GHG Inventory and Reduction Plans for the American University of Sharjah

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1 University Description

The American University of Sharjah (AUS) was established in 1997 by the ruler of Sharjah, Sheikh Dr. Sultan Bin Mohammad Al Qassimi, as a not-for-profit, independent, and privately owned co-educational institution offering undergraduate and graduate degrees (AUS, 2016). AUS is home to approximately 6,011 students, 563 staff, and 374 faculty members. Most students and faculty members reside on campus, whereas most staff live off campus.

AUS occupies an area of 128 hectares comprised of the College of Architecture, Art and Design, the College of Arts and Sciences, the College of Engineering, the School of Business Administration, two administration buildings, housing units for students, staff, and faculty, sports facilities, and a library (Figure 1). In addition, AUS owns and manages a daycare center, a mosque, and a health clinic. The university premises also include a branch of Sharjah Islamic Bank (SIB), restaurants, coffee shops, convenience stores, a pharmacy, a travel agency, and a barber shop.

AUS created its sustainability office in 2011 to educate the university community about the importance of developing sustainable practices on campus. However, it has not developed any concrete greenhouse gas (GHG) reduction plan. In fact, although AUS has never conducted a GHG inventory, it has welcomed this exercise and provided valuable assistance in data collection. Stephen Fenn, Executive Director of Operations, authorized this project and Reem Deeb, Sustainability Officer, provided all data used in the analysis. However, due to the large number of departments involved in the provision of data, requests were often met with slow response, no response, or unusable data.

2 Organizational and Operational Boundaries

AUS owns and controls all on-campus facilities and all related emissions are the university's responsibility. Although some facilities are independently managed, their energy consumption is contractually AUS's responsibility. In addition, they must comply with university standards and requirements. Thus, the fact that AUS controls all facilities suggests that the equity share and operational control approach would be appropriate for defining AUS's organizational boundaries. Indeed, the fact that the presence of SIB, restaurants, and coffee shops on campus is conditional on

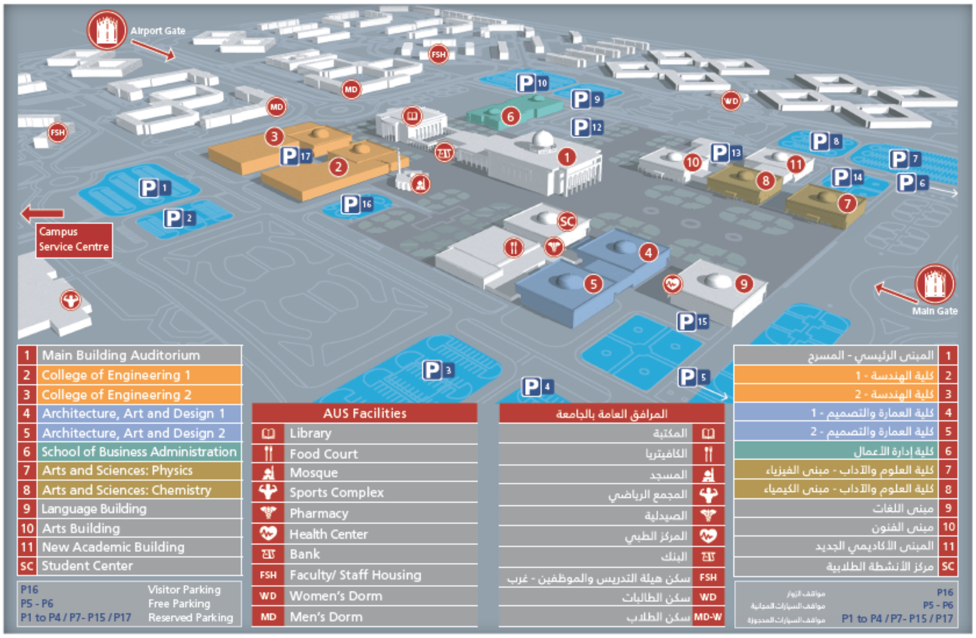

Figure 1: University Map (Source: AUS Website: http://goo.gl/cnvCvk)

satisfying a number of operating policies is consistent with the guidelines outlined in Greenhouse Gas Protocol (2004).

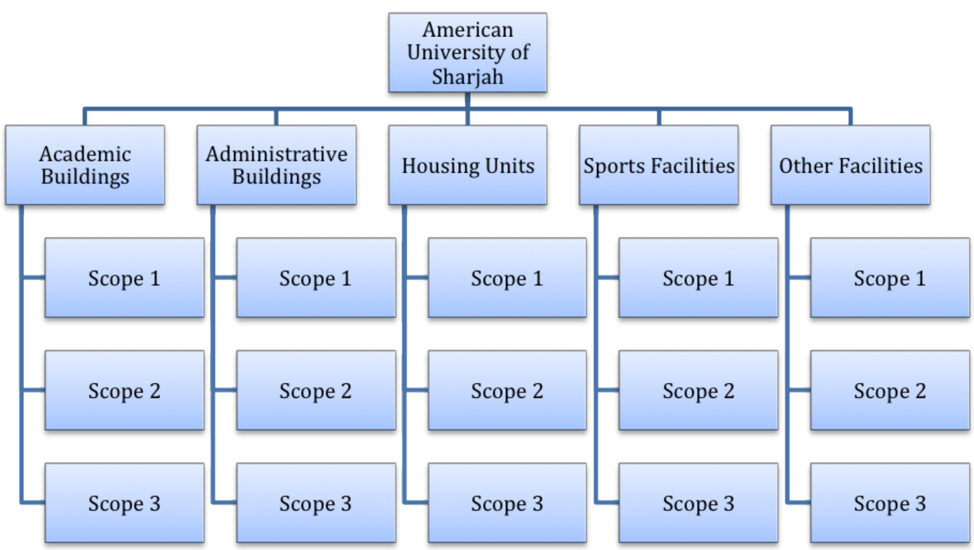

Figure 2: Organizational and Operational Boundaries for the American University of Sharjah

Figure 2 shows the organizational and operational boundaries of AUS where Scope 1, 2, and 3 categories would be included for all facilities. Academic buildings represent those dedicated to the College of Architecture, Art and Design, the College of Arts and Sciences, the College of Engineering, the School of Business Administration, and the library. Administrative buildings are comprised of the Main Building (#1 in Figure 1), which houses the Chancellor's office and academic staff and the Campus Service Center, which houses operational staff. Housing units include on-campus homes of staff and faculty and student dorms. Sports facilities include a leisure center for faculty and staff on the Western side of the campus and a sports complex for the university community. Finally, remaining facilities include all other units (e.g. mosque, daycare, restaurants).

Within Scope 1, all facilities are equipped with air conditioning units and are therefore contributing to emissions arising from the use of AC refrigerants. They also rely on backup power generation from the combustion of diesel. The university fleet is also used at least in part to provide maintenance and repair services to all university facilities. As for Scope 2, all facilities consume electricity. Finally, within Scope 3, all buildings have administrators who take business trips and employees who commute to and from work. Waste and wastewater are also generated by all facilities.

3 Sources of Emissions

Table 1 summarizes the relevant sources of emissions. However, due to lack of data not all of them are included in the GHG inventory. All data used in this GHG inventory are provided by the university sustainability administrator, Ms. Reem Deeb.

3.1 Scope 1 Emissions

Under Scope 1, sources of GHG emissions consist of AC refrigerants, diesel for backup power generation, and fuel combustion from the university fleet. The AC refrigerants that are currently used at AUS include R22, R410A, and R134A (R. Deeb, personal communication, March 13, 2016). However, the university does not keep records of refrigerant use as AC maintenance is subcontracted to an outside company. In addition, none of the responsible parties on-campus were able to provide any relevant details (e.g. make and model of AC units, refrigerant capacity).

In the absence of appropriate data, estimating refrigerant use is a daunting task. Housing

Table 1: University Emission Sources

Emission Sources	Included in Inventory	Details
Scope 1		
AC Refrigerants	No	No data
Diesel for Power generation	Yes	Data suggest an annual consumption of about 500 gallons.
University Fleet	Yes	A total of 40 vehicles consumed 14,612 gallons of gasoline and 438 gallons of diesel.
Scope 2		
Electricity usage	Yes	Total annual consumption of 62,251,033 kWh.
Scope 3		
Business Air Travel	Yes	A total of 303 flights resulting in 4,013 short-haul miles, 76,821 medium-haul miles, and 2,051,852 long-haul miles.
Employee Commuting	Yes	A large share of the university population does not commute as it resides on-campus. Staff do most of the commuting.
Waste	No	No data.
Wastewater	No	No data.

units include studios, one-bedroom, and two-bedroom apartments, which would each have a single AC unit. On the other hand, there are townhouses, which can each contain up to three AC units. Most of these units are inaccessible to the public and can only be reached through service ladders. Given the importance of cooling at AUS, emissions from AC refrigerants are likely significant. Several data requests have been sent to the responsible parties without success.

The second source of emissions represents diesel combustion for backup power generation. Despite occasional power cuts especially in the summer months, AUS rarely resorts to backup power. As for fuel combustion by the university fleet, AUS used 40 company-owned vehicles in 2015 (R. Deeb, personal communication, March 2, 2016). Such vehicles are provided to administrators as a fringe benefit and to staff for activities related to university operations. The available data are detailed enough to estimate corresponding emissions.

3.2 Scope 2 Emissions

The university consumes a large amount of electricity mainly due to its need for cooling. Since the establishment of AUS in 1997, utilities such as water and electricity have been provided to everyone living on campus free of charge. It is only in recent years that AUS has installed metering systems to monitor electricity consumption across facilities. Electricity consumption always peaks in the summer during which the temperature is known to be in excess of 47 °C.

3.3 Scope 3 Emissions

Scope 3 emissions are comprised of business air travel, employee commuting, waste, and wastewater. A large share of plane tickets purchased by AUS are contractually mandated although not directly related to university operations. These tickets are purchased for new employees and for those repatriating upon the termination of their employment. Other tickets are for trips related to university operations that are taken by administrators. It is important to note that faculty members also purchase tickets to attend conferences around the world. However, no relevant data are available since faculty members are responsible for purchasing their own tickets.

Employee commuting represents another source of Scope 3 emissions. In 2015, all faculty members and about 40% of the students lived on campus, whereas most staff members lived off campus. Available data about car stickers only provide a snapshot showing 313 stickers assigned to faculty members, 455 stickers to staff, 1,616 to students, 69 stickers to dependents, and 26 stickers to contractors (R. Deeb, personal communication, March 27, 2016). Unfortunately, there are no data or clarifications as to whether these stickers are held by individuals residing on campus or off campus. In addition, there is no information about the whereabouts of off-campus residences and about the modes of transportation used to get to campus. Thus, estimations of emissions from employee commuting will necessitate a set of assumptions as described in the estimation section.

As for waste and wastewater, the university campus falls under the jurisdiction of the Sharjah municipality, which is responsible for the collection of trash, sewage, and wastewater and for the irrigation of university lawns. Although the university pays minimal fees on sewage and wastewater, there is no data on the volumes collected.

4 Estimation of GHG Emissions

Scope 1 and Scope 3 emissions are estimated using the simplified GHG emissions calculator (SGEC) created by the EPA Center for Corporate Climate Leadership (EPA, 2014), whereas Scope 2 emissions are estimated manually following the procedures outlined in Climate Registry (2013).[1] Table 2 summarizes AUS's GHG inventory for the sources for which data are available. Overall, AUS operations in 2015 resulted in emissions totaling 38,943 metric tons of CO_2e (MTCE). The following is a breakdown of such emissions.

Table 2: University Emissions in 2015

Emission Sources	MTCE	% of total emissions
Scope 1		
Diesel for Power generation	5.1	0.013%
University Fleet	133.7	0.343%
Scope 2		
Electricity usage	37,226	95.6%
Scope 3		
Business Air Travel	409.3	1.05%
Employee Commuting	1,169.3	3%
Total Emissions	**38,943**	

4.1 Scope 1 Emissions

About 500 gallons of diesel are reported to have been used for backup power generation in 2015 (R. Deeb, personal communication, March 13, 2016). This value is entered into SGEC as stationary combustion of distillate fuel oil. The resulting emissions amount to 5.1 MTCE. As for university fleet, the available data include details about the make, model, year, mileage, and fuel consumption of university-owned vehicles (R. Deeb, personal communication, March 27, 2016). The relevant data are input into SGEC under mobile sources. The corresponding emissions amount to 133.7 MTCE.

[1] Two worksheets are enclosed consisting of SGEC and manual calculations. Table 3 in the appendix represents the summary table extracted from the SGEC.

4.2 Scope 2 Emissions

Emissions from electricity use are estimated manually following the procedures outlined in Climate Registry (2013) and using the emissions factors in Table 14.4 of Climate Registry (2015). Calculations are based solely on an emissions factor of 598 g/kWh of CO_2. To my knowledge, there is no data on emissions factors for CH_4 and N_2O for the UAE. AUS consumed 62,251,033 kWh in 2015 (R. Deeb, personal communication, February 29, 2016), resulting in emissions amounting to 37,226 MTCE.

4.3 Scope 3 Emissions

Business air travel data are from the university travel agency and include information about passengers, flight origin and destination, and the fare paid (R. Deeb, personal communication, March 29, 2016). Initially, the data included 363 data points, which were revised down to 303 tickets. The revisions involve removing entries related to insurance premiums paid on flights, fees for changing tickets, and round-trip tickets booked for faculty members. One-way tickets purchased for faculty members are included since they are purchased for new staff and faculty and for repatriation. Flight distance data are compiled for individual flights using webflyer.com. Each flight is then classified according to its distance as short-haul when passenger-miles are less than 300 miles, medium-haul when they are between 300 and 2,300 miles, and long-haul when they exceed 2,300 miles. The relevant data are subsequently entered into the Business Travel tab of SGEC. The resulting emissions amount to 409.3 MTCE.

Employee commuting is estimated by assuming that the 455 staff who have car stickers commute to the university five days a week. After accounting for employee leave, staff are assumed to have commuted over a 48-week period in 2015, resulting in a total of 240 commuting days. According to www.distance-cities.com, the commuting distance is approximately 14.38 miles, which represents the road distance between AUS and Al Majaz area of Sharjah.[2] Based on these assumptions, employee commuting is estimated to result in 3,140,592 passenger car miles (calculated as 28.76 miles per day $\times$ 455 employees $\times$ 240 days). This value is entered into the Commuting tab of SGEC, resulting in emissions amounting to 1,169.3 MTCE.

[2] The Al Majaz area is selected due to its affordability and high desirability by local residents.

5 Data Analysis

Table 2 shows that more than 95% of the emissions arising from AUS operations are from electricity use. Figure 3 shows that monthly electricity consumption at AUS is highly correlated with mean cooling degree days (CDD).[3] In fact, correlation between electricity consumption and CDD is estimated at 0.98 (as reported in the calculations worksheet). This suggests that electricity use is largely driven by the university's cooling needs. Indeed, the temperature in most of the UAE is known to reach uncomfortable levels between May and October.

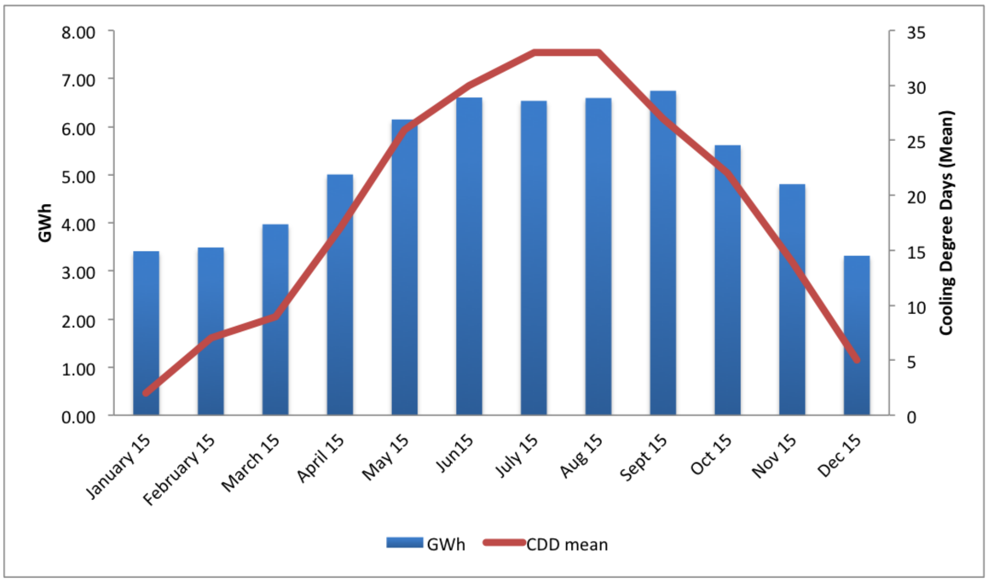

Figure 3: AUS Electricity Consumption (GWh) and Mean Cooling Degree Days in Sharjah in 2015

The second largest contributor to AUS emissions is employee commuting, which represents 3% of total emissions. This is not surprising given that passenger cars in the UAE are relatively affordable and the price of gasoline has been subsidized by the UAE government for years until recently. In fact, in 2015, the average price across unleaded gasoline types 91, 95, and 98 was barely $0.50 per liter (UAE Ministry of Energy, 2016).[4] In addition, the high level of affluence in the UAE makes the use of public transportation and carpooling relatively unattractive.

The third largest source of emissions is business air travel, which represents 1.05% of total emissions. As described above, a number of tickets purchased by the administration are for newly

[3]CDD data are from Weather Underground (2016).

[4]The average price was computed by averaging across the different fuel types for each period then averaging across periods. The average price was estimated at AED 1.86.

hired staff and faculty or for repatriating departing families. As for the remaining tickets, there is no information on the nature of trips taken and whether any of them were unnecessary.

6 Current GHG Reduction Plans

AUS has pursued a number of initiatives in reducing its carbon footprint. They include the introduction of indoor and outdoor recycling bins on campus and regular awareness campaigns directed to encouraging the university community to consider the environmental impact of their choices. To address its high electricity consumption, AUS has installed smart meters monitoring hourly electricity consumption across housing units on campus. It is also currently developing a plan to install solar panel roofs on all its golf carts.

AUS has also taken steps in reducing its electricity consumption especially for cooling. It has installed an adiabatic cooling system at the university library and is currently monitoring its performance (R. Deeb, personal communication, April 21, 2016). AUS expects to implement the system into other academic buildings once the library unit is deemed successful and efficient especially during the upcoming hot summer months.

AUS is also currently working with an external consultant and an advisory committee on developing a plan for the installation of photovoltaic systems across campus. It has designated a vendor and is expected to finalize an appropriate contract in the near term. This will likely help AUS reduce its energy cost extensively especially given the fact that the UAE and neighboring countries are naturally endowed with average daily solar radiation exceeding 6 kWh/m^2 (Alnaser and Alnaser, 2011).

Finally, AUS has also been working with an external consultant on achieving ISO 14001 certification, which would help the university develop a framework for reducing its carbon footprint (BSI, 2016). AUS expects to receive this certification by the end of 2016.

7 Suggested GHG Reduction Strategies

Just like many other places throughout the UAE, AUS is still using R22 refrigerant despite the fact that it is ozone depleting and has a global warming potential of 1,760 (Greenhouse Gas Protocol, 2015). Considering that R22 was banned in the European Union from use in new air conditioning units in 2004, banned for maintenance and service in its virgin form in 2010, and banned completely in any form in 2015 (B-DACS, 2016), the UAE has yet to develop similar legislation. Given the scale of AUS, it should consider phasing out the use of R22 as expediently as possible. While the cost of replacing AC units that only take R22 refrigerant may be too substantial to allow the immediate transition to other refrigerants, AUS could opt for using substitute refrigerants with a lower global warming potential such as R-441A and HFC-32 (EPA, 2016).

In 2015 alone, AUS spent more than $7 million on electricity consumption (R. Deeb, personal communication, February 29, 2016).[5] As Figure 4 shows, about 50% of electricity use comes from academic buildings, costing AUS around $3.5 million. This is followed by about 30% from student dorms ($2.1 million) and about 20% from staff and faculty housing units ($1.4 million). In fact, electricity cost imposes such a great burden that AUS considered the possibility of billing staff and faculty members for their electricity use as a means to reduce consumption and to remedy for budgetary shortfalls. However, faculty member expressed stiff resistance and prevented the change from taking place.

AUS can address its electricity use problem by getting faculty and staff involved in the process. First, it should make use of electricity consumption data to derive mean usage values by dwelling size. Second, it should identify thresholds for each dwelling size over which residents would be billed for electricity use. These thresholds could also be connected to a specified electricity consumption target level. Alternatively, AUS could hold residents accountable for their electricity consumption while financially supporting them with a lump-sum payment of about $0.7 million, to be divided according to some pre-determined criterion. This arrangement is likely to be better received since concerned parties would not necessarily incur electricity costs as long as their consumption does not exceed the sum allocated to them. Thus, it could reduce not only electricity consumption but also the cost currently borne by AUS by about 10%. Indeed, the potential $0.7

[5] Actual cost is in UAE dirhams (AED) which is converted to U.S. dollars at a fixed exchange rate of $1 to AED 3.6725.

million saving resulting from this suggested reduction plan is so significant that it represents 1.6 times the cost of installing smart meters in all housing units (R. Deeb, personal communication, April 27, 2016).[6]

Most academic buildings currently require the physical monitoring of lighting by security staff. The university can benefit tremendously by installing motion sensors to control lighting in hallways, offices, and all other rooms. With electricity consumption in these buildings representing more than half of the university's electricity use, this modification is likely financially viable and can yield substantial benefits by not only reducing electricity consumption but also the required security staffing.[7]

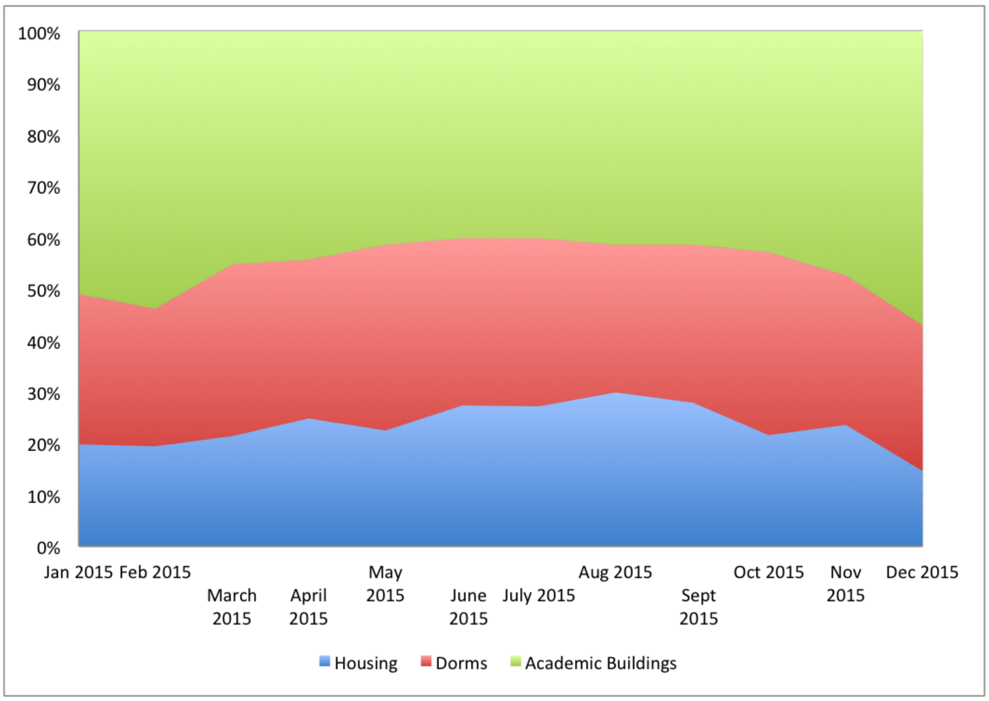

Figure 4: Distribution of AUS Electricity Consumption

In sum, AUS can immediately reduce the cost associated with its electricity consumption by at least 10%, thus freeing funds for allocation towards the adoption of sustainable energy sources (e.g. solar panels). This option should be considered a top priority area given the fact that it requires no additional resources and can be implemented at no cost. Other suggested GHG reduction strategies should be evaluated carefully along with those already in process to assess

[6]AUS installed smart metering for 420 units at a per-unit cost of approximately $1,000.

[7]The university does not maintain data on lighting fixtures. In addition, academic buildings have been built gradually since 1997. As a result, lighting and lighting efficiency vary greatly across buildings.

their financial viability.

8 Conclusions

Since the data used in this GHG inventory are in some cases imperfect or unavailable, the estimations presented above remain tentative. It is recommended that AUS revisits these estimates through the provision of accurate data especially for the sources of emissions that have been excluded from the analysis. Nevertheless, the findings presented in this report represent an important impetus for AUS to managing the environmental impact of its operations.

As one of the leading institutions of higher learning in the region, AUS must develop a good understanding of the environmental impact of its operations. By setting and actively committing to concrete emission reduction targets, AUS is able to contribute to mitigating environmental emissions. The enhancement of AUS's environmental stewardship can represent an important and needed source of inspiration to current students and alumni, to the business community, and to other aspiring institutions in the region.

References

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[12] Weather Underground (2016). *Weather History of OMSJ*. Retrieved on April 14, 2016 from http://www.wunderground.com.

[13] Web Flyer (2016). *Mileage Calculator.* Retrieved on April 14, 2016 from http://goo.gl/uwBZaF.

Appendix

Table 3: Scope 1 and Scope 3 Emissions

Organizational Information:

Organization Name:	American University of Sharjah
Organization Address:	Sharjah, United Arab Emirates
Inventory Reporting Period:	*Calendar Year 2015*
	Start: *MM/DD/YY* End: *MM/DD/YY*
Name of Preparer:	Jay Squalli
Phone Number of Preparer:	
Date Prepared:	

Summary of Organization's Emissions:

	Direct Emissions		
Go To Sheet	Stationary Combustion	5	CO_2-e (metric tons)
Go To Sheet	Mobile Sources	134	CO_2-e (metric tons)
Go To Sheet	Refrigeration / AC Equipment Use	0	CO_2-e (metric tons)
Go To Sheet	Fire Suppression	0	CO_2-e (metric tons)
Go To Sheet	Purchased Gases	0	CO_2-e (metric tons)
	Indirect Emissions		
Go To Sheet	Purchased and Consumed Electricity	0	CO_2-e (metric tons)
Go To Sheet	Purchased and Consumed Steam	0	CO_2-e (metric tons)
	Optional Emissions		
Go To Sheet	Employee Business Travel	409	CO_2-e (metric tons)
Go To Sheet	Employee Commuting	1169	CO_2-e (metric tons)
Go To Sheet	Product Transport	0	CO_2-e (metric tons)
	Total Company Emissions		
	Total GHG Emissions (Not Including Optional Emissions)	139	CO_2-e (metric tons)
	Total Optional Emissions	1579	CO_2-e (metric tons)
	Total GHG Emissions	1717	CO_2-e (metric tons)
	Reductions		
Go To Sheet	RECs and Green Power Purchases	0	CO_2-e (metric tons)
Go To Sheet	Offsets	0	CO_2-e (metric tons)
	Net GHG Emissions	1717	CO_2-e (metric tons)