Clark University Greenhouse Gas Emissions Update: 2019

Executive Summary

Clark University’s gross total greenhouse gas emissions in 2019 were 13,802.28 metric tons of carbon dioxide equivalents: a 1.21% decrease from 2018 emissions. Our net greenhouse gas emissions after offsets were 13,794.93. As of 2019, Clark has reduced total emissions by 15.62% over the 2005 baseline of 16,357.4 MTCO\textsubscript{2}e.

The Climate Action Plan (CAP) interim goal set for 2015, 16,357.4 MTCO\textsubscript{2}e, was achieved in 2010, one year after the CAP was released. It has not been exceeded since. The next goal in the Climate Action Plan is carbon neutrality - net zero emissions - by 2030. This bold goal will require willingness on the part of all members of the Clark University community to recognize and invest in mitigation action as an institutional priority.

We are moving in the right direction this year, after several years of increased greenhouse gas emissions. This is of particular note because Clark has put considerable technological investment toward reduction since 2013: adding renewable energy sources via ASEC and Solar Flair; replacing an inefficient cogeneration engine; replacing all aging steam distribution lines; completing energy efficiency upgrades with LED lighting, controls, motors and more; adding technology to ‘smart rooms’ to manage downtime energy use, and numerous other upgrades. Conversely, we have also expanded our physical footprint and employee population since 2013 and have successfully managed to maintain and even control emissions as we have managed our per capita and per square foot energy consumption.

Background

In June 2007, President Bassett signed the American College and University Presidents Climate Commitment (ACUPCC), making Clark University a charter signatory to an exciting initiative aimed at mobilizing the resources of colleges and universities in efforts to reduce greenhouse gas emissions. The core goal of the commitment is to achieve climate neutrality with net zero greenhouse gas emissions, also known as carbon neutrality. The Clark University Environmental Sustainability Task Force (CUES) accepted the task of developing a Climate Action Plan with mitigation strategies to lead the University toward its goal of climate neutrality. In December of 2009, Clark University released the Climate Action Plan (CAP), detailing strategies for the University to reduce its greenhouse gas emissions. The plan sets two goals: an interim goal of reducing emissions to 20% below 2005 baseline levels by 2015 (to 16,357.4 MTCO\textsubscript{2}e), and the ultimate goal of carbon neutrality by the year 2030. The CUES Task Force retained responsibility for recording and reporting on Clark’s emissions. In 2014, the CUES Task Force considered an update to address changes and potential additional strategies, however the CAP remains as published. The Task Force has not convened since 2014, pending the appointment of a Chair and Task Force members.

ACUPCC’s reporting and administrative platform was replaced by Second Nature.org in 2015. Second Nature redefined the Climate Commitment to include both emissions and resilience plans. Clark elected not to sign on for resilience, and this ‘rolled’ our Climate Commitment to what is now termed a Carbon Commitment. A Climate (carbon) Action Plan update was required in 2018 per our reporting requirements to Second Nature. Clark elected to maintain the existing Climate Action Plan as published, without any updates.

Methodology: Calculator

In order to effectively manage carbon footprint and emission reduction strategies, data for a Greenhouse Gas (GHG) Emissions Inventory has been collected annually since 2008. (GHG inventories for prior years
use largely estimated data). Data is gathered from a range of campus entities, and their cooperation is essential to ensure reasonably accurate and complete calculations. 2019 represents Clark’s third year of using an on-line third-party calculator from UNH’s Institute for Sustainability, SIMAP. Previously (2008-2016) we used the Campus Carbon Calculator, now defunct (for additional information regarding our choice of third-party calculators and software, please read prior Annual Updates on file). There is confidence from Second Nature that SIMAP is a valid replacement for the CCC.

Methodology: Inventory Inputs

In the Inventory, inputs are recorded for Scope 1 sources (on-site combustion, such as boilers and vehicle use); Scope 2 sources (off-site combustion, such as purchased electricity) and certain Scope 3 sources (other combustion such as commuting). The six greenhouse gases inventoried are those included in the Kyoto Protocol: carbon dioxide (CO$_2$), methane (CH$_4$), nitrous oxide (N$_2$O), hydro fluorocarbons (HFCs), perfluorocarbons (PFC), and sulfur hexafluoride (SF$_6$). For ease of understanding and comparison, all gases are converted to a common measure: Carbon Dioxide Equivalents, CO$_2$e. The results of past inventories in CO$_2$e and Kyoto Protocol gasses have been reported to ACUPCC/Second Nature and shared with University administration via the annual Greenhouse Gas Emissions Update. The annual Updates are also available at Sustainable Clark, under Energy & Climate.

Methodology: Scope 2 Purchased Electricity

SIMAP defaults to the Emissions & Generation Resource Integrated Database (eGRID) to calculate emissions equivalents in our Scope 2 Purchased Electricity. The eGRID is a regionally based averaged “source of data on the environmental characteristics of almost all electric power generated in the United States”, according to the EPA, and is considered a standardized approach to comparative measurement of emissions. Our assigned eGRID sub-region is NPCC (Northeast Power Coordinating Council) New England which publishes averaged regional resource mixes and emissions data; the most recent data in use by SIMAP are from eGRID 2018. The alternative in SIMAP is to select Custom Fuel Mix and input the state-specific resource mix data published by the utility provider in a Disclosure Label under requirement of the MA Department of Public Utilities. The most recent Disclosure Label from our purchased electricity supplier, National Grid, was published in 2019 and is specific to Massachusetts, although it is also noted that the information in the Disclosure Label comes from a range of suppliers in an integrated power grid, not from specific power-generating plants.

In 2017, the GHG Protocol, which is the international arbiter of “best practices” in carbon accounting across all sectors, issued an updated guidance document for Scope 2 emissions calculation. That document recognized that there are inherent strengths and weaknesses in both approaches (using supplier-specific versus regional eGRID factors) and recommended that organizations understand the results and implications of both types of calculations. The Protocol does not require a specific method. Given the specificity of the 2019 Disclosure Label combined with the fact that Massachusetts ranks high in renewable power generation compared to regional averages, and in the interest of providing the most accurate greenhouse gas emissions inventory for the University, Clark has elected to use the Custom Fuel Mix option in SIMAP with the fuel mix data supplied in the Disclosure Label. SIMAP still calculates the emissions factors for each category of fuel based on accepted standards.

Updated Equivalencies; Impact on Data
Due to the evolving nature of greenhouse gas emission factor science, third-party calculators such as SIMAP update emissions factors annually with information from the EPA, IPCC, E-grid, DOE and other sources to determine the number of metric tons of carbon dioxide equivalent (MTCO$_2$e) added to the atmosphere by campus operations across all inventoried inputs. Many standards are retroactive and almost all of Clark’s past data stored in SIMAP from 2005-2018 is affected by various updates. Even small changes in the factors will add up over time and retroactively. Therefore, previous Updates from 2009 – 2018 may show annual or category data points that differ from the current Update; included charts will reflect this. Clark’s interim goal was based on 2005 emissions and the standards at the time, as were the benchmarks and mitigation strategies in the CAP; our interim goal therefore remains unchanged at 16,357.4 MTCO$_2$e.

**Benchmarking**

It should be noted in all data comparisons that 2014 is considered a ‘benchmark-normal’ year. Weather patterns were typical and therefore the amount of heating and cooling produced on campus (Scope 1) can be termed ‘average’. 2014 is also a ‘benchmark-normal’ year in regard to campus operations; the co-generation engine operated throughout the year with normal inputs and there were no major renovation projects (Scope 2). As unforeseen or scheduled operational events occur to influence production capacity and as other factors (including changes in technology, population or footprint) influence Clark’s demand for energy it is important to recognize that improving Clark’s core energy efficiency and energy consumption practices will be measured against 2014 as a benchmark of ‘normal’ per capita and per square foot energy usage.

**2019 Emissions Data: Overview**

Total GHG emissions in 2019 were 13,802.28 MTCO$_2$e. This represents a slight decrease of 1.21% from total 2018 GHG emissions of 13,970.67 MTCO$_2$e. GHG emissions in 2018 were in turn 2.71% greater than 2017 emissions. This report details some of the probable causes for the differences year-to-year.

If and when all else is held constant, emissions will change in proportion to aggregated personal energy use. However, year-to-year differences in weather and other conditions beyond University control will impact larger scale, generated emissions from energy production and campus fleet. External factors will also affect emissions from purchased electricity and personal transportation. As climate instability increases it is ever more important to manage those University practices that do fall within our sphere of influence, and to consider resilience as a proactive strategic planning approach for those factors that fall without.

Below is a chart showing the trend over time in Clark’s greenhouse gas emissions, measured in MTCO$_2$e.
The largest source of Clark’s greenhouse gas emissions is Scope 1: fossil fuel consumed on-site at Clark. This Scope is primarily two sectors: the co-generation plant and boilers, producing electricity, light and heat for campus buildings. Smaller contributors include back-up generators and campus fleet. Scope 1 comprised 71% of all emissions in 2019; in 2018 Scope 1 comprised 58% of all emissions. Our Scope 2 emissions derive entirely from the operations of the electric utility (National Grid) from which Clark purchases electricity for needs not served by the co-generation plant. This sector is termed Purchased Electricity and comprised 4% of all emissions in 2019 compared to 12.2% in 2018, 2.58% in 2017, and up to 30% in the years prior to Clark’s partnership with Solar Flair; more on this beneficial arrangement below. Our second largest emissions source is Scope 3, also primarily two sectors: Employee Commute and University Sponsored Air Travel. This Sector comprised 25% in 2019 compared to 29% in 2018. Scope 3 is behavioral as opposed to mechanical and in the absence of institutionally managed solutions for transportation, such as carpooling or working remotely, will continue to present a challenge. Clark is not alone in struggling with Scope 3 realities, and there are no easy answers.

Lesser emissions sources in Scopes 1 and 3 include refrigerants, utility-based transmission and distribution losses, waste to energy (incineration), and campus fleet; all less than 1% of total emissions.

Below are charts of emissions by MTCO₂e with all sectors combined, by sector percentage of total, and of significant individual sectors from 2014-2019. It is useful to recognize overall trends within each sector, bearing in mind that the scales differ (see Y axes in each chart).
The chart below indicates percent-of-total emissions for the major contributing sectors.

The series of charts below, while at varying scales (see Y axes), indicate the specific annual volumes and therefore overall trend of individual contributing Sectors from 2014 – 2019. All measures are in MTCO2e; Scope and Sector totals by year are found in the stacked bar chart above.
**Explanations Scope 1 Emissions:** On-Site Fuel Combustion from Cogeneration and Boilers; Fleet

Fuel combustion from Clark’s co-generation engine, the three large boilers in the power plant, other boilers and generators across campus and campus fleet are all included in Scope 1 calculations. Clark’s cogeneration engine was offline for 8 weeks of 2019 (during May, June, October, November) for routine maintenance and to repair a short in the electrical switch gear; a mid-size offline period compared to 2018, when it was offline for nearly six months. The 2018 lapse was also due to the impacts from a failed switchgear. Our electrical system runs in parallel to National Grid’s system; ‘transient events’ in National Grid’s system such as power surges jolt Clark’s aging system. The co-generation engine operated for most of 2016 and 2017 and the data reflects this year over year variation. As Scope
1 is the single largest source of emissions on campus, and the co-generation engine serves to maximize fuel efficiency, perturbations will have a significant impact on Clark’s greenhouse gas emissions.

2019 emissions derived from natural gas combustion in boiler operations increased slightly over 2018 by 0.49%, but both years were among the highest from this source since we have been tracking. (Natural gas has been the sole fuel source for the power plant boilers since 2016. Prior to 2016 the boilers also consumed ‘dirtier’ #6 fuel oil, which added to overall source emissions). 2018 and 2019 are roughly similar in fuel usage and emissions. The explanation for the spike is potentially weather related for both 2018 and 2019; the former was colder than average overall whereas degree heating days in 2019 were 15% higher because of an extended cold spring time. A separate factor illustrates the impact of the co-gen being offline for two to six months of heating season. The steam and hot water byproducts of co-generation are supplemented by hot water produced by the three boilers in the power plant to support ambient heating through the fall, winter and spring. Because the co-gen acts as the system’s primary heating source but was not operational for parts of heating season in both years, more fuel was consumed in the boilers as the sole heating source: we will consume 15-20% more fuel for heating buildings when the co-generation engine is offline. Natural gas consumed in independent building boilers is trending up as well; it was 8% greater in 2019 than 2018 which was 4% than 2017.

**Explanations Scope 2 Emissions: Purchased Electricity & Renewable Energy Sources**

We purchase supplemental electricity from National Grid electric utility for several reasons: to supply buildings that are not connected to the co-gen, to supply a demand gap from connected buildings beyond co-gen production capacity, and when the co-gen is not operational.

Electricity purchased in 2019 to supply buildings not connected to the co-gen was 3.41% greater than 2018 purchases, which was 9.84% greater than 2017. This is partially due to increasing and record-setting summer temperatures and therefore higher demand on window air conditioners.

Electricity purchased to supplement the demand gap for buildings connected to the co-gen – with it being offline for 8 weeks - was 57.69% of total purchased electricity; in our ‘benchmark’ year of 2014 when the co-gen operated consistently, it was 13.7% of total.

**Scope 2 Emissions, Other Impacts: Solar Flair, SREC’s, SFASEC Array**

Solar Flair:

- 2019 marked the fifth full year of our partnership with Solar Flair providing Clark solar energy “credits” through what is known as an Alternative Power Purchase Agreement. We calculate an equivalent kWh from the partnership’s solar production financial incentives. (For a full explanation of Clark’s arrangement with Solar Flair and National Grid, please see the Emissions Update 2014). Because Solar Flares farms are operating at full build-out production capacity and we are receiving the full benefit, any additional decreases in Scope 2 emissions will require that Clark commit to comprehensive energy efficiency, targeted management of consumption practices, or additional renewable energy sources.
- In 2019, the solar production kWh equivalent accounted for 55.28% of Clark’s total purchased electricity, compared to 31.7% in 2018, 59.3% in 2017.
Shaich Family Alumni and Student Engagement Center (SFASEC) Solar Array:

- SFASEC is an all-electric building (heating and cooling as well as lighting, equipment and appliances) and is not connected to the co-gen. The rooftop solar array was designed to supply 50% of the building’s electricity demand. In the twelve months of 2019, the solar array produced 151,491 kWh, or 30% of SFASEC’s total annual electricity demand of 519,544 kWh. In 2018 the array did indeed provide almost 50% of the building’s needs. The lower percentage is due to two primary factors: SFASEC’s energy demand is trending up significantly year over year (2019 usage was 24% higher than 2018), and for several months a non-functioning inverter in the array affected production capacity. Solar energy produced by the SFASEC array directly offsets the building’s electricity, so our total Scope 2 purchased electricity is reduced by the amount of kWh produced; however, there is demand in excess of on-site solar production for which we purchase electricity. Emissions from SFASEC’s net purchased electricity are included in the 2019 total.

Renewable Energy Certificates (SREC’s):

- SFASEC’s solar array generates not only power for the building’s needs, but also solar carve-out renewable energy certificates (SREC’s) under the Massachusetts Department of Energy Resources (DOER) Green Communities program. Each certificate represents the environmental attributes of one megawatt-hour (MWh) of energy generation and is made available for sale via the New England Power Pool energy credit market. Clark has a third-party vendor managing the sale of our SREC’s. Due to the workings of the market and verification procedures, there is up to a six-month delay in receiving the credits for the sale of SREC’s. In 2019 we claimed four fiscal quarters of applicable credits from June 2018 – June 2019 for a total of 135 MWh, equivalent to credits of $41,148.
- While our net purchase of electricity and therefore Scope 2 emissions are obviously reduced by the amount of solar energy produced and used on-site, and the University receives direct financial benefit from the market activity, the creation and sale of SREC’s actually adds to our Scope 2 emissions consistent with the EPA’s Renewable Energy Certificate methodology. When an SREC is purchased on the market, it offsets emissions produced by the buyer. When an SREC is sold, however, the producer takes on those equivalent emissions through the mechanism of the SREC. We have already received the double benefit of “free” solar power and payment; we cannot “double dip” by using a sold SREC as an offset.

Excess Production:

- Under normal conditions, the cogeneration engine runs consistently day and night at optimum load and so during low-demand periods produces more electricity than campus can use. Since 2018 the University has participated in net metering for which Clark receives payment for excess electric production that is transferred to the utility’s supply grid. However, even under this agreement we must still include emissions from the production of unused electricity in our reporting. The 2019 amount of excess production is 238,439 kWh, equivalent to 2.6% of the co-gen’s total electricity production, or 169 MTCO₂e.
**Explanations: Scope 3 Emissions: Commute and Travel**

Scope 3 decreased 4% in 2019 over 2018, following an increase of 4.7% in 2018 over 2017. Daily vehicle commute emissions decreased slightly, but air travel decreased significantly in 2019. We are unable to identify an exact cause; it may simply be in how the data are collected. This data is very hard to come by for any institution, and most use informed estimates; SIMAP and AASHE sponsor an on-going working group focusing on Scope 3 tracking. To calculate emissions from daily commuting we use full-time and part-time employee data provided by the institution and assume weekly mileage based on survey data rather than actual recorded mileages. SIMAP splits Faculty versus Staff commute data, we substitute normalized part-time and straight full-time employee numbers to fill the required blanks. Neither study abroad nor student commute are included in Clark’s version of the greenhouse gas emissions inventory. University-supported behavior-change solutions to the single-driver commute, such as offset incentives, carpooling and shuttle programs, or telecommuting, might reduce this emissions source.

To calculate air travel emissions, we use industry-accepted average cost-per-mile standards and actual University travel expenses. Air travel produces a large amount of emissions due to the magnified effects of fuel combustion at high altitudes, so even a small change in directly financed air travel has a significant effect on Scope 3 emissions. Institutional solutions include incentivized carbon offsets, changing behavior to travel less frequently or more efficiently, and electronic options such as remote conferencing. Certainly, air travel for necessary conferences, recruiting and other institutional functions is vital to the continued success of Clark University. As is the case with faculty and staff commute, this data will not change significantly until viable alternatives are enacted.

**Campus Energy Consumption (Electrical and Thermal)**

The Climate Action Plan’s goals and mitigation strategies, including energy management strategies, are expressed in MTCO2e. In the emissions inventory, we measure total consumption of fossil fuels, however this data includes over-production that is not consumed on campus. There is of course a direct relationship between fossil fuel combustion and MTCO2e. There is also a direct relationship between personal energy consumption - campus electrical energy and thermal (heating) energy demand - and emissions that bears a closer look. This can be termed energy usage. It is helpful to look at campus electrical and thermal energy usage over time to identify patterns and results. Technology-dependent strategies to reduce energy consumption (for example lighting efficiency, mechanical system upgrades) will reduce MTCO2e although they may be offset by other non-technological increases such as a larger population or physical space footprint. Non-technological mitigation strategies (for example personal energy conservation practices, maximizing use of space) are harder to quantify than technology strategies but significant in managing Clark’s energy consumption patterns as they will have a long term and aggregate effect. Smaller scale, incremental projects are always on-going, although there are no comprehensive reduction plans at this time.

In 2019 Clark replaced the steam distribution line between the co-gen and Jefferson/Atwood Halls; this is expected to greatly increase efficiency and save 1,758 MTCO2e per year over the lifetime of the system. In order to track this and similar ongoing energy savings initiatives and projects, Clark has begun to utilize a sustainability project management tracker called “GRITS”. GRITS is a program of the Sustainable Endowments Institute (SEI), a Boston-based organization. SEI launched GRITS in 2014 as part of its mission of mobilizing institutional leaders to invest in energy-efficiency focused climate solutions. By inputting project metrics such as investment cost, expenses, energy type and units saved, etc. GRITS can track and report year over year return on investment, energy saved, and carbon emissions reduced overall or project by project. The steam distribution project is the
only one we have input so far; the net present value (savings over the life of the project) is projected by GRITS to be $6,454,827 based on current prices. This tool should significantly enhance Clark University’s ability to plan and invest in reliable energy savings projects in the long term.

**Electricity**

Actual total campus electrical load (Scope 1 electricity produced in the co-gen less that exported, plus Scope 2 purchased electricity) in 2019 of 13,097 MWh is an increase of 4.38% over 2018’s 12,547 MWh. 2018’s electricity use was a 7% increase over 2017, which was a 3% increase over 2016; 2016 was in turn a 3% increase over 2015. There does not seem to be a discernable pattern nor a single causal explanation. The campus load has remained relatively stable over time even with a variety of factors including increased population, additional personal and academic electronic use, and hotter summers requiring more air conditioning. This is a testament to our energy management and upgrades.

**Heat**

Clark’s 2019 thermal energy use for heating was equal to 6,380.3 MTCO$_2$e, compared to 6,258.8 MTCO$_2$e in 2018. This measure has increased slightly through both 2018 and 2019 when factoring in changes in conditioned space (i.e. changes to square footage that we heat); until and unless there is comprehensive University support for lower ambient temperatures and reduced set points (i.e. 65° instead of 68°) and an investment in our control technology (i.e. program controlled thermostats, sub-metering buildings, zone analysis and updating), it is likely to vary along with seasonal temperature variations, community demand, and University practices in areas such as space use and closure.

**Therms**

As there is a direct relationship between energy consumption and MTCO$_2$e created, it is helpful to examine the University’s electrical and thermal energy consumption in terms of a standard unit of energy measurement: therms. This is expressed in million British thermal units, or MMBtu’s, and is in common use across industry when evaluating energy output or consumption regardless of source. An energy consumption profile differs from an emissions profile; it evens out the impact of different Kyoto Protocol gasses to a common measure. The conversion from kWh to MMBtu uses EPA standards. The charts below show Sectors 1 and 2 addressed in this report with their measures of electricity kWh and natural gas therms expressed in MMBtu’s. Additional charts show Clark’s electrical and thermal energy consumption per capita and per square foot over a set of years. Per capita includes full-time employee and student equivalents as determined by the Office of Institutional Research; per square foot does not include non-conditioned space such as garages but considers increases in our footprint over time.

**Energy Consumption Year over Year in Therms**

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<tr>
<th>Year</th>
<th>Electricity</th>
<th>Heat</th>
<th>Electricity per Capita (MMBtu)</th>
<th>Heat per Capita (MMBtu)</th>
<th>Electricity per Sq Ft (MBtu)</th>
<th>Heat per Sq Ft (MBtu)</th>
<th>Electricity per Capita per Sq Ft (Btu)</th>
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It is helpful to look at energy consumption across a period of years. The first chart below shows therms of fuel consumed in thermal energy (heat) consumption campus-wide (co-generation engine + power plant boilers + independent boilers); all in Scope 1. We do the same with therms of fuel consumed to supply campus-wide electricity demand (co-generation engine + utility electricity purchased); Scope 1 and Scope 2. While thermal energy (heat) consumption is largely a factor of weather variations, it is
also affected by steam distribution efficiency, building envelope conditions, and individual behavior. Clark was on a downward trend until 2018, due to efficiency and building upgrades; this year’s major steam line replacement is expected to support that trend. As we do not sub meter thermal energy, however, it will be difficult to identify precisely the impact of this new steam distribution line. The overall trend in electrical energy consumption was also downward due to previous years’ lighting and electrical efficiency improvements until 2019. These trends are significant in that both our population and space footprint have increased in the same period of time, indicating that we are doing relatively well at managing consumption per capita and per square foot, standard measures of energy efficiency.

The chart below shows campus-wide thermal (heat) and electrical energy consumption, expressed in MMBtu.

The chart below shows per capita thermal (heat) and electrical energy consumption, expressed in MMBtu.
The chart below shows thermal (heat) and electrical energy consumption per square foot of all space for which Clark has operational control, in MMBtu. The square footage used in the calculation includes un-conditioned (not heated or cooled such as garages) and dormant (areas currently not in full use) spaces but does not include owned but not occupied (such as rental property) spaces in order to maintain comparative validity, consistency across years, and include population data.