Towards Eco-friendly Green University: A Case Study of Benha University, Egypt

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Abstract. Sustainability is a challenge at the global level as well as for institutions of higher education, especially in Egypt. Benha University (BU) aims to transform itself into a green university by using UI Green Metrics Tools to make achieve environmental benefits. Data in all categories were obtained via (a) field observations at campus, (b) reports prepared by the international ranking unit of university. Results showed that, the strongest category score for BU was for energy and climate change (21 %) as well as education and research (31 and 24 %), while the weakest category score was water (16, 10 and 11%) for 2019, 2020 and 2021 respectively. BU was also found to have the highest energy and climate change of 21, 22 and 23% for 2019, 2020 and 2021 respectively. This is due to construction and renovation policies in BU by energy efficient appliances usage, smart green building implementation, renewable energy sources policies (Biodiesel, solar power, clean biomass and wind power), electricity efficient usage (hybrid power); greenhouse gas emission reduction program implementation, carbon footprint policies (Zero carbon) and increase number of innovative programs on climate change. In this way, the application of environmental management at BU led to an improvement towards an eco- friendly green university.

Keywords: Sustainability, Energy and climate change, Education and research, Green University, Benha University

1. Introduction

The goal of sustainable societies is a worldwide challenge, especially in Egypt. Recently, the Egypt's development has emphasized based on a sustainable development goal. Sustainable development is development which meets the needs of the present without compromising the ability of future generations to meet their own needs [(1)]. Wherefore, sustainable development is an enormous challenge because of the underlying current dependence on older, non-sustainable, cheap energy/resource paradigms. Human society has exceeded sustainable limits in terms of greenhouse gases emissions, climate change, water depletion, and waste disposal [(2)]. Environmental enhancement is that where there has been contamination or degradation, there needs to be reclamation and/or remediation so that the prior land use has been recovered and environmental protections from every activity adversely affect the environment, particularly the climate; this would mean aiming for a low carbon society [(3)], including the institutions of higher education, especially in Benha University.

Benha University (BU) is an Egyptian government university in the city of Benha, the capital of Al Qalyubiyah Governorate. It is one of the prestigious Egyptian public universities. It consists of 16 faculties and 36 special centers and units that serve the university and the community distributed over the university and has a modern scientific climate for technological advancement which encourages students to be creative and innovation and education based on skills development and competencies.

BU has five campuses (Benha 1, Benha 2, Moshtohor, Shoubra and Obour). BU campus requires a significant amount of energy and water to support its academic mission and research functions. The waste generated and air pollution (greenhouse gas emission and dust particles) emitted is significant. In 2019, BU committed to start to be a sustainable university in an effort to minimize environmental impact by using UI Green Metrics. Wherefore, efficiently managing the energy supply and demand will be considered in the future. The purpose of the current study was to determine the feasibility of boosting BU campus to the next step of being an Eco-friendly Green University.

2. Materials and methods

2.1. Site description

Benha University has five campuses (Benha 1, Benha 2, Moshtohor, Shoubra and Obour), as shown in to figure 1; and it is in the arid zone (total annual rainfall is 5 mm) with an average temperature of 27.5°C in summer and 13.3°C in winter. The wind speed is 12 km h^{-1} and generally blows from the north and northeast directions. This area encompasses a strange-mixture of anthropogenic activities (*e.g*. housing, agricultural and industrial ones).

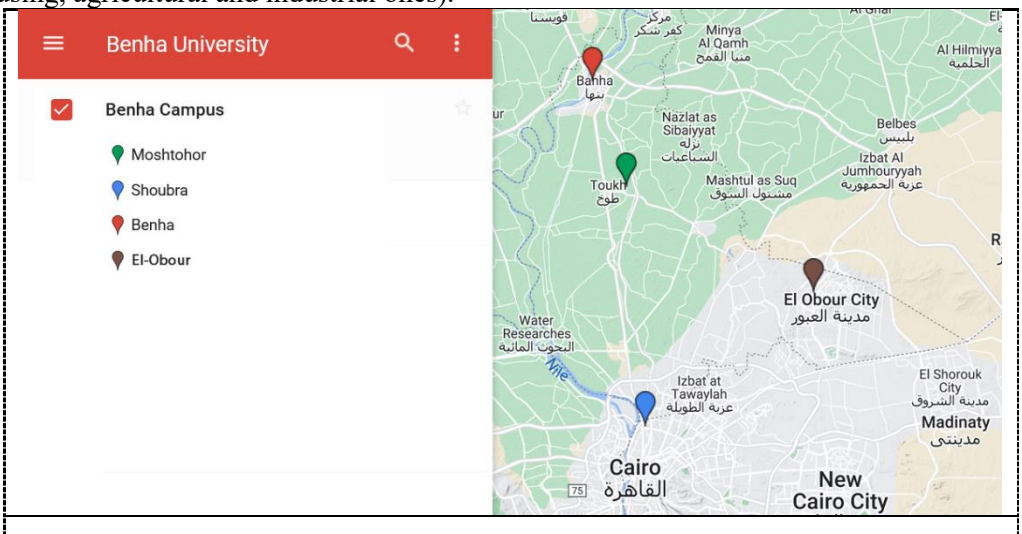

Figure 1. Benha University Campus.

2.2. Data collection

The Data in all categories were obtained via (a) field observations at campus, (b) reports prepared by the international ranking unit of university. The data collection and analysis were done between June and November of 2019, 2020 and 2021Yr.

3. Results and Discussion

The score to evaluate the sustainability of the university was calculated using the UI Green Metrics Guideline [(4)]. The data set comprised six categories. The six categories included: 1) Setting and Infrastructure; 2) Energy and Climate Change; 3) Waste; 4) Water; 5) Transportation; and 6) Education. The total possible score for the 6 categories is 10,000 points while the calculated score for BU was 5950, 5850 and 6375 for 2019, 2020 and 2021 respectively (Table 1). Results showed that, the strongest category score for BU was for energy and climate change (21 %) as well as education

and research (31 and 24 %), while the weakest category score was water (16, 10 and 11%) for 2019, 2020 and 2021 respectively.

Table 1. Total score based on the six categories of Benha University.

NO.	Categories	2019	2020	2021
1	Setting and Infrastructure (SI)	1025	700	825
2	Energy and Climate Change (EC)	1275	1275	1475
3	Waste (WS)	975	825	750
4	Water (WR)	525	575	700
5	Transportation (TR)	950	675	1125
6	Education (ED)	1200	1800	1500
	Total	5950	5850	6375

The attention to the use of energy and climate change issues is the indicator with the highest weighting in this ranking. In our university, we define several indicators for this area of concern, *i.e.,* energy-efficient appliances usage, the implementation of smart buildings/automation buildings/intelligent buildings, renewable energy usage policy, total electricity usage, energy conservation programs, elements of green buildings, climate change adaptation and mitigation programs, greenhouse gas emission reductions policy, and carbon footprint. Within these indicators, the BU is expected to increase their efforts in energy efficiency in their buildings and to care more about nature and energy resources. BU was also found to have the highest energy and climate change of 21, 22 and 23% for 2019, 2020 and 2021 respectively.

Table 2. Total possible scores for energy and climate change of Benha University.

NO.	Indicators	2019	2020	2021
1	Energy efficient appliances usage	100	100	100
2	Smart building program implementation	150	75	300
3	Number of renewable energy source in campus	150	300	225
4	The total electricity usage divided by total campus population	300	300	225
5	The ratio of renewable energy production towards total energy usage per year	50	50	100
6	Element of green building implementation	150	75	150
7	Greenhouse gas emission reduction program	150	150	100
8	The ratio of total carbon footprint divided campus population	225	225	100
9	Number of innovative program(s) during covid-19 pandemic	-	-	100
10	Impactful university program(s) on climate change	-	-	75

UI Green Metrics requires A University to increase its efforts in energy efficiency vis-à-vis their buildings and to conserve nature and energy resources. The score in this category is the largest number compared with all categories. This category comprises ten indicators included:

1) Energy efficient appliances usage: This Indicator aims to motivate the university to provide more the number of energy-efficient appliances and the number of conventional ones used on campus and provide them in percentages. Examples of energy-efficient appliances are A/C with inverter technology, LED light bulbs and computers. Results showed that, the total possible score for indicator is 100 and the percentage of score to maximum score for energy efficient appliances usage of university is 50% with past three years (Table 2 and 3).

2) Smart building program implementation: This Indicator aims to motivate the university to provide the total area (including ground floors and other floors) of university smart buildings on campus. A building that is classified as a smart building must have the general requirements of smart building features: automation, safety (physical security, presence sensors, video surveillance/CCTV), energy, water (sanitation), indoor environment (thermal comfort and air quality), and lighting (low power lighting). Table 2 and 3 reveals that the values of total possible score for indicator is 150, 75 and 300; and the percentage of score to maximum score for smart building program implementation of university is 50, 25 and 100 % for 2019, 2020 and 2021 respectively.

3) Number of renewable energy sources on campus: The availability of more sources of renewable energy (Biodiesel, solar power, clean biomass and wind power) is considered to indicate that a university has put more effort into providing alternative energy (Figure 2). Table 2 presents the total possible score is 150, 300 and 225; and the percentage of score to maximum score for renewable energy sources on campus of Benha university is 50, 100 and 75 % for 2019, 2020 and 2021 respectively (Table 3).

4) Total electricity usage: Results showed that, the total possible score for indicator is 300, 300 and 225; and the percentage of score to maximum score for total electricity usage of university is 100, 100 and 75 % for 2019, 2020 and 2021 respectively. 5) The ratio of renewable energy production towards total energy usage per year: Table 2 and 3 reveals that the value of total possible score is 50, 50 and 100; and the percentage of score to maximum score for energy production of university is 25, 25 and 50 % for 2019, 2020 and 2021 respectively. This is due to construction and renovation policies in Benha University by electricity efficient usage (hybrid power); as shown in to Figure 2.

Table 3. Percentage of score to maximum score for energy and climate change of Benha University.

NO.	Indicators	2019	2020	2021
1	Energy efficient appliances usage	50	50	50
2	Smart building program implementation	50	25	100
3	Number of renewable energy source in campus	50	100	75
4	The total electricity usage divided by total campus population	100	100	75
5	The ratio of renewable energy production towards total energy usage per year	25	25	50
6	Element of green building implementation	50	25	75
7	Greenhouse gas emission reduction program	75	75	50
8	The ratio of total carbon footprint divided campus population	75	75	50
9	Number of innovative program(s) during covid-19 pandemic	-	-	100
10	Impactful university program(s) on climate change	-	-	75

6) Element of green building implementation: Results showed that, the total possible score is 150, 75 and 150; and the percentage of score to maximum score for green building implementation of university is 50, 25 and 75 % for 2019, 2020 and 2021 respectively.

7) Greenhouse gas emission reduction program: Table 2 presents the total possible score is 150, 150 and 100; and the percentage of score to maximum score for greenhouse gas emission reduction program of university is 75, 75 and 50 % for 2019, 2020 and 2021 respectively. This is due to construction and renovation policies in BU by greenhouse gas emission reduction program implementation.

8) The ratio of total carbon footprint divided campus population: The transportation system is associated with carbon dioxide emissions, the cause of global warming. The use of environmentally friendly public transportation will decrease the carbon footprint around the campus. Results showed that, the total possible score is 225, 225 and 100; and the percentage of score to maximum score for total carbon footprint of university is 75, 75 and 50 % for 2019, 2020 and 2021 respectively (Table 2 and 3).

9) Number of innovative programs during covid-19 pandemic: This Indicator represents the number of courses or subjects; the contents of which are related to sustainability offered by the university (smart gate sterilization system, face mask production unit and smart room sterilization system) as shown in to figure 3. The total possible score is 100; and the percentage of score to maximum score for innovative programs during covid-19 pandemic of university is 100 % with 2021.

10) Impactful university program on climate change: The total possible score is 75; and the percentage of score to maximum score for program on climate change of university is 75 % with 2021. Accordingly, were all curricula revised to include subject material on sustainability, the score would be improved. Note that sustainable courses can be in any field including environmental science, social science, art, or economics. The website and report are updated; the scores for both indicators should automatically increase.

Figure 2. Renewable energy sources of Benha University (solar power, Biodiesel, clean biomass and wind power).

Figure 3. Innovative program s during covid-19 pandemic of Benha University (smart gate sterilization system and face mask production unit).

3.1. Impact of scientific research on energy and climate change issues in Benha University

The attention to the energy and climate change issues is the indicator with the highest weighting in this ranking for BU. Results showed that, the strongest category score for BU was for energy and climate change (21 %) as well as education and research (31 and 24 %) for 2019, 2020 and 2021 respectively. This is due to number of research published on energy and climate change of BU about 65, 110, 111 and 130 in international journals according to Scopus databases during (2018, 2019, 2020 and 2021) respectively; as shown in to figure 4. BU was also found to have the highest energy and climate change of 21, 22 and 23% for 2019, 2020 and 2021 respectively. This is due to progress of BU several indicators energy and climate change according to Scopus databases *i.e.,* general Energy

(0.9%), energy (miscellaneous) (0.4%), energy engineering and power technology (5.2%), as well as renewable energy, sustainability and the environment (4.7%), nuclear energy and engineering (0.7%) and fuel technology (2.1%).

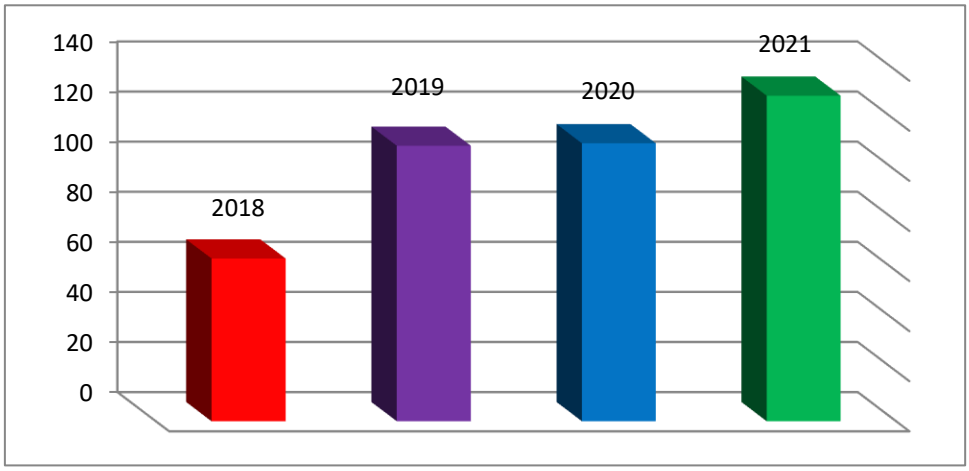

Figure 4. Number of research published on energy and climate change of Benha University in international journals according to Scopus databases during (2018, 2019, 2020 and 2021)

4. Conclusion

BU campuses are part of a larger, interconnected ecosystem. Several activities have negative effects upon the natural environment, so the BU needs to tackle these problems first. Our findings reveal that BU has a vision to become a sustainable university and could make incremental steps to achieving this objective by adopting sustainable designs for green spaces and buildings, upgrading to energy saving equipment, endorsing environmental policies, and gaining the support of university administrators. Collectively these efforts will help the BU to reach its environmental goals to become an eco-friendly Green University.

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References

[1] Lee K H, Barker M and Mouasher A, 2013. Is it even espoused? An exploratory study of commitment to sustainability as evidenced in vision, mission, and graduate attribute statements in Australian universities. *Journal of Cleaner Production*, vol 48, pp 20-28. https://doi.org/10.1016/j.jclepro.2013.01.007

[2] Rice C, Ragbir NK, Rice S and Barcia G, 2020. Willingness to pay for sustainable aviation depends on ticket price, greenhouse gas reductions and gender. *Technology in Society*, vol 60, p 101224. https://doi.org/10.1016/j.techsoc.2019.101224

[3] Andrades Peña F J, Larrán Jorge M and Muriel de Los Reyes, M J, 2018. Analysing the incorporation of sustainability themes into the university curricula: a case study of a Spanish public university. *International Journal of Sustainable Development & World Ecology*, vol 25 (7), pp 642-654. https://doi.org/10.1080/13504509.2018.14374 84

[4] UI GreenMetric World University Rankings.https://greenmetric.ui.ac.id