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The Workability of Dominican University of California (DUoC) Transitioning to a Community Choice Aggregation (CCA) Program Energy Supply

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This Master's Project

The Workability of Dominican University of California (DUoC) Transitioning to a Community Choice Aggregation (CCA) Program Energy Supply

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List of Acronyms and Abbreviations:

CCA - Community Choice Aggregation

CO_2 - Carbon Dioxide

DUoC - Dominican University of California

GHG - Greenhouse Gas

HVAC - Heating Ventilation and Air Conditioning

kWh - Kilowatt Hour (s)

Lbs. - Pounds

PG&E - Pacific Gas & Electric Utility Company

TOU - Time-of-Use

1. Abstract

For almost 10 years Community Choice Aggregation (CCA), or community-based energy programs, have been developing and or providing clean energy resources to both commercial and residential customers in various regions around the United States. Although there are several programs in communities in the surrounding regions of California, this study focuses on a specific California program known as MCE. This research examines the feasibility of Dominican University of California (DUoC) transitioning from Pacific Gas and Electric (PG&E) to becoming a client of MCE in the future. Out of the 19 community energy programs currently available in the state, MCE is the local choice for the University if a transition is to be made. The Sustainability Committee for the University not only brought forth the proposal to transition but was also responsible for carrying out the analysis captured in this research.

The analysis discussed in this paper utilizes a predictive commercial rate calculator, provided by an MCE program contact, in order to assess each individual utility account attributed to the spaces on the University campus. It is imperative that regardless of the utility provider being used, all energy consumption needs of the University campus need to be met whether or not it is clean, renewable energy. Upon thorough analysis of the 2018 utility bills for the University it became apparent that, regardless of the renewable package that could be opted for with MCE, the University campus would not only be breaking even, possibly saving money in the transition, but would also be preventing thousands of pounds of carbon dioxide (CO_2) emissions from entering the environment. It would not only be financially responsible but also communally responsible for DUoC to make the transition to a cleaner energy resource provider.

2. Introduction

a. Renewable energy in the world today

Humans as a species are dependent on the utilization of energy for everything, we do throughout the calendar year, and regardless of the season energy demands need to be met whether by one source, multiple sources or alternative sources. In order to meet this unending demand for energy humans need to use fossil fuels in order to make electricity; even renewable energy sources like solar and wind power projects use fossil fuels during their life cycle, from production to usage to the landfill, in order to bring customers "clean" emission free energy (Polack et al. 2019). Although there can be greenhouse gas (GHG) emissions attributed to the life cycle of the majority of energy resources, the sources that have the least amount of or no impact should be considered to fulfill the insatiable hunger of humanity for electricity before utilizing the ones that impact the planet we live on. Computing the actual GHG emissions attributed to each resource is difficult as emissions data are primarily founded in rough estimates as few energy sources are sampled continuously (Rypdal and Wilfried, 2001).

However there are technologies and strategies that have no net impact although they are still utilizing fossil fuels and producing emissions in order to come to fruition; once implemented these "negative emission" mechanisms begin to sequester emissions, such as carbon dioxide (CO_2), and offset the GHG emissions used in production and transportation (Voskian and Hatton, 2019). An example of one of these "negative emission" mechanisms is a carbon capture and use system being implemented at several coal-powered plants; although there are still GHG emissions attributed to this strategy, this addition to the already dirty energy plant tries to offset the environmental and societal damage it has caused, even though it is only by a small margin (Jacobson, 2019). Creative alternative resources and strategies are going to be necessary in order for the expanding world to fulfill its energy requirements (Coccolo et al, 2015).

There are several options for citizens and their communities to choose from when taking steps to make the transition to cleaner resources. Wind and solar are by far the most common although rooftop solar systems are not necessarily the most cost-effective energy solution for consumers (U.S. Department of Energy, 2018). For almost a decade new solar and other alternative energy projects have been in development but creating a cheap and large-scale renewable system has been out of reach due to the amount of raw material required to manufacture the technology (Fagiolari and Bella, 2019). The surge of carbon-free and renewable electricity has brought about many advantages, but it is also creating a challenge for the power grid and its operators, both at the transmission and distribution levels resulting in an overhaul in the energy systems design and operation (Chalendar et al. 2019).

Economic impact, to both the community and the customer, plays a rather large role when considering what option to select from the variety of available resources. Although, perhaps the most important thing to consider when trying to transition, is ensuring that there is a diverse and reliable balance of resources that can be utilized for electricity needs (Gundlach and Webb, 2018). There is a level of security that comes with a large and diverse selection of resources as there are options on hand if one of the resources is unforeseeably unable to meet whatever energy requirements there are. Regardless of what economic or political pressures are prevalent at any given moment, unless there is a focus on deterring fossil fuel use (perhaps via a carbon tax) society will not shift away from the security of dirty energy (York, 2012). It is theorized that simply by raising the awareness of energy impacts on the environment as well as its citizens can help facilitate the mentality shift necessary to adopt cleaner resources as well as lower GHG emissions (Robinson et al. 2015)

b. Buildings and Energy Usage

All of the human built spaces that humans utilize and occupy require electricity regardless of the time of day. Urbanized spaces, man-made and not, are the largest contributors to global GHG emissions (Hoornweg, 2011). The building sector specifically is an area of the global energy portfolio that utilizes a significant amount of energy; as developed countries have progressed this sector has begun to steadily surpass the usage of both the industrial and transportation sectors (Perez-Lombard, 2008). Heating Ventilation and Air Conditioning (HVAC) within the built environment is one component that has greatly increased energy usage within the US alone; approximately 50% of energy consumption in the building sector (Perez-Lombard, 2008). There is a tremendous amount of energy in the form of heat lost throughout the infrastructure of the building especially with HVAC units; this, however, is not an area of the built environment that is generally considered and as such energy that could be redirected and repurposed is lost to the environment (Hussain et al. 2017). With this in mind it has become ever more imperative that the energy and heat efficiency in these spaces and energy resources supplying these structures are readdressed and redesigned.

Unfortunately conducting in depth studies into specific building types and their usage is difficult as spaces such as schools, museums, and other public structures are all categorized, and studied, under a "service" classification, as they do not fall under the residential or commercial building sectors (Perez-Lombard, 2008). That being said, it has been estimated that retail and business centers are utilizing the most energy intensive technologies, and resources out of all non-domestic buildings, generally utilizing more than 50% of the total energy consumption for the built environment (Perez-Lombard, 2008). Coming in closely behind, medical facilities, temporary housing (e.g. hotels, motels, etc.), culinary spaces, and education centers utilize the next significant amount of energy. Clean renewable energy for the built environment should not always be thought of secondary; unfortunately, with the infrastructure we have today it would cause more of an environmental impact to remove outdated technology from each building and start over again. To try and prevent this difficult situation from arising in future building projects, renovations or new construction, green architects and designers are developing theoretical building models in order to reach optimal energy efficient decisions for a given space with minimal, if any, financial or environmental impacts (Petri, et al. 2017).

Education centers such as primary schools, high schools, and university campuses utilize energy in all forms in order to conduct administration, research, classes, maintenance, security, and other operational demands. Whether the electrical demand be from interior or exterior lights, HVAC systems, or technological equipment, these built spaces are energy intensive; and as such the schools should conduct research into various strategies, both material and not, that could reduce energy costs and boost the overall sustainability of the buildings and the campus as a whole (Han et al. 2015). For the last decade countries around the world have been studying the energy efficiency of buildings and how to best improve upon it as the carbon footprint of the built environment is growing along with the global population (Almeida et al. 2012). As an educational campus grow as does the carbon footprint of said space; this footprint is a culmination of the GHG emissions from all of the activities carried out across the organization. Activities emitting these GHG gases on any given campus include but are not limited to the amount of electricity used in buildings, additional operational processes and any campus vehicles currently in operation (Gao et al., 2013 and Padey et al. 2010). The electricity usage of a campus is the largest contributing factor to the carbon footprint of most universities (Letete et al. 2011) Knowing what the specific carbon footprint looks like for a facility is beneficial when determining viable sustainability decisions for the campus (Townsend and Barrett, 2015).

Educational spaces, especially higher education campuses not only serve their local citizens, but many universities have enrolled students from all over the world or have satellite campuses located in various regions (Robinson, 2018). As such, the environmental impact a campus has during their operation needs to be held in heavy consideration as it not only affects those on the estate but also the surrounding global community as well (Baboulet, 2010). Operational efficiency is important but equally so, ensuring that the population utilizing the built environment is properly educated in sustainable practices and technology options also aids in improving the health of the environment (Barth et al. 2014, Lozano et al. 2013). A truly sustainable environment is one that minimizes any and all negative effects on the occupants along with the interior and exterior environments. (Klein-Banai et al. 2011) China for example has been studying the correlation between emission reduction, and energy efficiency improvements within the built environment over the last decade and has concluded that indeed there is a link between them (Li and Colombier 2009).

Universities, such as the University of California Berkeley (UC Berkeley), have done studies into the feasibility of transitioning to alternative energy resources, and suppliers. UC Berkeley conducted a study into the community choice aggregation program that is the focus of this research paper. Similarly, the study recognized that the impact of the campus on the environment needs to be weighed in the decision as to whether or not a new utility provider should be chosen. UC Berkeley pulls an incredible amount of energy every year, approximately 212 million kWh, and in order to fulfill this energy demand it needs to invest and/or subscribe to energy projects that will fulfill their expected needs and more (Kuo, 2014). Although the resulting suggestion of the UC Berkeley study recommended not transitioning to the available local CCA program, the study emphasized the importance of exploring other options as the electricity load of the campus is greater than what can be produced by current standing energy programs (Kuo, 2014).

Similarly, at the North China University of Science and Technology, there was a study conducted in 2015 where the campus took a hard look at alternative energy options for their campus (Han et al. 2015). As a result of this study it was put forward that not only can this campus, as well as others, have tremendous energy savings but it is only achievable with a combination of efforts; such efforts include updating infrastructure and technology, and managing the energy resources, and the behavior of the occupants (Han et al. 2015). Shandong Normal University - Lishan College, in Qingzhou, Shandong, China is one university in particular that has achieved a zero-carbon campus in which the energy the campus requires are met via a multitude of clean renewable resources overlapping and coinciding with each other (Xu et al. 2018) This campus had the ability to install various energy projects across the campus, and although this is not feasible for every campus or system, the Shandong Normal University - Lishan College campus can be seen as a tangible example that supports the movement coming from the North China University of Science and Technology for updating any and all facets of a built system in order to reach true clean sustainability.

c. Community Choice Aggregation

Local governments are mandated to maintain and implement state and federal requirements, such as basic infrastructure and utilities, for their citizens and residences while ensuring any GHG emissions are minimalized or reduced (Larson and Edgar, 2009). Community Choice Aggregation (CCA) is what allows local government entities to take the communities collective electricity load and purchase, and/or develop, clean electricity projects on behalf of their commercial, and needs of the residential citizens (CalCCA, 2019). Another way to view a CCA is as “collective purchasing”, this idea revolves around the theory that purchasing renewable energy in a larger volume may create fiscal savings and GHG reductions for the community as a whole and thus the individual (Bartling, 2018). Even though buying more could cost less in various circumstances, it takes community involvement, and understanding of the groups energy usage to successfully pool, and purchase enough renewable energy resources (Skatova et al. 2016).

The first CCA law was passed in Massachusetts in 1997 and was utilized as a community strategy to acquire cleaner electricity at a lower cost than what was provided by the state utility (Lichtenstein, 2015). Community Choice law, Assembly Bill 117 (AB 117) (Midgen) can be found in the California Public Utilities Code within section 441.1,381.1, code section 366.2. In 2002 AB 117 was enacted allowing local governments to aggregate their customers electricity needs and elect a CCA program to fulfill those needs (Smith, 2019). CCA programs became active in California three years after AB 117 (Midgen) was enacted, when San Joaquin Valley Power Authority received the first CCA authorization from the California Public Utilities Commission (Smith, 2019). In 2010, nearly eight years after AB 117 (Midgen) was enacted, MCE became the first active CCA program in the state of California to provide electricity to their subscribed customers (Smith, 2019).

Local communities often serve as a launching off point for many innovations within local or even state government environmental policies, but without in-depth knowledge of deeply integrated systems, such as the electricity sector, these small changes could cause massive negative impacts throughout the larger statewide systems (Gunther, 2018). These complications generally arise when communication is not properly coordinated between local and state agencies, this has contributed to the criticism of CCAs and new renewable energy sources in the past (Gunther, 2018). As an example, uncertainty arose amongst California state agencies as their planning/organization efforts were disrupted by local policy makers not properly communicating their new alternative energy policies (Gunther, 2018). Although these community energy programs are taking actions towards local, and clean generation, their unique independent rate policies introduce a layer of complexity into an already-complex energy market (Shoemaker, 2018). When the community is well informed however, there are many positive impacts to making the transition to locally produced energy. Not only are small communities, and the people living and working there, being empowered to make their own choices, any possible revenue manifested from electricity projects can be funneled back into the local community, and possibly back into incubating new green innovation ideas (Battaglioli, 2017). Perhaps the most important bonus to these local projects, is the socio-economic boost from clean renewable jobs that are being created in the region.

CCA programs invest in and contract renewable energy producing facilities and projects, such as solar and wind farms, in order to procure the energy required to meet consumers demand (O'Shaughnessy et al. 2019). As it currently stands within California, there are presently 19 CCA choices and/or programs that are being utilized by various communities (Figure 1, CalCCA, 2019). Each CCA is unique, not only do they make the decision as to where they source their energy from, but they also negotiate specific time of usage rates with the suppliers and the transmission company (CalCCA, 2019). Although CCA programs are generating and/or purchasing clean energy the program is still dependent upon using PG&E infrastructure in order to deliver electricity to customers. For example, Pacific Gas & Electric (PG&E) updates electricity rates with customers two to three times a year with oversight by the California Public Utilities Commission (PG&E 2019). CCA programs such as Clean Power SF and MCE provide online literature for their customers, in which they lay out the various rates associated with their different packages as well as the rates based on the type of customer a client might be; that being a residential or commercial customer account. Although unique negotiations occur within each CCA program, in general the rates do not appear to vary widely from community programs to community programs. Comparing these two programs there is little variation between the two rate structures; for example, MCE charges around $0.117/kWh during the peak of the summer season and Clean Power SF charges approximately $0.115/kWh during the same time of year (MCE, 2019 and Clean Power SF, 2019).

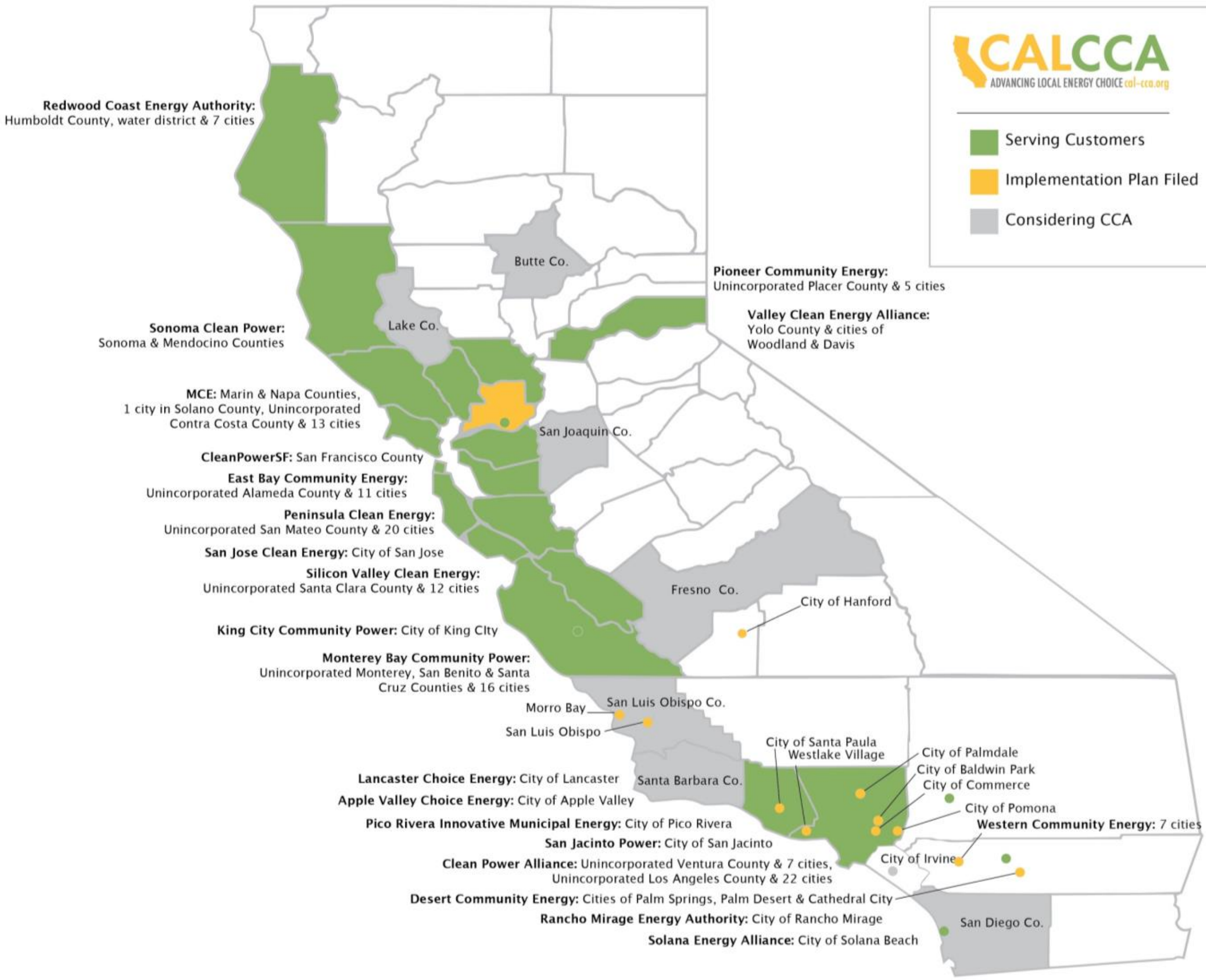

Figure 1. California CCA actual and proposed coverage (CalCCA, 2019)

d. MCE

The specific CCA of interest in this study is one of the Northern California programs called MCE, formerly known as Marin Clean Energy. Starting on May 7, 2010, Marin Clean Energy began supplying electricity to Marin County customers, residential and commercial, who opted into the new program (Faulknerk, 2010). As the company began to make headway in the California energy market, in April of 2013 the CCA program began offering different clean energy efficiency packages to their customers (MCE, 2018). What began in Marin County has now spread across four San Francisco Bay Area counties (Marin, Napa, Solano and Contra Costa), enveloping 34 different communities (Concord, Danville, El Cerrito, Lafayette, Martinez, Moraga, Oakley, Pinole, Pittsburg, Richmond, San Pablo, San Ramon, Unincorporated Contra Costa, Walnut Creek, Belvedere, Corte Madera, Fairfax, Larkspur, Mill Valley, Novato, Ross, San Anselmo, San Rafael, Sausalito, Tiburon, Unincorporated Marin, American Canyon, Calistoga, Napa, St. Helena, Unincorporated Napa, Yountville, Benicia and Unincorporated Solano). As the coverage of the company coverage expanded, the program rebranded as simply MCE (MCE, 2019). The adoption of MCE energy has been quite successful, and the impact it has had on the environment is impressive. Across all four of the major counties, the aggregate estimates that nearly 343,000 metric tons of GHG emissions have been reduced over the lifespan of MCE, which is equivalent to taking almost 72,000 cars off the road for one full year (MCE, 2019). In Marin County alone there are roughly 94,000 customers, both residential and commercial, and together it is estimated they have reduced their emissions by over 178,800 metric tons (MT) of GHG emissions; equivalent to approximately 38,000 cars being taken off the road for a year (MCE, 2019 and MCE, 2019).

Since their initial launch of electricity projects in 2013, MCE has created and now offers three different renewable Energy Packages: the 60% renewable energy plan (company package known as Light Green), the 100% renewable energy plan (company package Deep Green), and the 100% localized solar plan (company package known as Local-Sol) (MCE, 2019). The MCE Light Green plan is the package usually opted into first, but the mix of resources that supply this package are only 60% renewable (Solar, wind, biowaste/biomass, geothermal, and eligible hydroelectric) and the remaining 40% is comprised of non-renewable resources (large-scale hydro, and other electricity purchases not linked to a specific source) which still have emissions and environmental impacts associated with them (MCE, 2019). It is the goal of the CCA program to improve upon their renewable Light Green package by increasing the renewable energy portfolio from 60% to 70% by 2030, but this is all dependent on rate negotiations and the availability of the necessary energy products (MCE Technical Committee, 2018). The increased cost of the MCE Deep Green plan has led to a slower adoption, but it utilizes 100% renewable energy sources to meet the energy demand. In order to have 100% clean electricity, 50% of the energy procured and provided is from wind projects and the remaining 50% is supplied from solar projects (MCE, 2019). The final energy package offered is the Local-Sol option which entails that 100% of all of the electricity provided by this package is supplied by California solar projects only (MCE, 2019) Each of the renewable energy packages could play a role individually or in tandem in making the energy transition, while meeting or exceeding the energy demands, for Dominican University of California. Each package utilizes a different mix of energy resources and in turn has a different cost associated with each one. The final utility cost billed to the customer is determined by a summation of how much it costs to generate the clean energy, the cost of transmitting the energy across PG&E utility lines, the cost of PG&E administration processing, and a small franchise fee for using MCE (MCE, 2019).

MCE utilizes specialized rate calculators in order to determine their kilowatt per hour (kwh) usage rates for both commercial and residential customers. There are separate rates attributed to not only each season (summer and winter) but also to the different times of day (Peak, Part-Peak and Off-Peak hours) (MCE, 2019). MCE identifies Summer as service provided between May 1st through October 31st and winter is identified as service provided from November 1st through April 30th (MCE, 2019). In terms of the rates attributed to the time of day, MCE has three different rate structures for Summer (Peak, Part-Peak and Off-Peak hours) and only two for winter (Part-Peak and Off-Peak hours) (MCE, 2019). Within the online structure of each CCA website there are documents available that lay out the various account classifications that non-residential and residential customers can choose from (MCE, 2019). However, regardless of which utility provider, or renewable energy package is elected, the commercial account sub-type attributed to the customer will have different energy rate costs associated with it (Pacific Gas and Electric, 2019). As a commercial account MCE customer have 25 different sub-account types that could be chosen from and depending on the classification various rates are attributed to each type of sub-account (MCE, 2019). For example, an A1-X Small General Service with Time-of-Use (TOU) account is charged

$0.0117 /kWh during the peak of the Summer season whereas an A10-X Medium General Service TOU account is charged $0.144 /kWh during the peak of the Summer season. When the account type is elected or determined from looking at your current standing energy bill, the commercial customer can contact the CCA and as a prospective client can retrieve the MCE Commercial Rate Calculator in the form of an editable Microsoft Excel document. The client utilizes the Microsoft Excel calculator specifically calibrated for their sub-account type in order to input their energy usage data, in kilowatt hours (kWh), and predict the costs per month of the various energy packages offered by not only MCE, but PG&E as well. As an extra facet to the MCE Commercial Rate Calculator, calculations are also carried out to determine how many pounds (lbs.) of CO_2 emissions will be emitted as the result of electing either MCE (Light Green and Deep Green) or PG&E as the energy supplier.

e. Dominican University of California

The subject of this research project is a small private university known as Dominican University of California (DUoC). The small Liberal Arts university takes its name from Saint Dominic de Guzman, who was born around 1172 in Caleruega, Spain. In 1890 the Dominican Sisters of San Rafael, also known as the Congregation of the Most Holy Name, became Incorporated in the State of California. In 1915 the Dominican Sisters opened the doors of a junior college and two years later it became a four-year college under the name "Dominican College of San Rafael". The campus of the University is nestled within a residential neighborhood in San Rafael within Marin County; just 12 miles North of the Golden Gate Bridge. For the first 56 years the college was in operation the campus only educated female students and provided housing for the Dominican Sisters within a single building. By the time the college became co-educational in 1971, the institution added an additional nine buildings to the campus footprint. These buildings were a blend of converted residential homes and independently developed structures. In the academic year of 2000 - 2001 Dominican College of San Rafael made the decision to re-name itself "Dominican University of California". The campus present day provides educational services to over 1,700 full-time students, with nearly 1,200 students being undergraduates, manifesting an average class size of 16 students. With a faculty assembly of nearly 323 instructors and 324 of staff at DUoC (Dominican University, 2019).

The campus of DUoC holds a special mission and values that goes beyond the student and the community and upholds their Catholic roots. The mission statement states that "Dominican educates and prepares students to be ethical leaders and socially responsible global citizens who incorporate the Dominican values of study, reflection, community and service into their lives. The University is committed to diversity, sustainability and the integration of the liberal arts, the sciences and professional programs." As a community member, the University has taken pride in offering tools for living a more sustainable lifestyle to not only the campus community, but also to any adjacent community members. On the operations side of the campus the University takes numerous measures to try and be sustainable as each space is drawing power regardless of occupancy; whether it is for the alarm systems, emergency lights, or the equipment within each space there is electricity being consumed twenty-four hours a day, seven-days a week. In terms of energy consumption specifically, the campus has implemented several methods to assist and reduce the electrical dependence of the University. For example, the University has implemented the use of temperature control timers, lighting motion sensors and smart energy metering around the campus to try and minimize electricity usage (Dominican University of California, 2019). Unfortunately, due to aged infrastructure and a shrinking budget, these energy saving features are not in 100% of the buildings on campus (Dominican University of California, 2019). The buildings that are utilizing the technology have seen an improvement in kWh used and overall functionality of the spaces. Although there has been an improvement in campus usage, the University is still under an account with a utility provider that is procuring its energy from non-renewable resources.

Compared to 12 various sources from higher education campus energy usage studies, the DUoC campus is a rare type of campus in that close to all of the buildings have their utility usage monitored by their own utility meter and thus have their own utility bill associated with it (Baboulet and Lenzen, 2010; Borin et al., 2014; Coccolo et al., 2015; Han et al., 2015; Klein-Banai and Thomas, 2011; Kuo, 2014; Letate et al., 2011; Lozano, 2013;

Robinson et al., 2015; Robinson et al. 2017; Shoemaker, 2018; Townsend and Barrett, 2015 and Xu et al., 2018). On the campus of DUoC there are 34 spaces utilizing energy; 24 of these spaces (the Conlan Center (Recreation Center), Bertrand Hall, Martin De Porres, Magnolia House, Facilities Services (Quonset Hut), Forest Meadows Amphitheatre and Athletic Complex (Forest Meadows Field, Castellucci Family Tennis Center, and John F. Allan Athletics Complex and Kennelly Field), Brown House, Edge Hill Village #100, Edge Hill Village #200, Edge Hill Village #300, Edge Hill Village #400, Edge Hill Village #500, Edge Hill Village #600, Edge Hill Village #700, Meadowlands Hall, Joseph R. Fink Science Center, Angelico Hall, Edgehill Mansion, Guzman Hall and Ralph Minor, and Albertus Magnus) have their energy usage measured by their own utility meter, or is bundled with an additional space(s), and thus have a separate utility account/bill associated with it (Figure 2) The remaining 10 spaces (the Pennafort and Fanjeaux freshmen residence halls, the Archbishop Alemany Library, the housing for the President of the University, Anne Hathaway Cottage offices, the San Marco gallery, the Edge Hill Village laundry room, the Carriage House, the Creekside Room and the Caleruega Dining Hall) are measured by a single utility meter and thus aggregated on a single utility bill; this account is noted as simply the Campus Main Line (Figure 2).

Each of the spaces on campus are utilizing varying kwh of energy due to their variations in square footage, infrastructure, capacity and day-to-day usage (Table 1). Although these factors individually do not dictate the total kWh the utility meter is recording each month, in combination these factors will determine the overall amount of energy that is being used. The University has systems (e.g. HVAC, security systems, scientific equipment, etc.) that are operational all times of the year regardless of occupancy and as such are constantly utilizing electricity (Dominican, 2019). As there are 20 different utility accounts under the DUoC name, the University is in a unique situation when it comes to electing a utility provider. According to the PG&E utility bills for the University, the campus accounts falls specifically under the A1-X commercial class (Small General Service with TOU), which simply means DUoC is charged for the amount of energy used in kilowatts (kW) over a fixed amount of time (hours) (Shoemaker, 2018). Although the specifics as to why the University has this classification over others was not released to the entity conducting this research, it is an important classification as it will determine the specific utility rates that will be utilized in the MCE Commercial Rate calculator for the predictive cost analysis. If the wrong commercial classification were to be utilized in the Microsoft Excel calculator the resulting electricity cost data would be heavily skewed and inaccurate.

Table 1. Dominican University of California utility accounts with Associated Function

Account Name	**Function**
Recreation Center	Multipurpose Gym, Basketball Courts and Pool
Bertrand	Marketing and Administration
Martin De Porres	Classrooms
Magnolia House	Admissions
Quonset Hut	Facilities Services
Amp/Athl Complex	Amphitheatre, Lacrosse and Softball Field, Tennis Courts
Campus Main Line	Two freshman dormitories, Library, President of the University Housing, Office Spaces, Studio Art Building, Laundry Room, Human Resources, Meeting rooms and Dining Hall
Brown House	Art Department
EHV#200	Upperclassmen Dormitory
EHV#300	Upperclassmen Dormitory
EHV#400	Upperclassmen Dormitory
EHV#500	Upperclassmen Dormitory
EHV#600	Upperclassmen Dormitory
EHV#700	Upperclassmen Dormitory
Meadowlands	Nursing and Occupational Therapy Department
Science Center	Natural Sciences and Mathematics Department
Angelico Hall	Concert Hall, Arts & Humanities Department, Classrooms
Edgehill mansion	Housing, Student Life, Campus Ministry, Meeting Room, Chapel, Dean of Students, Title 9 Office, International Studies
Guz Hall/Ralph Minor	Senior Administration, Classrooms, IT, Lecture Hall
Albertus Magnus	Classrooms and Offices

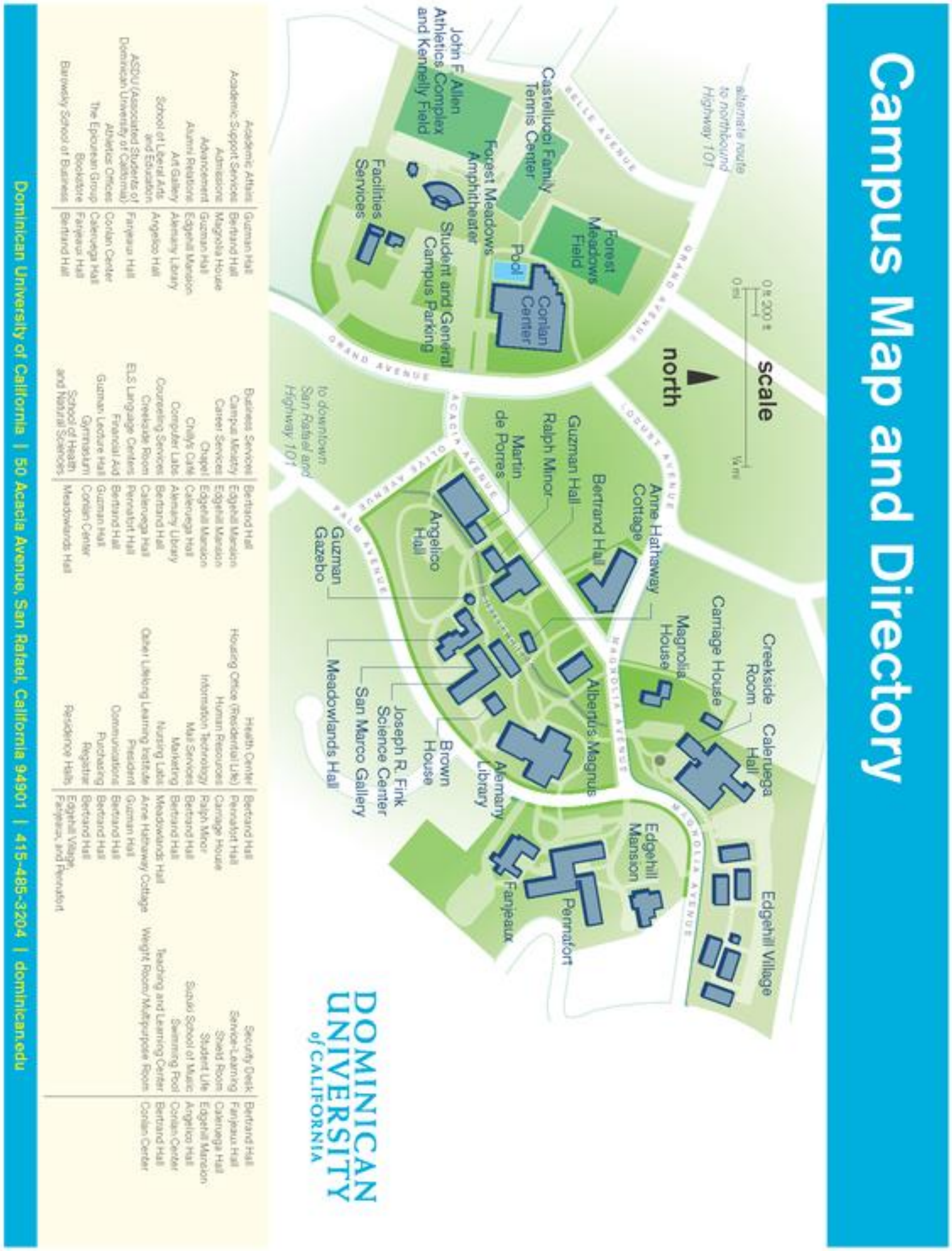

Figure 2. Campus map of Dominican University of California. (Dominican University of California, 2019)

i. The DUoC Sustainability Committee

The Sustainability Committee has seven members representing the entire campus, from faculty, staff and administration. The Sustainability Committee at Dominican University of California has consistently been trying to transition the University to a truly sustainable, and cleaner renewable energy resource for nearly three years. In the Spring of 2017, the Sustainability Committee created an initial utility transition proposal for the campus. It was presented to the Chief Financial Officer and the Director of Facilities and Grounds. It unfortunately failed as the Committee merely had rough estimates of comparative systems that were available from online resources rather than hard data that could be discussed with the board of directors to create a compelling case for transition. Until recently the Committee was unable to obtain any of the utility account detail electrical data for analysis of the campus consumption of electricity. This proved to be a major roadblock for many years, because in order to bring a transitional proposal to the University Board of Trustees, the Sustainability Committee required the utility bills for the University in order to run a cost comparison analysis between PG&E and the local CCA program, MCE. The new Director of Facilities and Grounds at the University, Mr. John Hashizume, joined the staff in August of 2018 and with this change of leadership, came a new outlook for the University campus, and an understanding of the improvement that could be made even if it seems incremental. John sponsorship has been instrumental in aiding the rekindled efforts to convert the University to renewable, sustainable and clean energy in the near future.

After the Sustainability Committee had brought forward the initial desire to make the transition to MCE, John expressed to the Committee that although he felt Dominican University as a whole should transition to a renewable package(s), he instructed the Committee needed to complete a thorough analysis of the DUoC 2018 utility bills for the entire campus. Near the end of May 2019, the utility bills from the previous year (2018) were retrieved from the Department of Facilities and Grounds; 20 individual utility bills were handed over to the Committee for data processing. With the University utility bills in hand, the analysis could begin, and the question of whether or not it is feasible for Dominican University to transition to clean renewable MCE power could be addressed. With a thorough analysis in hand, John and the Committee could bring the transition proposal forward to the Board of Trustees, and the rest of the University for any final decisions made.

3. Methodology

a. Data Procurement

The data of interest within each of the 20 utility bills were the monthly energy usage data for each of the utility accounts around the DUoC campus. The account(s) with the largest kWh "Peak Usage" data for summer and winter (Peak, Part-Peak, and Off-Peak) were the data of specific interest for the cost analysis. The kWh energy usage data isolated for each utility account can be inputted into the Commercial Rate Calculator provided by MCE. The calculator used initially was downloaded in the form of a workable Microsoft Excel datasheet from the MCE website (Busto, 2018). The commercial rate calculator not only calculates what MCE is going to charge for its renewable energy packages, using the commercial rates determined by the CCA, but it also produces data for various PG&E energy packages so the two companies and their commercial energy rates can be compared (MCE, 2019). There is an additional component to this calculator; MCE utilizes the utility data extracted from the electricity bills of the University and predicts the number of pounds of carbon dioxide (CO_2) Dominican University of California would be emitting depending on which utility provider the University is going to be using. Although it is very important for the University to know how much money will be needed, to budget for the electricity bills, it is also important to Dominican that they fulfill the sustainability goals of the mission statement not only economically, but environmentally and morally as well.

b. Analysis Design

Over the entire month of June 2019, utilizing the Marin Clean Energy Commercial Rate Calculator that can be found on the MCE website, each of the 20 utility accounts belonging to Dominican was analyzed extensively (Busto, 2018). As confirmed by the PG&E electricity bills, the University is classified as an A1-X Small General Service with TOU account and as such the rate calculator being utilized will be specifically computing the rates that would be applied to an A1-X customer class. Although there are varying classes that currently fit under the Small General Service category the University falls specifically under the A1-X class. It is vital that the calculator is set to the right account as the commercial rates laid out in the General Service (non-residential) Rate document vary from class package to class package (MCE, 2019). With a large number of independent utility accounts and bills contained within one University, any slight difference in rate costs could add up very quickly.

In order to understand exactly what the seasonal usage of the University looks like, the Director of Facilities and Grounds asked for three separate Microsoft Excel documents for each utility account to be created before a final compilation document for the 2018 cost comparison analysis between the prospective providers, PG&E and MCE, was to be created. One document would hold the data for the summer season usage, the second containing the data for the winter season usage and the third contains the combined data, and thus true monthly rate the University may have been charged, if it were on either of the MCE renewable packages vs. the various PG&E services. The final document that was created took the data rendered in the various individual Microsoft Excel calculators and consolidated the data into a single cost analysis Microsoft Excel document. This document contains the difference data for what PG&E did charge monthly for each utility account vs the price MCE would have charged if the University were under the MCE 60% renewable energy plan (Light Green) or the MCE 100% renewable energy plan (Deep Green) utilizing the same amount of kWh.

Out of the five types of statistical analysis, this study made the decision to conduct a ‘difference’ type of analysis as this research is analyzing two different entities in order to identify if there are similarities and/or differences. Histograms were generated for the comparison of each utility provider and energy package as the data would be visualized side by side in an easier to digest bar graph. If the generated visualizations proved to be inconsequential further analysis was conducted on the energy usage data. The cost analysis would be taken a step further within the same Microsoft Excel document, where the projected monthly rate data for each provider and package would be annualized to project what a full calendar year expenditures might have looked like in 2018, if the University had been a customer of MCE and utilized the maximum amount of energy for all 12 months.

c. Carrying Out the Analysis

With the analysis strategy in place and the physical paper utility bills retrieved from the Department of Facilities and Grounds, the data analysis could begin. The kWh data for each utility account: “Summer Peak Usage”, “Summer Part-Peak Usage”, “Summer Off-Peak Usage”, “Winter Part-Peak Usage”, and “Winter Off-Peak Usage” was compiled within Microsoft Excel. Before conducting the rate calculations for each utility account, it was decided that the project should first determine and analyze the two utility accounts that are utilizing the largest amount of energy. Although the campus has large buildings that are occupied and utilizing energy nearly year-round, there are four utility accounts that register the most kWh: The Recreation Center, the Marketing and Administrative Building (Bertrand Hall), the Science Center, and finally the Campus Main Line. The two utility accounts that are costing the University the most in terms of electricity, as of 2018, are the Science Center and the Campus Main Line accounts; the Campus Main Line account is a collection of quite a few heavy use buildings, specifically the two freshmen residence halls on campus, the library, the housing for the President of the University, a small office building, and the dining hall. These are the two accounts that were analyzed first in order to get an idea as to whether or not a full cost analysis would be worth the effort.

With the two largest utility accounts of Dominican University identified for analysis the next step was to determine which month within the MCE Summer, and MCE Winter season time frames has the greatest amount of kWh usage. MCE has their Summer season starting in May and finishing out at the end of October. The winter season for MCE begins the first of November and ends at the end of April. Upon examination of the collated 2018 PG&E utility bill data, the energy usage data for the peak months of summer and winter was extracted from or both the Campus Main Line and the Science Center utility accounts. Copies of the original MCE commercial calculator were made, and each version of the document was renamed to correspond with the season(s) and utility account it would represent.

As the Director of Facilities and Grounds, John, had requested during the analysis design phase of the project, for each of the two larger utility accounts, three separate Microsoft Excel documents were created, for each of the seasons (summer and winter);

separately and combined. Using the Microsoft Excel documents containing the rate calculator, the electrical usage data for each of the two energy intensive utility accounts, the Science Center and the Main Campus Line, was input into its corresponding seasonal document for analysis. Upon taking a preliminary look at the two sets of energy usage data that were compiled for the largest accounts, John confirmed the preliminary observation that there was enough of a cost difference between the two tested providers, and as such the cost analysis calculations should be conducted for the remaining 18 University utility accounts. Although the collective seasonal data are what would be compiled into the final master document, it was still imperative to analyze each season in relation to the utility account as to ensure the DUoC cost analysis represents the maximum expense the University campus could be charged in a given year. As such each utility account had three separate documents created detailing the seasonal usage and accompanying rates.

Upon completion of all 61 Microsoft Excel documents of utility account data, everything was collated into a single Microsoft Excel datasheet, for each season (summer and winter) and each utility account independently. The data output from the collective data gave a more accurate depiction as to the monthly rates, price per kWh, DUoC could have been paying if the campus were an MCE utility customer under either package in 2018. With the final calculations ready to be displayed and discussed, final master documents were produced for both the cost analysis and emissions impact. The cost analysis document includes columns containing the data for: the total kWh consumed by each utility account for the peak months in 2018, the monthly cost per kWh for each utility account in relation to each of the utility companies, as well as the renewable package offered, the cost difference between the two utility providers, and the predicted annualized savings or cost for each electricity provider. The emissions analysis document contains data for: the total kWh consumed by each utility account for the peak months in 2018, the monthly pounds of CO_2 emissions each utility account would emit in relation to each of the utility companies, as well as the renewable package offered, the emissions difference between the two utility providers, and the predicted annualized difference in pounds of CO_2 that would be emitted depending on which renewable energy package.

The final cost analysis document was completed and already converted into four easy to digest histograms (one comparing MCE Light Green costs with PG&E, one comparing MCE Deep Green costs with PG&E, one comparing MCE Light Green Emissions with PG&E, and one comparing MCE Deep Green Emissions with PG&E), all that was needed was the final approval from John. During the Sustainability Committees meeting in early August 2019, John informed the Committee that MCE had updated their rates, and renewable packages as of July 1, 2019. With this information in hand, it became apparent that the project data needed to be updated, if the renewable energy transition proposal was to still be brought to the Chief Financial Officer of the University. Due to the rates being relatively new to the public domain, the updated MCE Commercial Rate Calculator had not yet been updated on the MCE website, or anywhere accessible with online resources. John retrieved and forwarded the updated July 2019 Commercial Rate Calculator from his correspondence with the MCE contact for the University. With the new Microsoft Excel document obtained and ready to be utilized, the utility data for each account, and corresponding visuals were updated and resynthesized into a final cost analysis document.

Although an assumption could have been made, it was imperative that the full analysis carried out above was repeated using the new MCE Commercial Rate Calculator. As such each utility account has three corresponding updated Microsoft Excel calculator documents that were then compiled in an updated cost analysis document. Although the price per kWh varied between the two rate calculators, the calculated pounds of CO_2 that could have been emitted did not vary as the carbon emitted in order to procure and transport the energy has not changed. With the final cost analysis document finalized it was sent over to John for approval. With approval, the summary table for the cost analysis was created. Four updated histograms were generated to be used in the comparisons between the initial cost analysis, and the updated cost analysis for the two renewable packages. The emission analysis data did not change upon recalculation and as such new histograms did not need to be created. Both cost analysis documents and all six histograms were presented to the Director of Facilities and Grounds; and is to be brought in front of the CFO for transition consideration.

4. Results

In comparison to the 20 utility accounts around the University campus, both the Campus Main Line account and the Science Center account independently pull roughly three times the kWh usage of the larger usage buildings, and more than 70 times as much energy as the smaller usage buildings on campus (Table 2). The two largest accounts were analyzed for their peak consumption periods during the calendar year. Upon compiling all of the energy use data for the Science Center account, it was clear the month of October was the peak month of the summer season, far greater than the month of September, with nearly 83,750 kWh of energy being used in just six months. As such the electricity data for the month of October is the focus of the summer cost and emissions analysis of the Science Center account. For the winter season of the Science Center account, the month of February had the greatest amount of kWh usage, totaling around 90,478 kWh utilized by the building. This is over 9,000 kWh more energy being utilized in the building than the month previous, indicating this month as a clear outlier in the utility dataset. Although it is not readily clear from the energy usage data as to where the higher energy consumption is being utilized in the building, it was clear that the energy usage data from February must be included in the analysis. The demand for power by the Science Center account far exceeds any and all spaces on the DUoC campus primarily due to the large amount of technological equipment and refrigeration units within the space.

Table 2. Cost analysis of energy use on the Dominican University of California campus utilizing the 2019 MCE Commercial Rate Calculator. Potential cost savings are denoted by the red values.

Utility Account	**Consumption (kWh) for peak months**	**PG&E Actual Cost**	**MCE Light Green Cost/ Month**	**Light Green vs. PG&E**	**MCE Deep Green Cost/ Month**	**Deep Green vs. PG&E**	**Light Green vs. PG&E Annualized**	**Deep Green vs. PG&E Annualized**
Rec Center	51,178	$12,245	$12,245	-$19	$12,738	$493	-$228	$5,913
Bertrand	42,845	$10,096	$10,081	-$15	$10,509	$414	-$178	$4,963
Martin De Porres	2,582	$613	$613	-$1	$638	$25	-$11	$299
Magnolia House	3,735	$900	$899	-$1	$936	$36	-$16	$432
Quonset Hut	5,523	$1,459	$1,457	-$2	$1,518	$59	-$22	$709
Amp/Athletic Complex	8,085	$1,925	$1,923	-$2	$2,004	$79	-$28	$942
Campus Main Line	117,795	$28,185	$28,141	-$43	$29,319	$1,135	-$521	$13,614
Brown House	1,514	$372	$371	-$1	$386	$15	-$7	$174
EHV#200	4,174	$979	$977	-$1	$1,019	$40	-$16	$484
EHV#300	5,689	$1,320	$1,318	-$2	$1,375	$55	-$22	$661
EHV#400	3,858	$903	$902	-$1	$941	$37	-$15	$448
EHV#500	5,192	$1,208	$1,207	-$2	$1,258	$50	-$20	$603
EHV#600	5,712	$1,329	$1,328	-$2	$1,389	$55	-$22	$663
EHV#700	7,244	$1,659	$1,657	-$2	$1,729	$71	-$23	$846
Meadowlands	21,773	$5,232	$5,224	-$8	$5,441	$209	-$99	$2,514
Science center	174,229	$41,651	$41,583	-$67	$43,326	$1,675	-$808	$20,100
Angelico Hall	11,621	$2,740	$2,736	-$4	$2,852	$112	-$49	$1,346
Edge Hill Mansion	10,120	$2,378	$2,374	-$3	$2,475	$98	-$41	$1,173
Guzman Hall/Ralph Minor	19,848	$4,719	$4,712	-$7	$4,911	$191	-$88	$2,293
Albertus Magnus	5,308	$1,359	$1,357	-$2	$1,413	$54	-$26	$646
Total		**$121,272**	**$121,085**	**-$187**	**$126,174**	**$4,902**	**-$2,242**	**$58,825**

Looking back at the utility bills for the Science Center account and the Main Campus Line account there was little correlation between the two utility accounts and their peak months of energy usage. When turning the analysis onto the Main Campus Line account the utility analysis presents a notable difference in energy consumption but not quite as stark as the difference seen in the Science Center account comparatively. The Main Campus Line utility bill for the true peak month were unfortunately missing the three-page breakdown of peak usage data needed for the calculator, as a result a comparative month was substituted; April of 2018. The stand-in peak month dataset utilized provided the necessary information but only varied by 321.3 kWh of energy versus the true peak month. Due to the lack of transparency of the utility bill for the Main Campus Line and the lack of access to the three pages of the utility bill containing the peak usage data for analysis it was determined that the project would be computing the necessary factors using the month of April merely for computational purposes. The Main Campus Line pulled approximately 79,696.2 kWh of electricity in the month of April across ten different campus spaces. With the peak months now identified for each of the two more energy demanding utility accounts, the data would now be entered into the MCE Commercial Rate Calculator. The resulting data for the two largest accounts indicated the feasibility of making the transition and as such the MCE Commercial Rate Calculator was applied to the kWh data for the remaining 18 utility accounts.

When the first round of calculations was conducted in August of 2019, it appeared as though there could be significant savings for the University depending on which of the MCE renewable energy packages was adopted. When analyzing the initial histograms however there appeared to be little to no savings for the University, in fact visually it appeared as though the University might end up spending extra for their energy usage depending on what energy package was selected. As the utility data for each utility account was updated the initial savings that was apparent using the first commercial calculator began to shrink rather quickly. Preliminary glances at the updated calculation results and histograms indicated the new rates for both MCE renewable energy packages appear to be quite similar to what PG&E was charging the University (Table 2, Figures 3 and 5). However, when the updated calculator data was annualized utilizing the same kWh utility data, the savings margin became much smaller for the Light Green option and the expenses margin started to become larger for the Deep Green package (Table 2).

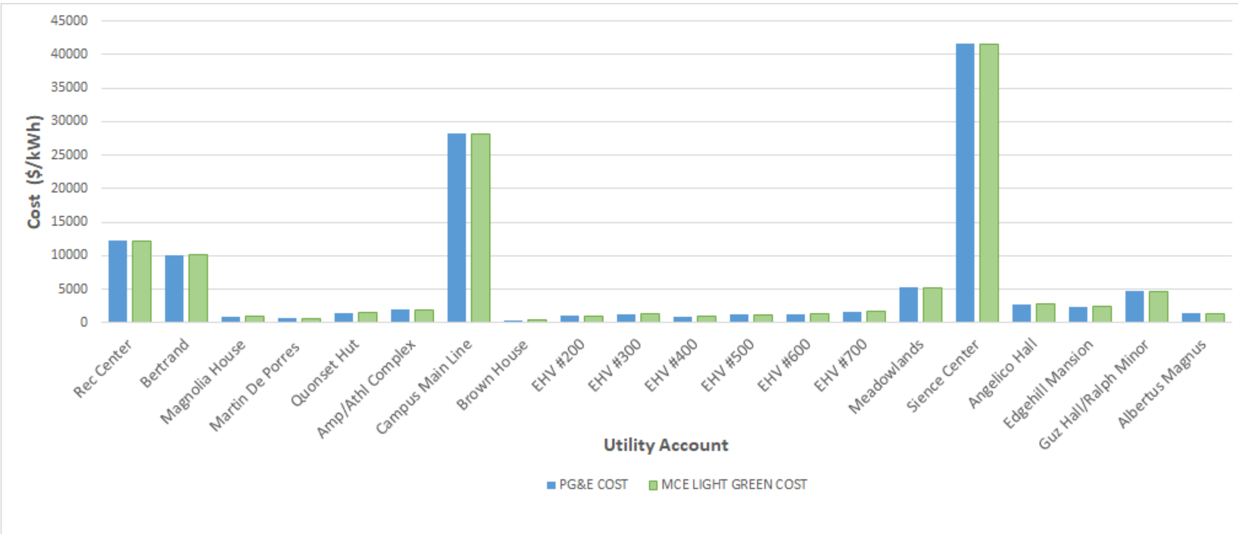

Figure 3. Monthly kWh cost comparison between MCE Light Green rates and PG&E for the campus of Dominican University of California.

In regard to a single one of the renewable energy packages, MCE Light Green, the projected monthly savings were calculated to be less than $20 for all of the DUoC utility accounts excluding the Science Center and Camus Main Line account (Table 2). Even the third and fourth largest utility accounts do not surpass the $20 savings threshold; $14.85 for the Bertrand Hall account and $19.03 for the Recreation Center account (Table 2). The results of the MCE Commercial Rate Calendar predict a monthly savings of $43.43 for the Campus Main Line account and $67.30 for the Science Center account (Table 2). The annual cost savings for each of the campus utility accounts attributed to the Light Green package vary widely from a low of seven dollars to a high of $808 (Table 2). The greatest annualized savings correlate to the four largest DUoC utility accounts; the Recreation center at just around $57, Bertrand Hall lowest of the four at $45, the Campus Main Line at the second highest of $130 and the Science Center as the largest with $202 annually (Table 2). The total financial savings for the complete transition of the University campus and all of the utility accounts to MCE Light Green, could be approximately $561/annually (Table 2). Although the amount of updated cost savings is far lower than what was anticipated or desired by both the research team and sustainability committee, the current energy package being utilized by the campus, provided by PG&E, is not 60% renewable energy. Over the course of 2018, the University paid over $121,000 for this non-renewable electricity (Table 2).

If the entirety of the campus utility accounts would have been converted to the MCE Light Green package in 2018, the campus would have saved a little over two thousand dollars in the year of 2018 alone and would also have reduced their carbon footprint of the campus. Regardless of which rate calculator was utilized the emission data was not affected as the associated GHG emissions are not associated to the utility rates and/or fees for electricity from MCE. As might be anticipated the utility accounts that utilize the greatest amount of electricity also emit the greatest amount of CO_2 and other GHG emissions. The four largest utility accounts for the University could have generated monthly emission reductions ranging from 14lbs of CO_2 to 1,568lbs of CO_2 (Table 3). The Science Center and the Campus Main Line generate the most GHG savings with projected monthly savings of around 1,568lbs of CO_2 and 1,060lbs of CO_2 respectively (Table 3). Although there is a significant amount of GHG emissions being kept out of the environment, just under 4,600lbs of CO_2 per month, the histogram visualization of the emission data for the MCE Light Green package appeared to show an inconsequential amount of emission reduction across the campus accounts (Figure 4). However, when looking at the annualized CO_2 emissions data, the comparison data between PG&E and MCE tell a different story (Table 3). If the University had done a full account conversion to MCE Light Green, DUoC as a campus could have prevented approximately 13,737lbs of CO_2 from being released into the environment over the course of 2018 (Table 3). The Science Center account as it stands alone could feasibly reduce the GHG emissions of the University by approximately 4,704lbs of CO_2 per year; accounting for approximately 34% of the projected CO_2 emissions savings with a single account switching (Table 3).

Table 3. Carbon Dioxide (CO_2) emission analysis on the Dominican University of California campus utilizing the 2019 MCE Commercial Rate Calculator. Potential emissions savings are denoted by the red values.

Location	**Consumption (kWh) for peak months**	**PG&E Emissions (Lbs. CO2)**	**MCE Light Green Emissions (Lbs. CO2)**	**Light Green vs. PG&E**	**MCE Deep Green Emissions**	**Deep Green vs. PG&E**	**Light Green vs. PG&E Annualized**	**Deep Green vs. PG&E Annualized**
Rec Center	51,178	15,046	15,046	-460	0	-15,046	-5520	-180,552
Bertrand	42,845	12,597	12,597	-386	0	-12,597	-4632	-151,164
Martin De Porres	2,582	759	736	-23	0	-759	-276	-9,108
Magnolia House	3,735	1,098	1,064	-34	0	-1,098	-408	-13,176
Quonset Hut	5,523	1,791	1,737	-23	0	-1,791	-648	-21,492
Amp/Athletic Complex	8,085	2,377	2,304	-73	0	-2,377	-876	-28,524
Campus main line	117,795	34,632	33,572	-1,060	0	-34,632	-12720	-415,584
Brown House	1,514	445	431	-14	0	-445	-168	-5,340
EHV#200	4,174	1,227	1,190	-37	0	-1,227	-444	-14,724
EHV#300	5,689	1,672	1,621	-51	0	-1,672	-612	-20,064
EHV#400	3,858	1,134	1,100	-34	0	-1,134	-408	-13,608
EHV#500	5,192	1,526	1,480	-46	0	-1,526	-552	-18,312
EHV#600	5,712	1,679	1,628	-51	0	-1,679	-612	-20,148
EHV#700	7,244	2,130	2,064	-66	0	-2,130	-792	-25,560
Meadowlands	21,773	6,401	6,205	-196	0	-6,401	-2352	-76,812
Science center	174,229	51,223	49,655	-1,568	0	-51,223	-18816	-614,676
Angelico Hall	11,621	3,417	3,312	-105	0	-3,417	-1260	-41,004
Edge Hill Mansion	10,120	2,975	2,884	-91	0	-2,975	-1092	-35,700
Guzman Hall/Ralph Minor	19,848	5,836	5,657	-179	0	-5,836	-2148	-70,032
Albertus Magnus	5,308	1,649	1,598	-51	0	-1,649	-612	-19,788
Total		**149,614**	**145,035**	**-4,579**	**0**	**-149,614**	**-54,948**	**-179,5368**

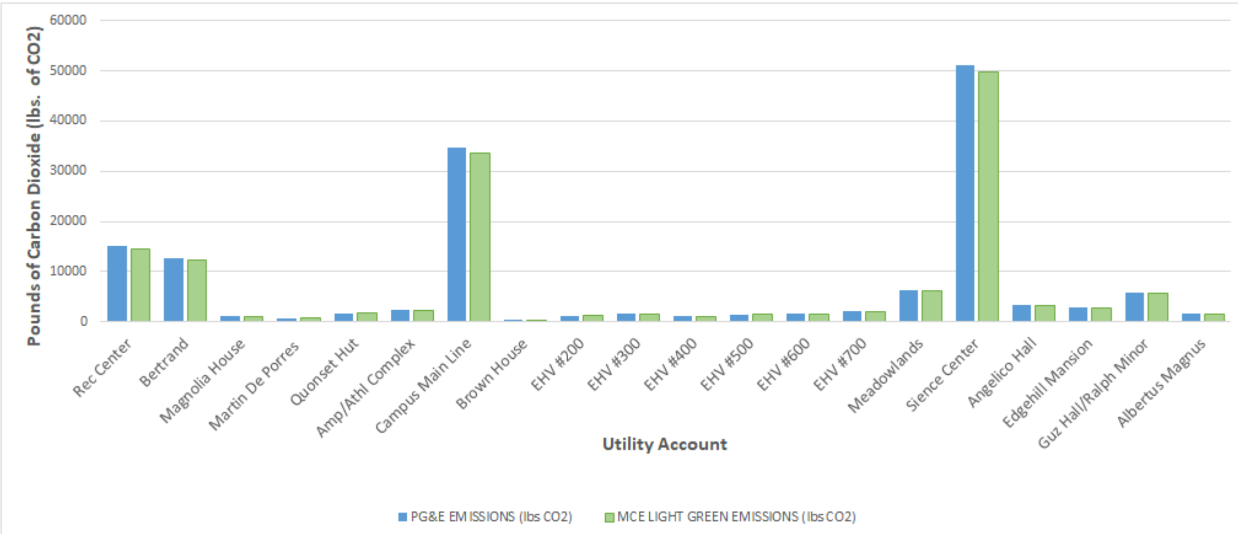

Figure 4. Monthly Pounds (lbs.) of carbon dioxide (CO_2) emissions comparison between MCE Light Green and PG&E for Dominican University of California.

If the DUoC campus made the decision to make a full utility account conversion to the MCE Deep Green 100% renewable energy package, there is going to be an additional financial expense to the annual cost of the utility bill accompanying the Deep Green package that must be taken into consideration (Table 2). It was discouraging to see the predicted cost drastically inflate to $126,174 per month for the Deep Green package once the updated rates were utilized in the MCE Commercial Rate Calculator (Table 2). Although the larger cost difference makes sense as the University would be subscribing to an additional 40% of renewable resources, it is somewhat alarming to present to the Director of Facilities and Grounds an updated value that is nearly three times what it originally was calculated to be. As with the MCE Light Green package the greatest financial expenditure is (attached) to the four largest utility accounts. The financial impact to the four largest utility accounts would have an increased expenditure once converted. Starting with the 4th largest utility accounts: Bertrand Hall their monthly billing would increase to $10,509; the Recreation Center monthly billing would increase to $12,738; the Campus Main Line as the second largest would increase to $29,319 and the Science Center as the largest utility account for Dominican University would increase to a monthly billing of $43,326 (Table 2). In total the University electric bill would be $4,902 more per month when compared to the prior provider, PG&E (Table 2).

The predicted annual expenditures produced from the Commercial Rate Calculator in relation to the MCE Deep Green package further emphasized the extra cost associated with procuring electricity from 100% renewable resources. The four largest utility accounts could have an increased expenditure totaling approximately $11,148 annually: the Bertrand Hall account as the smallest of the four accounts could end up with an increased annual expenditure of $1,478 more; the 3rd largest utility account, the Recreation Center account could cost the university an extra $1,241 annually; the Campus Main Line account could cost the university an extra $3,401 annually and the Science Center account could cost the university an extra $5,025 annually (Table 2). The culmination of the difference data between PG&E and MCE Deep Green would result in the University paying an extra $14,706 a year for 100% renewable energy (Table 2).

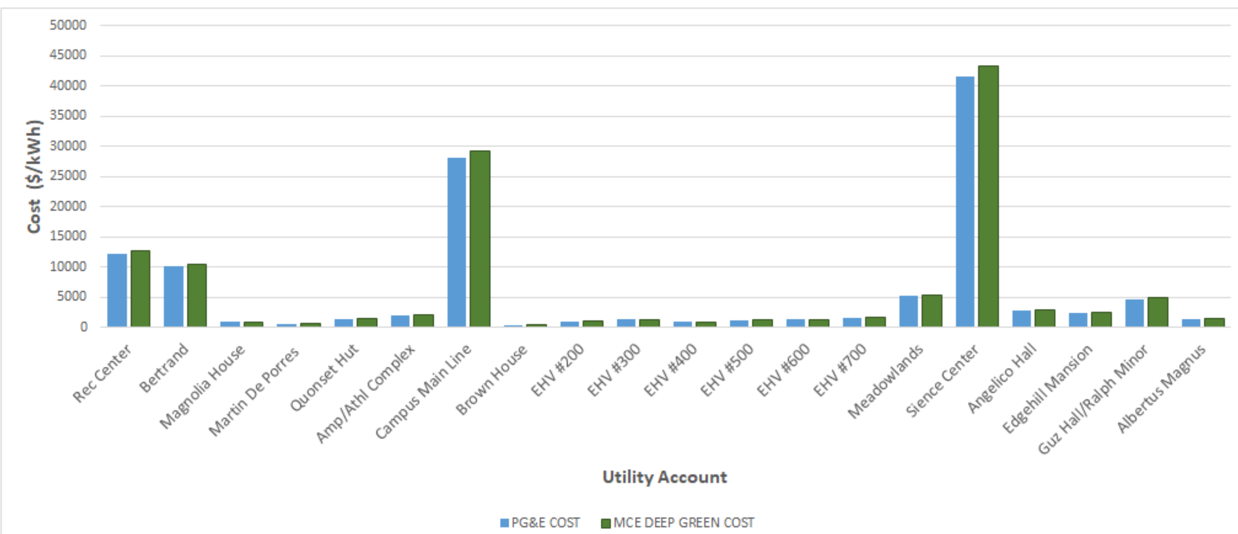

Figure 5. Monthly kWh cost comparison between MCE Deep Green rates and PG&E for the campus of Dominican University of California.

As with the Light Green emission data, the Deep Green emission values did not vary when the cost analysis calculations were redone with the updated kWh usage rates. If the campus was willing to disregard the $14,706 financial impact to the University utilities budget, DUoC could be positively reducing the environmental impact the campus has (Table 2). Due to lack of emissions associated with the MCE Deep Green package, as it is comprised of only clean energy sources, any emissions that would have been produced from PG&E are offset by this choice of energy program (Figure 6). For example, the largest utility account for the university would normally produce approximately 51,223lbs of CO_2 per month under the PG&E account (Table 3). As such if this account elected the MCE Deep Green option it could keep all 51,223lbs of CO_2 per month, or 153,669lbs of CO_2 emissions annually (Table 3). In total the University could be keeping nearly 448,882lbs of CO_2 out of the atmosphere annually if the campus elected to utilize the MCE Deep Green package across all utility accounts (Tables 3). With the updated cost and emission data, more questions arise as to whether or not a transition to MCE could be feasibly cost effective for DUoC, despite the current environmental impact of the campus and their carbon footprint.

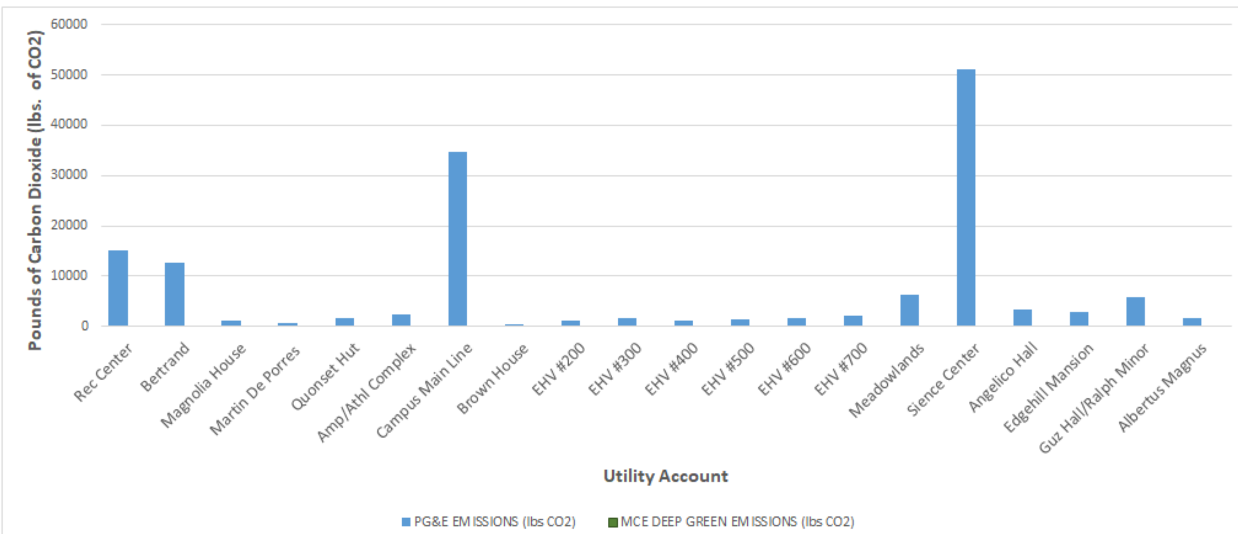

Figure 6. Monthly Pounds (lbs.) of carbon dioxide emissions comparison between MCE Deep Green and PG&E for Dominican University of California.

5. Conclusions and Recommendations

Upon analysis and discussion, DUoC has quite a few options to choose from moving forward. The final results of this analysis were both exciting and unexpected. Although the initial savings computed earlier in 2019 gave the transition more of a financial motivation, there is still the possibility of breaking even or possibly saving money if the campus converted to MCE. Influenced by the mission of the school to be a sustainable environment for not only education but also operation, it was important to visualize the raw data that had been collected in relation to the current campus energy provider in order to better understand their differences. The research created histograms of the monthly kWh costs associated with each campus space in an effort to help visualize any foreseeable cost difference that might exist between MCE and PG&E. However, the resulting visual histograms did not seem to accurately represent the difference in hard data synthesized from the cost analysis conducted using the MCEs Commercial Rate Calculator. If the entirety of the University was to convert to MCEs 60% renewable package (MCE Light Green) there would be a measurable annual savings in both our GHG emissions and finances that could be funneled into other University improvements and needs.

Now taking a look at the MCE Deep Green data does not illicit as much financial reward and hope. Due to the fiscal impact that a total Deep Green conversion would bring about, it would be unwise to recommend to the University to take this course of action. However, it is possible that a mixed model may be successful with the University campus. The money saved from converting one or more utility accounts to the Light Green package could be used to offset the extra costs of the utility accounts that were converted to the Deep Green package. There are a multitude of combinations of utility accounts that if implemented properly could result in the DUoC campus breaking even or generating cost savings.

It is the recommendation of this study that the Director of Facilities and Grounds, examine the possibility of generating a mixed model for the campus to adopt for their energy consumption needs. The ideal scenario would be to take the greatest energy usage spaces of the Dominican University campus (the Science Center, Campus Main Line, Recreation Center and Bertrand Hall) and convert those accounts to the MCE Deep Green energy package and convert the remaining campus utility accounts to the MCE Light Green package. As this would allow a financial gain for the University and gain a step forward in limiting the university's environmental impact. If this proves to be too challenging or convoluted to implement, then a full conversion to MCE Light Green would be the next course of action the analysis readily supports.

This model and approach that has been discussed within this paper could be applied to other systems or university campuses, if the universities or systems had similar attributes to Dominican University. Primarily the system that is in consideration for replacement not only would need to hold the same commercial classification as DUoC (A1-X Small General Service with Time-of-Use (TOU), but the system that is being discussed would also need to have a multi-meter system in use. A system with this structure would allow for the usage of the fiscal energy savings from one alternative electricity option to be utilized as a cost offset for any extra expenditures associated with the lesser cost-effective alternative for renewable energy options.

6. References

1. Almeida, J., Verbist, B., Achten, W.M.J., Maertens, M. and Muys, B., et al. 2012. Sustainability in Development Cooperation: Preliminary Findings on the Carbon Footprint of Development Aid Organizations. Sustainable Development 22: 349–359. doi:10.1002/sd.1553. https://onlinelibrary.wiley.com/doi/abs/10.1002/sd.1553

2. Baboulet, O and Lenzen, M. 2010. Evaluating the Environmental Performance of a University. Journal of Cleaner Production 18: 1134–1141. doi:10.1016/j.jclepro.2010.04.006. https://www.sciencedirect.com/science/article/pii/S0959652610001435

3. Barth, M., Adam-Bent, M., Fischer, D., Richter, S. and Rieckmann, M., et al. 2014. Learning to Change Universities from within: a Service-Learning Perspective on Promoting Sustainable Consumption in Higher Education. Journal of Cleaner Production 62: 72–81. doi:10.1016/j.jclepro.2013.04.006. https://www.sciencedirect.com/science/article/pii/S0959652613002072

4. Bartling, H. 2018. Choosing community choice aggregation: The experience of Illinois municipalities in the electricity market. Illinois Municipal Policy Journal 3: 48-65. https://las.depaul.edu/centers-and-institutes/chaddick-institute-for-metropolitan-development/research-and-publications/Documents/IMPJ_2018.pdf#page=58

5. Battaglioli, D. 2017. Options for community choice energy in Del Mar, California. Capstone Project, UC San Diego. https://escholarship.org/uc/item/94w5t8zb

6. Busto, N. 2018. Commercial Rate Calculator. Microsoft Excel. Marin Clean Energy. https://www.mcecleanenergy.org/rates/attachment/commercialcalculator_072518/

7. California Community Choice Aggregation (CalCCA). 2019. CCA Impact. CalCCA. https://cal-cca.org/cca-impact/

8. Chalendar, J.A., Glynm, P.W. and Benson, S.M. 2019. City-Scale Decarbonization Experiments with Integrated Energy Systems. Energy & Environmental Science 12: 1695–1707. doi:10.1039/c8ee03706j. https://pubs.rsc.org/en/content/articlelanding/2019/ee/c8ee03706j#cit1

9. Clean Power SF. 2019. Commercial Rates Effective July 15, 2019. PDF, Clean Power SF. https://static1.squarespace.com/static/5a79fded4c326db242490272/t/5d702821bb9a4200012a947c/1567631394410/CPSF_CommercialRates_Updated2019-4.pdf

10. Coccolo, S., Kaempf, J. and Scartezzini, J.L., et al. 2015. The EPFL Campus in Lausanne: New Energy Strategies for 2050. Energy Procedia 78: 3174–3179. doi:10.1016/j.egypro.2015.11.776. https://www.sciencedirect.com/science/article/pii/S1876610215025084

11. Dominican University of California. 2019. Campus Map and Directory, Dominican University of CA. https://www.dominican.edu/about/visiting-dominican/mapsandparking/dominicancampus_map-directory_2019-2.pdf

12. Dominican University of California. 2019. History of the University https://www.dominican.edu/about/at-a-glance/history-and-traditions

13. Dominican University of California. 2019. Sustainability Operations. https://www.dominican.edu/about/at-a-glance/sustainability/operations

14. Fagiolari, L. and Bella, F. 2019. Carbon-Based Materials for Stable, Cheaper and Large-Scale Processable Perovskite Solar Cells. Energy & Environmental Science 12: 3437–3472. doi:10.1039/C9EE02115A. https://pubs.rsc.org/en/content/articlehtml/2019/ee/c9ee02115a

15. Faulkner, K. 2010 Community choice aggregation in California. Acedido em: https://nature.berkeley.edu/classes/es196/projects/2010final/FaulknerK_2010.pdf

16. Liu, G. T., Q. and Wang, J., et al. 2013. A Comparative Study of Carbon Footprint and Assessment Standards. International Journal of Low-Carbon Technologies 9: 237–243. doi:10.1093/ijlct/ctt041. https://academic.oup.com/ijlct/article/9/3/237/812115

17. Gundlach, J. and Webb, R. 2018. Distributed Energy Resource Participation in Wholesale Markets: Lessons from the California ISO. Energy LJ, 39, 47. https://heinonline.org/HOL/LandingPage?handle=hein.journals/energy39&div=8&id=&page=

18. Gunther, S.J. 2018. Challenging the system: The role of community choice aggregation in California's transition to a renewable energy future. Master of Public Policy, Oregon State University. https://ir.library.oregonstate.edu/concern/graduate_projects/1831cq717

19. Han, Y., Zhou, X. and Luo, R. 2015. Analysis on Campus Energy Consumption and Energy Saving Measures in Cold Region of China. Procedia Engineering 121: 801–808. doi:10.1016/j.proeng.2015.09.033. https://doi.org/10.1016/j.proeng.2015.09.033

20. Hoornweg, D., Sugar, L. and Gomez, C.L.T., et al. 2011. Cities and Greenhouse Gas Emissions: Moving Forward. Environment and Urbanization. 23: 207–227. doi:10.1177/0956247810392270. https://journals.sagepub.com/doi/10.1177/0956247810392270

21. Hussain, A., Bui, V.H., Kim, H.M., Im, Y.H. and Lee, J.Y., et al. .2017. Optimal Energy Management of Combined Cooling, Heat and Power in Different Demand Type Buildings Considering Seasonal Demand Variations. Energies 10: 789. doi:10.3390/en10060789. https://www.mdpi.com/1996-1073/10/6/789

22. Jacobson, M.Z. 2019. The Health and Climate Impacts of Carbon Capture and Direct Air Capture. Energy & Environmental Science 12: 3567–3574. doi:10.1039/c9ee02709b.

https://pubs.rsc.org/en/content/articlelanding/2019/ee/c9ee02709b?fbclid=IwAR3R9SUyEG0Za0cRvXvJ2ga3o4WVg721YUEeIDKgyYv05tz2-ybT1Y3AhJA#!divAbstract

23. Klein-Banai, C. and Thomas L. 2011. Quantitative Analysis of Factors Affecting Greenhouse Gas Emissions at Institutions of Higher Education. Journal of Cleaner Production 48: 29–38. doi:10.1016/j.jclepro.2011.06.004. https://www.sciencedirect.com/science/article/pii/S0959652611002071

24. Kuo, P. 2014. Should UC Berkeley Use Community Choice Aggregation (CCA) to Achieve Zero-Carbon Electricity By 2025? UC Berkeley. Class project for CE268, 5. https://sustainability.berkeley.edu/sites/default/files/peida_kuo_ce268_proj_uc_berkeley_cca.pdf?fbclid=IwAR2UfbQt5DnZznEIpAiNUiVuk5ZTnfr_EdjMSVywJVHMggR7GoIEcaGBI4g

25. Lichtenstein, G.R. and Reid-Shaw I. 2015. Community choice aggregation (CCA) in Massachusetts. Dissertation, University of New Hampshire Sustainability Institute. https://sustainableunh.unh.edu/sites/sustainableunh.unh.edu/files/media/Fellows/lichtenstein_-_aggregation_in_ma_report.pdf

26. Larson, H. N. and Edgar G.H. 2009. The Case for Consumption-Based Accounting of Greenhouse Gas Emissions to Promote Local Climate Action. Environmental Science & Policy 12: 791–798. doi:10.1016/j.envsci.2009.07.010. https://www.sciencedirect.com/science/article/pii/S1462901109001038

27. Letete, T.C.M., Mungwe, W., Guma, M. and Marquard, A., et al. 2011. Carbon footprint of the University of Cape Town. Journal of Energy in Southern Africa 22. ISSN 2413-3051 www.scielo.org.za/scielo.php?script=sci_arttext&pid=S1021-447X2011000200001.

28. Li, J. and Colombier, M. 2009. Managing Carbon Emissions in China through Building Energy Efficiency. Journal of Environmental Management 90: 2436–2447. doi:10.1016/j.jenvman.2008.12.015. https://www.sciencedirect.com/science/article/pii/S0301479708003824

29. Lozano, R., Lukman, R., Lozano, F. J., Husingh, D. and Lambrechts, W., et al. 2013. Declarations for Sustainability in Higher Education: Becoming Better Leaders, through Addressing the University System. Journal of Cleaner Production 48: 10–19. doi:10.1016/j.jclepro.2011.10.006. https://www.sciencedirect.com/science/article/pii/S0959652611003775

30. MCE. 2018. FINANCIAL STATEMENTS Years ended March 31, 2018 & 2017 with report of independent auditors. PDF, MCE. 3(11): pg. 2. https://www.mcecleanenergy.org/wp-content/uploads/2018/09/MCE-Audited-Financial-Statements-2017-2018.pdf

31. MCE. 2019. MCE Commercial Rates- MCE General Service (Non-Residential) Rates. PDF, MCE. https://www.mcecleanenergy.org/wp-content/uploads/2019/12/MCE-commercial-general-service-non-residential-rates_110119.pdf

32. MCE. 2019. MCE Electric account participation rate by county as of August 31, 2019. Infographic-JPG, MCE. https://www.mcecleanenergy.org/member-communities/#iLightbox[ba09d615cf185024a54]/0

33. MCE. 2019. MCE CLIMATE ACTION UPDATE Fall 2019: County–by–County Highlights. PDF, MCE. https://www.mcecleanenergy.org/wp-content/uploads/2019/11/MCE_Climate_Action_Update-Fall-2019_County_by_County_Highlights.pdf

34. MCE. 2019. 2018 Power content label. Infographic-JPG, MCE. https://www.mcecleanenergy.org/wp-content/uploads/2019/09/2018-Power-Content-Label-600x576.jpg

35. MCE Technical Committee. 2018. 2019 Integrated resource plan. PDF, MCE. https://www.mcecleanenergy.org/wp-content/uploads/2019/01/MCE-2019-Integrated-Resource-Plan_11-8-2018_V_12-21-18.pdf

36. O'Shaughnessy, E., Heeter, J., Gattaciecca, J., Sauer, J., Trumbull, K. and Chen, E., 2019. Community Choice Aggregation: Challenges, Opportunities, and Impacts on Renewable Energy Markets. Golden, CO: National Renewable Energy Laboratory. NREL/TP-6A20-72195.https://www.nrel.gov/docs/fy19osti/72195.pdf

37. Pacific Gas and Electric. 2019. PG&E MCE Joint Rate Comparison. PDF, PG&E. https://www.pge.com/pge_global/common/pdfs/customer-service/other-services/alternative-energy-providers/community-choice-aggregation/mce_rateclasscomparison.pdf

38. Pacific Gas and Electric. 2019. Overview: Regulatory Oversight. PG&E. https://www.pge.com/en_US/residential/rate-plans/how-rates-work/learn-how-rates-are-set/learn-how-rates-are-set.page

39. Pandey, D., Agrawal, M. and Pandey, J.S., et al. 2010. Carbon Footprint: Current Methods of Estimation. Environmental Monitoring and Assessment 178: 135–160. doi:10.1007/s10661-010-1678-y. https://link.springer.com/article/10.1007/s10661-010-1678-y

40. Pérez-Lombard, L., Oriz, J. and Pout, C. 2008. A Review on Buildings Energy Consumption Information. Energy and Buildings 40: 394–398. doi:10.1016/j.enbuild.2007.03.007. https://doi.org/10.1016/j.enbuild.2007.03.007

41. Petri, I., Kubicki, S., Rezgui, Y., Guerriero, A. and Li, H., et al. 2017. Optimizing Energy Efficiency in Operating Built Environment Assets through Building Information Modeling: A Case Study. Energies 10: 1167. doi:10.3390/en10081167. https://www.mdpi.com/1996-1073/10/8/1167

42. Polack, R. Ph.D., Wood, S. BSW and Kimyatta N. Smith, BSW, MSW (Cand.). 2019. An Analysis of Fossil-Fuel Dependence in the United States with Implications for Community Social Work. Critical Social Work 11(3). https://ojs.uwindsor.ca/index.php/csw/article/view/5837

43. Robinson, O. J., Twekesbury, A., Kemp, S. and Williams, J. D., et al. 2017. Towards a Universal Carbon Footprint Standard: A Case Study of Carbon Management at Universities. Journal of Cleaner Production 172: 4435–4455. doi:10.1016/j.jclepro.2017.02.147. https://www.sciencedirect.com/science/article/pii/S0959652617303736

44. Robinson, O., Kemp, S. and Williams, I., et al. 2015. Carbon Management at Universities: a Reality Check. Journal of Cleaner Production: 109–118. doi:10.1016/j.jclepro.2014.06.095. https://www.sciencedirect.com/science/article/pii/S0959652614007082

45. Rypdal, K. and Wilfried W. 2001. Uncertainties in Greenhouse Gas Emission Inventories — Evaluation, Comparability and Implications. Environmental Science & Policy 4: 107–116. doi:10.1016/s1462-9011(00)00113-1. https://www.sciencedirect.com/science/article/pii/S1462901100001131

46. Skatova A., Bedwell B. and Kuper-Smith B. 2016. When Push Comes to Shove: Compensating and Opportunistic Strategies in a Collective-Risk Household Energy Dilemma. Front. Energy Res. 4:8. doi: 10.3389/fenrg.2016.00008 https://www.frontiersin.org/articles/10.3389/fenrg.2016.00008/full

47. Smith I.D. 2019. Energy Transition and Social Movements: The Rise of a Community Choice Movement in California. In: Kurochkin D., Shabliy E., Shittu E. (eds) Renewable Energy. Palgrave Macmillan, Cham https://link.springer.com/chapter/10.1007/978-3-030-14207-0_4

48. Shoemaker, S.B. 2018. Impacts of the changes made to Solar Net Metering by Northern California Community Choice Aggregators. Thesis, Humboldt State University https://digitalcommons.humboldt.edu/cgi/viewcontent.cgi?article=1140&context=etd

49. Townsend, J. and Barrett J. 2015. Exploring the Applications of Carbon Foot printing towards Sustainability at a UK University: Reporting and Decision Making.

Journal of Cleaner Production 107: 164–176. doi:10.1016/j.jclepro.2013.11.004. https://www.sciencedirect.com/science/article/pii/S0959652613007634

50. U.S. Department of Energy. 2018. City energy: From data to decisions. Hutchinson, Minnesota: Evaluating local solar energy generation potential. National Renewable Energy Lab. NREL/FS-7A40-71611; DOE/GO-102018-5092 https://www.nrel.gov/docs/fy19osti/71611.pdf

51. Voskian, S. and Hatton, T. A. 2019. Faradaic Electro-Swing Reactive Adsorption for CO2 Capture. Energy & Environmental Science 12: 3530–3547. doi:10.1039/c9ee02412c. https://pubs.rsc.org/en/content/articlelanding/2019/ee/c9ee02412c?fbclid=IwAR3RFHhF1sgEXA1sik6_f9v5POaOVtps4rzHRoIXAjFihGTHI6u8BdxZTqc#!divAbstract

52. Xu, P., Jin, Z., Zhao, Y., Wang, X and Sun, H., et al. 2018. Design and Operation Experience of Zero-Carbon Campus. E3S Web of Conferences 48: 3004. doi:10.1051/e3sconf/20184803004. https://www.e3s-conferences.org/articles/e3sconf/abs/2018/23/e3sconf_iwgm2018_03004/e3sconf_iwgm2018_03004.html

53. York, R. 2012. Do alternative energy sources displace fossil fuels?. Nature Clim Change2. 441–443. doi:10.1038/nclimate1451. https://www.nature.com/articles/nclimate1451#citeas