energy and water and they generate waste. Any successful applications and solutions tested on campus can be applied later on a bigger scale. Doha Living Lab implemented at Qatar University Campus, will attempt to design and develop productive and sustainable food systems that increase food security, enhance nutrition and strengthen resilience. With the main highlights being the urban scale greenhouse with minimum water use, open field cultivation, use of traditional and new crops and organic waste management the Doha Living Lab will try to produce food and close the loop of organic waste in the Campus.

Keywords

Urban, Food, Agriculture, Campus, Sustainable

1. Introduction

1.1 Food, energy and water nexus issues

Climate change, population growth, and economic development (FAO, 2018) make the need for a sustainable FEW Nexus more urgent than ever since the demand for food, energy and water is increased. Urban communities are very vulnerable in the coming changes as 66% of the total population will be urban by 2050 (United Nations, 2018) and food security is crucial. Food waste is another big challenge to tackle, as 30% of the total food produced worldwide gets lost or wasted throughout the food chain with respected losses in inputs (FAO, 2011) and yet, 795 million people are malnourished (FAO, 2015). Urban agriculture could be the key solution to the nexus with the effective use of water and energy, the use of new food crops and the application of the circular economy in the management of organic waste.

In Qatar, a hot and arid country with limited freshwater availability and 99.1% of the total population being urban (FAOSTAT, 2018), the need for a sustainable nexus is timely than ever. Food security is also a

national priority for the State of Qatar, in line with Qatar National Vision 2030 (Planning, 2008) and after the imposed embargo from the neighboring countries and allies in 2017. Up to then, Qatar was importing 90% of its foodstuff and since then the country has increased self-sufficiency in many goods, like fish, eggs and vegetables, however, the imports are still high (Qatar Ministry of Environment and Municipalities, 2020). In addition, Qatar is going through a silent water crisis as the demand is high and increasing mainly due to the economic and population growth (Hussein & Lampert, 2020). Moreover, Qatar is an important oil-producing country and even more important natural gas reserver with the highest CO_2 emissions per capita in 2017 at 49t, followed by Trinidad and Tobago at 30t, Kuwait at 25t and the United Arab Emirates at 25t CO_2 emissions (Ritchie, 2019).

1.2 FEW Nexus in Campus

University campuses are urban communities with a considerable need for food, energy, and water and waste generation and are notably contributing to the global environmental footprint. In 2020 there are approximately 250.8 million students and more than 29,400 universities worldwide (TopRanks, 2020). This will expand to 594.1 million students by 2040, making their impact more powerful (Calderon, 2018). Each campus has a significant population of students, research and scientific community, as well as residents. Mixed social and commercial activities are taking place including shops, food outlets, health medical clinics, and athletic facilities. Whereas campuses can be considered mini-cities, they have a major difference from other urban environments. The universities' scientific communities can be models for the whole community as they can test and disseminate new ideas. Their role is not only the advancement of science per se; it is advancing science in order to serve society (Verhoef & Bossert, 2019). Consequently, they can have an active role in the transition and move towards a sustainable future, enabling a social change, and having a positive influence on society (Malekpour, 2017).

2. Qatar University Case Study

2.1 Research Project

The Doha Living Lab is part of the ''Moveable Nexus: Design-led Urban Food, Water and Energy Management Innovation in New Boundary Conditions of Change'' Belmont Forum Project, led by Qatar University and funded by Qatar National Research Fund (QNRF). The short title M-NEX is the acronym of the key concept ''the Moveable Nexus''. The project's goal is to develop an integrated design methodology and Moveable Nexus that links complex location-specific FEW problems at the architectural, urban, and regional scales. The Moveable Nexus is a ''participatory design support platform'' deploying local resources by integrating different disciplines, expert knowledge and technology (Yan & Roggema, 2019), which will be implemented by Living Labs in different regions.

The M-NEX Doha Living Lab will attempt to design and develop productive and sustainable food systems that increase food security, enhance nutrition and strengthen resilience (Leung Pah Hang, 2016). In Qatar, the Doha Living Lab will be implemented at Qatar University Campus, an urban community of over 20.000 students and 1.000 faculty and staff members (Qatar University, 2020). Qatar University, est. 1973, is a public research university in Qatar, 7 km north of Doha's capital, 2 km from the Gulf shore, with a campus area 8.1 km^2 (2,000 acres). QU campus has its carbon footprint, with 3.33 metric tons average amount of CO_2e (carbon dioxide equivalent) emissions per person, staff, and students, and a total campus carbon footprint 63,732.98 metric tons of CO_2e in 2015 (Qatar University, 2017).

2.2 Doha Living Laboratory

Qatar University has already integrated the concept of sustainability through green practices and research activities. To this end, the Doha Living Lab will contemplate the Food, Energy, Water and Waste Nexus and integrate different fields, stakeholders and campus members. The facilities will include a production site composed of an urban scale nethouse, open-field plots and composting units to sustainably manage the organic waste generated within the Campus. Traditional crops and new food crops will be tested, cultivation methods with effective water and energy use will be implemented and the produced compost will be incorporated in open field cultivation plots. Moreover, local stakeholders and the whole QU Community will be actively engaged and participate in various farming practices at the production site. The community members will develop a long-standing knowledge of how to produce, harvest, postharvest manage and store food, acquiring important agricultural production skills, strengthening resilience among people and food systems.

Consequently, the Doha Living Lab will try to close the loop on the Campus in terms of food, water, energy resources, and waste generation through the following main axes: Water conservation and reuse techniques with the adaptation of a hydroponic farming method and use of TSE water for irrigation purposes, Organic Waste Management, Food production through the net house and open field farming and finally, Community engagement and training.

3. Future Research and impact

Universities can be models for the community as they can apply, promote, and disseminate new ideas. Any successful applications and solutions tested on the campus can be applied later on a bigger scale (Malekpour, 2017). Besides, the Moveable Nexus can be transferred to different bioregions on shared design principles, co-creative methodology and cybernetic technologies.

The implementation of the Living Laboratory will be the reference point for a larger scale application for the future Campus Master Plan or other urban designs. As the evaluation of a design is important, the environmental footprint of Food, Energy and Water (FEW) resources consumption and Waste processing will be calculated in the urban context in two scenarios: Present situation and future predictions, which depend on the choices the community makes towards a more sustainable lifestyle.

4. Acknowledgments

This research was made possible by the BFSUG award (BFSUGI01-1120-170005) from the Qatar National Research Fund (a member of Qatar Foundation). The statements made herein are solely the responsibility of the authors. The M-NEX is a project of Collaborative Research Area Belmont Forum led by Keio University in consortium with partners from Japan, Qatar, USA, Netherlands, United Kingdom, and Australia.

5. References

Calderon, A. J., 2018. Massification of higher education revisited. Melbourne, Australia: RMIT University.

FAO, 2011. *FAO Homepage.* [Online] Available at: http://www.fao.org/save-food/resources/keyfindings/en/ [Accessed 20 April 2020].

FAO, 2018. *The future of food and agriculture – Alternative pathways to 2050.* Summary version. License: CC BY-NC-SA 3.0 IGO. ed. Rome: FAO.

FAO, IFAD and WFP, 2015. *The State of Food Insecurity in the World 2015. Meeting the 2015 international hunger targets: taking stock of uneven progress.,* Rome: FAO.

FAOSTAT, 2018. *Country data: Qatar.* [Online] Available at: http://www.fao.org/faostat/en/#country/179 [Accessed 19 April 2020].

General Secretariat For Development Planning, 2008. *PSA, Qatar National Vision 2030.* [Online] Available at: https://www.psa.gov.qa/en/qnv1/Documents/QNV2030_English_v2.pdf

Gu, Y. et al., 2018. Environmental footprint assessment of green campus from afood-water-energy nexus perspective. *Energy Procedia 2018,* Volume 152, pp. 240-246.

Gu, Y. et al., 2019. Quantification of interlinked environmental footprints on a sustainable university campus: A nexus analysis perspective. *Applied energy,* Volume 246, pp. 65-76.

Hussein, H. and Lampert, L. A., 2020. A Rentier State under Blockade: Qatar's Water-Energy-Food Predicament from Energy Abundance and Food Insecurity to a Silent Water Crisis. *Water,* 12(4), p. 1051.

Leung Pah Hang, M. Y., Martinez-Hernandez, E., Leach, M. and Yang, A., 2016. Designing integrated local production systems: A study on the food-energy-water nexus. *Journal of Cleaner Production,* Volume 135, pp. 1065-1084.

Malekpour, S. et al., 2017. *Food-Energy-Water Nexus: Ideas for Monash University Clayton Campus,* Melbourne, Australia: Monash University.

MME Qatar, Food Security Department, 2020. *Qatar National Food Security Strategy 2018-2023.* [Online] Available at: http://www.mme.gov.qa/pdocs/cview?siteID=2&docID=19772&year=2020 [Accessed 2020].

Qatar University, 2020. *Qatar University Homepage.* [Online] Available at: http://www.qu.edu.qa/ [Accessed 11 August 2020].

Qatar University, 2017. *Results of Campus Carbon Footprint 2013-2015*. [Online] Available at: http://www.qu.edu.qa/ar/newsroom/esc/Results-of-Campus-Carbon-Calculator-2013%E2%80%932015-revealed, 2017 [Accessed 22 September 2020].

Ritchie, H., 2019. *Our World in Data Homepage.* [Online] Available at: https://ourworldindata.org/per-capita-co2 [Accessed 12 August 2020].

United Nations, Department of Economics and Social Affairs, 2018. *United Nations Homepage.* [Online] Available at: https://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html [Accessed 19 June 2020].

Verhoef, L. and Bossert, M., 2019. The University Campus as a Living Lab for Sustainability A Practitioner's Guide and Handbook. Delft University of Technology and Hochschule für Technik Stuttgart.

Webometrics, 2020. *Countries arranged by Number of Universities in TopRanks.* [Online] Available at: http://www.webometrics.info/en/node/54 [Accessed 14 May 2020].

Yan, W. and Roggema, R., 2019. Developing a Design-Led Approach for the Food-Energy-Water Nexus in Cities. *Urban Planning,* 4(1), pp. 123-138.

Zhang, P. et al., 2019. Food-energy-water (FEW) nexus for urban sustainability: A comprehensive review. *Resources, Conservation and Recycling,* Volume 142, pp. 215-224.