Investing in a Green Future: Universities and Renewable Energy

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Abstract

This paper explains how the implementation of renewable energy is a favorable energy choice and explores the growing trend of investing in a green economy. The report begins by providing some context as to what renewable energy is and explains why it is a favorable energy choice. The first section outlines the energy industry and deciphers between the two forms of energy currently making up the sector. Breaking up the industry into two separate sectors, being renewable energy and nonrenewable energy, provides an understanding on which form is currently dominating the market. Moreover, the outline describes the concept of investing in a green economy and illustrates an emerging trend that suggests a continuation of growth. Next, we analyze the three key drivers responsible for the expansion of this industry, further explaining why this sector is a smart investment and seeing significant growth. We provide a complete overview of both energy sectors and create an overall investment thesis and provide a portfolio analysis of a fund currently investing in renewables. The section concludes with a report on the analysis' results and findings, confirming or disproving the created investment thesis. The paper then explores the advantages of implementing renewable energy on a college campus and describes why a college campus is a suitable venue to utilize this energy. Specifically, the section will look into three New England universities that have already begun making the transition to renewable energy. To conclude, the final section includes a case study that analyzes Bryant University's current sustainability efforts, as well as the potential for implementing on-campus renewable energy sources.

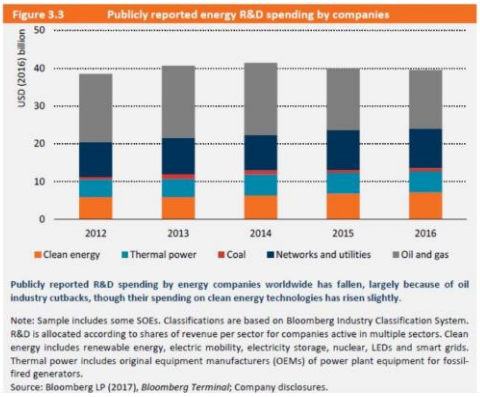
Key Words

Finance – Green Investment - Energy - Sustainability - Carbon-neutral

Introduction

Colleges are dominant energy users in the United States, spending nearly $14 billion on energy costs each year.[1] With the high spending on energy each year, it is crucial for not only Bryant, but all colleges across the country to invest in renewable and green energy. In doing so, these universities will be benefiting the environment, their general health, and save money in the long run as renewable energy is far less expensive as it comes from sustainable resources.[2] While implementing this energy source within college campuses is environmentally conscious and eco friendly, investing in this sector can be beneficial as well. Although the benefits of investing in this sector will be further explained later in the paper, it is important to provide context as to why this sector is a smart investment. The large majority of companies being invested in today do not have renewable energy practices. Conversely, they rely on resources such as oil and coal to operate their businesses and fail to acknowledge the fact that these are finite resources and will eventually run out (see figure below). With more national attention and awareness supporting the harsh realities of our current environment, companies engaging in renewables and practicing sustainability will continue to see significant growth and prove to be a smart investment. When analyzing the uses, benefits, and costs of renewable energy one needs to first gain insight into exactly what renewable energy entails and what it looks like on a college campus.

[1] "Renewable Energy 100," Environment America, March 2017. Accessed on October 31, 2019.
[2] ibid.



What is Renewable Energy?

Environment America and Frontier Group recognize renewable energy as the decline of the use of fossil fuels and the global economy recognizing the change from big oil to sustainable, yet profitable practices. Renewable energy should be gathered from natural resources that are safe, pollution free, and regenerative (solar and wind) as there would not be a limited supply, like there is for oil or coal. Types of renewable energy such as wind, solar, tidal, river and geothermal energy for heating and cooling all prove to be extremely effective and have recently outperformed some of the big oil companies. When looking into renewable energy and providing an explanation for making the switch from fossil fuels, it is useful to look at why carbon-based energy methods like crude oil, coal and natural gas are no longer a viable or sustainable option for energy production. A *Wall Street Journal* article written by Lauren Silva Laughlin, a senior columnist who specializes in subjects relating to energy and corporate finance, outlines the rise in the financial benefits of renewable energy as well as the hardships of carbon-based energy companies. Laughlin's article provides insightful statistics pertaining to these two methods of energy production, "Exxon's return on invested capital was 25% in 2011, and less than 10% last year, according to FactSet. Chevron's metrics look similar."[3] Potential causes for these

[3] Laughlin, Lauren. *"Green Investments Are in the Black." The Wall Street Journal*, September 27, 2019

diminishing returns might include how the future of the auto industry is likely to be challenged by the rise in production of electric vehicles which in turn decreases the need for oil. Laughlin goes on to comment on the success of companies in the renewable energy sector, "Vestas Wind Systems of Denmark has seen its ROIC go from negative-5% in 2011 to an average of 22% over the past five years. Canadian Solar, a big solar-panel manufacturer, posted an ROIC of almost 15% last year versus negative-16% in 2011."[4] The recent contrasting performances of these industries strengthen and encourage the current national urge to globally shift the economy towards complete renewable energy and sustainable practices that are not only economically advantageous but also replace the harmful effects of carbon-based energy.

Fuel of the Future: *The Battle of the Energies*

Overview of the Energy Industry

The Energy Industry has been, still is, and will be one of the biggest and most vital components in the world's economy. The industry is made up of various renewable and non renewable forms of energy. Even though both types reside in the same industry, differences between the two split the industry into their own respective sectors. Renewables, or clean energy, makes up a smaller portion of today's energy market when compared to nonrenewables, or fossil fuels. Despite non renewable energy's current dominance in the industry, investors are speculating a decline in the sector and rise in the renewable energy sector. This prediction is attributed to the negative environmental impacts stemming from the use of fossil fuels, as well as the increasing amounts of scientific studies and innovative technologies associated with renewable energy. Although the reign of fossil fuels is still very apparent, the growth of the renewable energy sector has many expecting an upcoming change in the industry.

[4] ibid.

Financial Analysis

In this section we will investigate this battle of energies from a financial standpoint. Much like how a car runs on gasoline, an economy and its industries run on the flow of funds supplied in their respective markets. The more funds allocated to an industry the more potential for economic growth and expansion to take place in said industry. The best way to effectively observe and track the allocation of these said funds is through a financial analysis. This analysis provides evidence for an investment thesis by examining current market trends and overall performance in an industry. If supported by compelling and relevant data, the investment thesis bares a likely prediction on where future funds will be allocated. In general, a financial analysis on the energy industry provides an optimal way to decipher which form of energy will fuel the future and which will be a thing of the past. The first step in this process is defining an investment thesis to examine. The investor speculation stated before, favoring renewable energy, gives enough reason to conjure up an investment thesis worth exploring.

The Investment Thesis

As the number of environmental issues stemming from the use of fossil fuels, as well as the number of supporting scientific findings and advancements in technology regarding renewables escalate, the renewable energy sector will be on the rise as the nonrenewable energy sector will be on the decline. The number of consumers and investors will dwindle from nonrenewables and their harmful effects and migrate to renewables and their sustainable and innovative properties. Clean energy products such as wind turbines and solar panels will increase in demand, while fossil fuel products such as coal and gasoline will decrease in demand.

Key Drivers

There are three apparent key drivers for the expansion of this industry, emerging policies, expanding investor interest, and advancing technologies. Emerging policies by the U.S. government have positively impacted the renewable energy sector. Federal tax credits are being given to companies that are implementing renewable energy, influencing firms to make the clean energy switch. Furthermore, forms of renewable energy are becoming more economically viable, attracting consumers and influencing them to embrace these new technologies. This can be attributed to decreasing tariffs on renewable energy imports, allowing companies to obtain the required raw materials at a lower cost. Expanding investor interest in the renewable energy sector is a result of the sustainability goals set by firms. From big corporations to small businesses, these firms are switching to renewable energy and reaping the benefits. Due to this influx in businesses pursuing sustainability, investments in the sector are increasing in numbers and value, reducing the risk of said investments. Recently, asset managers have been putting together renewable energy portfolios, which have been gaining popularity among investors. Economies of scale are produced by the pooling of these securities, reducing the transaction cost of these investments and increasing their overall returns. Finally, advancing technologies are boosting the value of renewable energy investments. These new technologies increase the effectiveness and efficiency of renewable energy, generating new markets and business opportunities.

Aside from positive driving forces in the renewable sector, the nonrenewable sector faces a multitude of risks, which in turn is gaining popularity for its sustainable substitute. For example, growing concerns over carbon dioxide emissions have peaked the interest of many individuals and companies, promoting self-awareness of carbon footprints. This of course pushes consumers and businesses to do away with the harmful non renewables and the switch to it’s

cleaner counterpart. Due to this gain in popularity for renewables, the U.S. nonrenewable energy sector has experienced significant declines in growth, losing said profits and funds to renewables.

Risks to Investment

The renewable energy sector faces two major risks stemming from opposition from the fossil fuel sector and the vulnerability of supply chains for rare earth elements. Since the current energy market is heavily dominated by fossil fuels, corporations in the sector have much leeway with various politicians and influential media personnel. As a result those in the sector have used this said influence to spread misleading information about climate change. The industry has been aware of the risks of global warming since the 1970s, according to researchers, but has responded by funding climate disinformation campaigns. These campaigns are aimed at casting doubt on both climate change and renewable energy. Despite scientific consensus, climate action remains a highly partisan issue in Congress, complicating efforts to move from fossil fuels to clean, renewable energy. Supply chains in the renewable energy sector face a major threat. Critical and rare metals are vital for renewable energy technologies. For example solar panels, an important material to make the product is tellurium, one of the rarest elements on Earth. The amount of rare metals required for production isn't enough to raise concerns about shortages. However, production of many essential elements is concentrated in just a few countries. China in particular, mines 93 percent of the world's rare earth elements. If China's ports were impacted by a natural disaster, for instance, world trade and the global economy would feel the repercussions. Also this grants China a near monopoly on crucial elements. When a conflict arose between Japan and China in 2010, for instance, China halted all shipments of rare earth elements to Japan, which the country needs to manufacture hybrid cars and electronics.

Current Trends & Overall Performance

Renewable energy firms have recently demonstrated exemplary performance overall, while non renewables seem to be falling behind. The renewable sector is primed to endure a new phase of growth driven largely by increasing customer demand, cost competitiveness, innovation, and collaboration. Reflecting this, for the first time ever renewable energy outpaced coal in regards to US power generation. According to Marlene Motyka, a principal of Transactions and Business Analytics, "Renewable energy produced 23 percent more output when compared to coal's 20 percent share in the market."[5] More specifically this growth is evident in the performance of wind and solar power. "Wind and solar together accounted for approximately 50 percent of total US renewable electricity generation."[6] This exhibits improvements in operations and displays an upward sloping trend in profits, further proving an increase in market power for clean energy.

Declining costs and rising energy capacity factors of renewable energy sources brought about growth to the sector. Motyka adds that, "In the first half of 2019, levelized cost of onshore wind and utility-scale solar declined by 10 percent and 18 percent, respectively, while offshore wind took a 24 percent dip. The greatest decline was in lithium-ion battery storage, which fell 35 percent during the same period."[7] This gradual drop in prices for energy capacity has begun to add value to renewables, showing that wind and solar power has been increasingly more and more competitive with traditional non renewable energy sources.

The renewable energy sector saw significant increases in demand from most market segments as overall consumer sentiment remained favorable to renewables and hurtful towards

[5] Motyka, Marlene. *"2020 Renewable Energy Industry Outlook." Deloitte*, October 23, 2019
[6] ibid.
[7] ibid.

fossil fuels. Motyka states that, "Renewable energy consumption by residential and commercial customers increased 6 percent and 5 percent providing a positive relationship, while industrial consumption declined slightly, by 3 percent, through June 2019 compared with the previous year."[8] Here trends suggest an upward slope for renewables and a downward slope for non renewables in regards to consumer interest. Taking into account the data provided on current values and trends in the market, the energy industry's performance seems to be suggesting a gradual but apparent change towards clean energy dominance.

Results from Analysis

The evidence and data provided thus far regarding trends, business operations, and overall public perceptions on both sectors provides enough support to back the investment thesis provided. This relatively thorough analysis on the energy industry gives a good enough reason for the pursuit of possible investment strategies that coincide with said investment thesis. The thesis provides investment opportunities for both a short and long position for investors to follow. The predicted rise of clean energy suggests taking a long position in companies residing in the renewables sector, which yields profits to investors through positive economic growth that increases the market value of said sector. The anticipated fall of fossil fuels suggests taking a short position in companies residing in the non renewables sector, which yields profits to investors through negative economic growth that decreases the market value of said sector. More simply put, this prediction suggests investors can benefit from investing in renewable energy and divesting in non renewable energy. As stated before industries run on the flow of funds they are allocated. Since funds are predicted to flow from fossil fuels to clean energy its safe to say the

[8] ibid.

energy industry will endure a renewable energy revolution, bringing an end to the long reign of fossil fuels.

Portfolio Analysis: Fidelity Select Environment and Alternative Energy Portfolio

This section will provide an analysis of a mutual fund that invests in companies engaging in renewable energy practices, sustainability and more. The analysis will include the funds overall performance, average returns, risk and conclude with a prediction as to where the fund is heading in the future. The fund that will be assessed in this section is the Fidelity Select Environment and Alternative Energy Portfolio, a fund "Investing primarily in companies engaged in business activities related to alternative and renewable energy, energy efficiency, pollution control, water infrastructure, waste and recycling technologies, or other environmental support services."[9] When measuring the performance of a mutual fund it is necessary to compare it to a given benchmark, this can differ from fund to fund according to certain factors such as the size of the fund.[10] In regards to the fidelity fund being analyzed in this section, the S&P 500 will serve as its benchmark and its performance will be judged according to how it performs against the S&P. However, before benchmarking the fund it is important to note that it has yielded positive average annual returns for its 1,3,5 and 10 year averages (see Figure 1). In regards to the funds performance against the S&P 500, the fund underperforms in comparison (see Figure 2). However the discrepancy between the two is minimal and it is quite difficult for actively managed funds like said mutual fund to beat the market. Due to the funds niche in the stock market, investors do take on some risk when investing in this mutual fund. The environmental sector is quite volatile and subject to price changes in stocks as many outside factors can

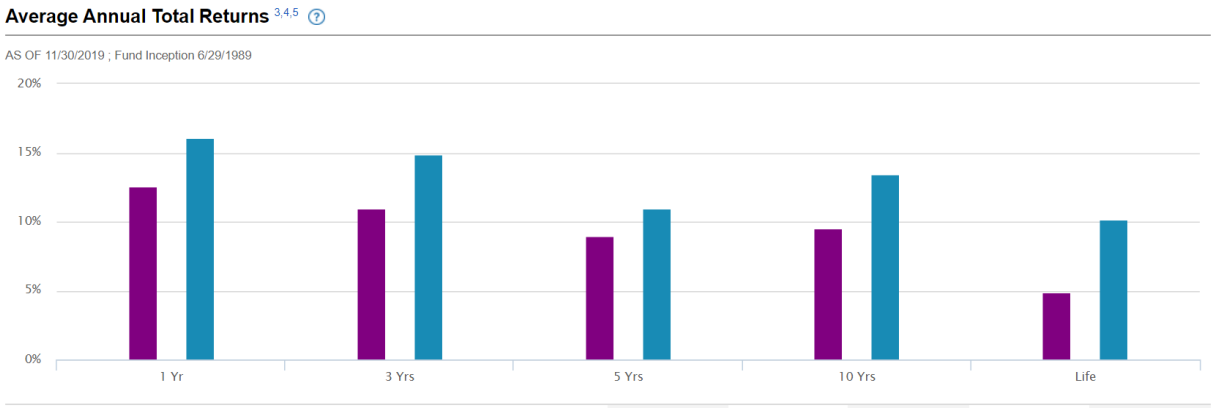
[9] Fundresearch.fidelity.com. (2019). *FSLEX - Fidelity ® Select Environment and Alternative Energy Portfolio | Fidelity Investments*. [online]
[10] Investopedia. (2019). *Average Mutual Fund returns*. [online]

influence the companies within this sector.[11] According to fidelity's assessment of the funds risk, "The environment and alternative energy industries can be significantly affected by government regulations and subsidies, changing supply and demand for traditional energy sources, and availability of funding for remedial cleanup efforts or the development of new technologies, and can be subject to risks associated with hazardous materials".[12] As discussed extensively throughout the report, the renewable energy sector is growing and will continue to experience growth. Due to the increased media attention directed towards the vulnerable state of our environment and emerging government policies being put into place, we believe that the fidelity fund will continue to grow and yield even greater returns in the future.

Figure 1.

Figure 2.

[11] Fundresearch.fidelity.com. (2019). *FSLEX - Fidelity ® Select Environment and Alternative Energy Portfolio | Fidelity Investments*. [online]
[12] Ibid.



Renewable Energy on College Campuses

Why College Campuses?

Although the benefits of renewable energy can be seen almost anywhere, college campuses can be great places to implement renewable energy for a number of reasons. According to Environment America, "college and university campuses are great places to transition to 100 percent renewable energy."[13] In 2012, educational buildings, which include colleges and K-12 schools, consumed 10 percent of all energy used in the commercial sector. As colleges are major energy users in the commercial sector, their use of renewable energy can have huge impacts. Also, colleges are known for their technical training and innovation, making them great for developing, testing, and deploying new clean energy technologies, all while educating students in the process. The students who attend college tend to be "climate-conscious and tech-savvy," so colleges that use clean energy can attract these students, which may make colleges more inclined to implement clean energy. Aside from transitioning to renewable energy, Mitchell Thomashow sees a college or university as "an ideal venue for addressing the global climate crisis."[14]

[13] Abigail Bradford, Johnathan Sundby, Bronte Payne, and Jake Taber, "America's Top Colleges for Renewable Energy: Who's Leading the Transition to 100% Renewable Energy on Campus," *Environment America*, April 2019
[14] Mitchell Thomashow, and Anthony Cortese, *The Nine Elements of a Sustainable Campus* (MIT Press, 2014), 2

According to Thomashow, former president of Unity College, colleges are ideal for addressing the climate crisis because of their ability to engage both students and employees. Colleges educate people to help them understand the potential impacts of climate change. Through educating these people, colleges mobilize a shift in their awareness and demonstrate the relationship between knowledge, commitment, and action.[15] Many colleges in the United States seem to agree that their campuses are good places for renewable energy, and have begun setting goals toward implementing clean energy technologies.

Leading the Way: Local Colleges and Universities Making the Transition to Renewable Energy

Throughout the country, there are countless colleges and universities that have ambitious renewable energy goals that are leading the way in making the transition to renewable energy systems and creating sustainable campuses. Three New England schools, Harvard University, Brown University, and Boston University, have ambitious goals, and can serve as examples for other schools hoping to transition to renewable energy and a more sustainable campus. Through reducing energy consumption, shifting to renewable electricity, repowering buildings with clean energy, and/or adopting sustainable transportation methods, these schools are taking the necessary steps toward more sustainable campuses.[16]

Beginning with Harvard University, the school has established two goals to make their campus more sustainable. The first goal is to become carbon neutral by 2026. In order to achieve this, the school plans to drastically reduce energy consumption, invest in renewable energy projects, and purchase offsets for their remaining emissions. Harvard's second goal is to completely stop using fossil fuels by 2050. To eliminate the use of fossil fuels on campus, the university will purchase 100 percent of electricity from renewable energy sources, make the

[15] Thomashow, *The Nine Elements of a Sustainable Campus*, 3
[16] Bradford, Sundby, Payne, and Taber, "America's Top Colleges for Renewable Energy"

switch to emission-free campus vehicles, use fossil-fuel free energy sources to obtain building energy needs, such as heating and cooling, and purchase goods and services that minimize the use of fossil fuels. Harvard has already begun implementing processes geared toward achieving their goals, including a competition to encourage students and employees to turn off the lights and close the fume hoods in research laboratories, in an effort to conserve energy. Harvard has already started seeing some results from their sustainability efforts, experiencing a ten percent decrease in campus-wide energy use between 2006 and 2016, even as the campus grew. Not far from Harvard University is Boston University, another New England school leading the transition to renewable energy.[17]

At the end of 2017, Boston University (BU) became a local leader in sustainability among colleges and universities, committing to creating a more sustainable campus by adopting the BU Bold Climate Action Plan. Through this plan, BU committed to purchasing 100 percent of its electricity from renewable energy sources beginning in 2020, and becoming carbon neutral by 2040. BU has already taken the necessary steps to purchase 100 percent of its electricity from renewable sources, announcing the construction of a South Dakota wind farm in 2018. The school plans to purchase the amount of electricity that it uses annually for 15-years. Instead of using the electricity, the school will then resell the power for use in the Midwestern United States, where the power grid relies more on fossil fuels.[18] Unlike some other schools, BU is looking at the bigger picture and trying to have an impact on places outside of their campus. Massachusetts-based schools have demonstrated significant goals and progress toward renewable

[17] ibid.
[18] ibid.

energy solutions, and the same can be said for colleges in Rhode Island, particularly, Brown University.[19]

In 2019, Brown made a commitment to build a more sustainable campus. By 2025, Brown hopes to reduce greenhouse gas emissions by 75 percent by reducing energy use and transitioning to 100 percent renewable electricity. By 2040, the university plans to switch to renewable energy sources for campus heating and cooling, in an effort to eliminate the use of fossil fuels for those activities. Brown has made great progress toward implementing systems to achieve their goals, finalizing agreements for two renewable energy projects that are expected to provide enough power to offset all electricity use on campus. The first project involves transforming a 240-acre former gravel pit into a solar farm, creating "Rhode Island's highest capacity contiguous solar generation project."[20] The second project is a wind power project in Texas that is expected to offset Brown's electricity use not already covered by the solar project.[21] Although not all colleges have made such significant goals and progress regarding renewable energy, the lesser goals and progress of other schools, such as Bryant University, cannot be discounted.

Bryant University has been pursuing a more sustainable campus since the early 1990s. Recently, in 2015, Bryant's sustainability committee set three goals for energy use on the campus. First, the university has committed to reducing electricity consumption by 10 percent by fiscal year 2010 through fiscal year 2020. Next, Bryant would like to reduce natural gas use by 10 percent over the same time period. The third and final goal is to explore the potential for renewable energy, both on- and off-campus, to cut costs, specifically solar and geothermal

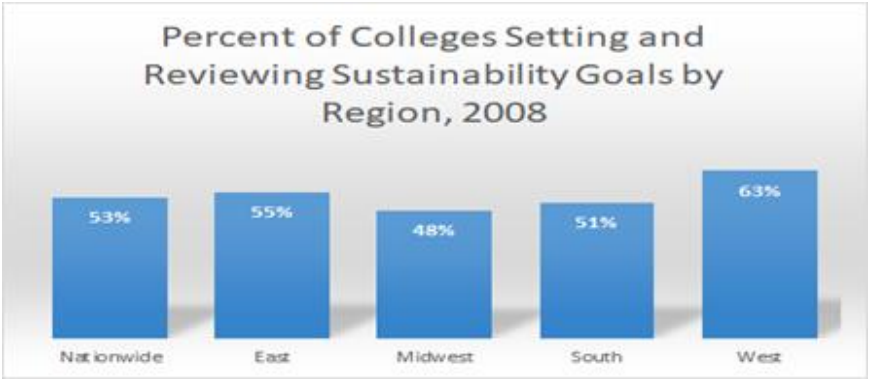
[19] ibid.
[20] ibid.
[21] ibid.

potential. Beyond these three goals, as expected from a school pursuing sustainability for nearly 30 years, Bryant has already made progress toward a more sustainable campus and implementing renewable energy technologies.[22]

United States Colleges and Renewable Energy

Like these New England schools, higher education institutions throughout the United States are making significant goals and progress toward more sustainable campuses. The National Wildlife Federation issued a report in 2008, outlining the environmental performance of United States colleges and universities. The report found that nationwide, 53% of these institutions were keeping up with setting and reviewing goals regarding sustainability (see Figure 3). Of that 53%, more than half of the institutions consistently set and review goals regarding energy conservation, the environmental performance in the design of campus buildings, and reducing solid waste and maximizing recycling.[23] While these statistics are important when reviewing the sustainability performance of higher education institutions, they are outdated.

Figure 3.



[22] Bryant University Sustainability Committee, "Bryant University Sustainability Plan," *Bryant University*, 2015
[23] "Campus Environment 2008: A National Report Card on Sustainability in Higher Education," *National Wildlife Federation*, 2008

Currently, there are 984 institutions registered to use the Sustainability Tracking, Assessment, and Rating System (STARS), a program from the Association for the Advancement of Sustainability in Higher Education (AASHE).[24] AASHE's mission is to "inspire and catalyze higher education to lead the global sustainability transformation,"[25] and 664 of the institutions registered to use STARS are AASHE members.[26] STARS gives a rating for each reporting school based on "the percentage of points it earns by pursuing relevant credits across the four main categories: Academics, Engagement, Operations, and Planning & Administration."[27] The STARS report remains valid for three years.[28] Of the 331 institutions with valid reports, 6 received a platinum rating, 125 received a gold rating, 141 received a silver rating, 54 received a bronze rating, and 11 were labeled "Reporter," schools that do not wish to receive a rating (see Figure 4).[29] Beyond the STARS rating, there are 180 schools that report their renewable energy data to AASHE, 91 percent of which are using some amount of renewable energy. Although many institutions in the United States are using or pursuing increased sustainability on campus, most have a lot of work to do to catch up to the 40 that currently obtain 100 percent or more of their electricity from renewable sources.[30]

[24] "STARS Participants and Reports," The Sustainability Tracking, Assessment, & Rating System, The Association for the Advancement of Sustainability in Higher Education, 2019
[25] "Mission, Vision & Commitments," The Association for the Advancement of Sustainability in Higher Education, AASHE, 2019
[26] "STARS Participants and Reports," The Sustainability Tracking, Assessment, & Rating System, The Association for the Advancement of Sustainability in Higher Education, 2019
[27] "Help Center," The Sustainability Tracking, Assessment, & Rating System, The Association for the Advancement of Sustainability in Higher Education, 2019
[28] ibid.
[29] "A Global Sustainability Standard," The Sustainability Tracking, Assessment, & Rating System, The Association for the Advancement of Sustainability in Higher Education, 2019
[30] Bradford, Sundby, Payne, and Taber, "America's Top Colleges for Renewable Energy"

Figure 4.

Case Study: Renewable Energy at Bryant University

Bryant's Sustainability Progress Thus Far

Currently, Bryant University's stake in regard to sustainability is similar to that of other colleges. Bryant's Sustainability Plan reflects the University's commitment to becoming a more sustainable campus community that values the environment and acknowledges the moral and financial benefits the use of renewable energy bares. It defines sustainability and provides a template for implementing said sources of energy. The plan seeks out measurable goals to guide campus initiatives, all while aiming to mitigate adverse impacts and amplify constructive practices while using these innovations on and off campus. Along with many other universities, Bryant's sustainability program recognizes the wide range of complex challenges we face as a society that threaten the future prosperity of our local and global communities. Bryant's Sustainability Plan is intended to generate integrated solutions that respond to economic, social, and environmental issues that are affecting our way of life today. Aside from the plan for sustainability, Bryant has already taken a course of action. On campus, Bryant has incorporated a heating system that runs on geothermal energy in two of its buildings. The implementation of said energy has not only reduced costs but has substantially reduced the output energy for these two buildings. Along with this, the sustainability program actively manages the campuses'

overall consumption of energy and influences the university to revise its allocation and overall amount of energy. Overall Bryant's efforts towards becoming a sustainable campus is very apparent and has even earned the university a STARS Silver rating in recognition of said achievements from the Association for the Advancement of Sustainability in Higher Education.

Furthering Bryant's Efforts

Bryant University has demonstrated a good effort in creating a more sustainable campus, but they can, and certainly should pursue greater efforts toward the cause. Bryant's 2015 sustainability report cites electricity as the university's largest energy expense and shows electricity accounting for the second-largest amount of energy used on campus. The report continues by outlining alternative energy, such as wind, geothermal, and solar, as a potential opportunity, then describes the goal of exploring the potential of implementing renewable energy sources on- and off-campus.[31] Given Bryant's opportunities and goals, we explore the potential for renewable energy on Bryant's campus and whether or not it would be worth it.

In 2017, Bryant used about 16,639,022 kilowatt-hours (kWh) of electricity, all of which the university purchased.[32] While purchasing electricity does not rule out the use of renewable energy sources, a relatively small amount of the electricity purchased came from such sources. Bryant only purchased electricity from one source of renewable energy, with 4 percent of their electricity coming from wind. The rest of the electricity used by the university came from other sources, notably, 38 percent from coal, and 24 percent from natural gas. As previously mentioned, Bryant has already begun incorporating geothermal energy on campus, however, the

[31] Bryant University Sustainability Committee, "Bryant University Sustainability Plan," *Bryant University*, 2015
[32] "Bryant University OP-5: Building Energy Consumption," The Sustainability Tracking, Assessment, & Rating System, The Association for the Advancement of Sustainability in Higher Education, 2019

school still has no source of on-site renewable electricity.[33] Because of these facts, we explore the potential for solar panels as a source of on-campus renewable electricity.

To begin, it was essential to find a place on Bryant's campus that was capable of supporting solar panels. Initially, the best place for solar panels seemed to be Bryant's Unistructure. The Unistructure is one of the campuses largest buildings, comprising a majority of the classrooms and research labs on campus, administrative offices, faculty offices, the university's dining hall, and more. Because the building is so large and contains so much, it seemed like a practical location for solar panels. However, after measuring the feasibility of this location, it appeared as though there were too many obstructions on the roof to support the panels. After investigating other possible locations for solar panels, two other buildings stood out: the George E. Bello Center for Information and Technology (see Figure 5) and the Chase Athletic Center (see Figure 6). Both buildings have large flat roofs with few obstructions and are capable of supporting an array of solar panels that could help power the university.

Figure 5.

Figure 6.

[33] ibid.

In order to do a financial analysis of the project, we first had to find out how much space these buildings had that was suitable for solar panels, how many panels could fit on the roofs, and how much electricity the panels would generate. We were unable to find the exact dimensions of the buildings, so we used Google Earth to estimate the dimensions of them in order to calculate the area of each. We found that there are roughly 14,870 square feet of roof space suitable for solar panels on top of the Bello Center, and 28,125 square feet on the Chase Athletic Center. The two buildings combine for a total suitable roof area of 42,995 square feet. We multiplied the total roof area by .75 in order to account for setback,[34] as the panels cannot extend all the way to the edges of the buildings, giving about 32,246 square feet that could actually be used for solar panels. After estimating the roof area suitable for solar panels, we needed to estimate how many panels could fit on the two buildings.

Our next step was to figure out the size of solar panels to get an estimate of how many could be used, and to determine how much power each panel can generate. Typically, commercial solar panels are 77 inches by 39 inches, roughly 20.9 square feet.[35] Knowing this, we divided the total roof area that could be used, 32,246 square feet, by 20.9. We determined that the buildings could support about 1,547 solar panels; 535 on top of the Bello Center and 1,012 on top of the Chase Athletic Center. Because not all solar panels are the same, they can produce a wide range of power, but around 320 watts was typical in 2018, which means that if one panel received one hour of peak sunlight, it would produce 320 watts of electricity.[36]

Knowing the number of solar panels that could fit on the two chosen buildings at Bryant as well as how much power they could produce, we found out how much it would cost to

[34] Andrew Sendy, "How many square feet of roof space is needed for solar panels," Solar-Estimate, 2019
[35] Brightstar Solar, "Common Sizes of Solar Panels," Brightstar Solar, 2017
[36] Ben Zientara, "How much electricity does a solar panel produce?," Solar Power Rocks, Wave Solar, 2019

implement the system by performing a few simple calculations. According to Energysage, solar panels cost $2.99 per watt on average.[37] To calculate the total cost of the solar panels, we simply multiplied the number of solar panels (1,547), the amount of power each panel produces (320 watts), and the cost per watt ($2.99). By our estimates, the total cost for the solar panels would be $1,480,169.60. The panels on the Bello Center would cost $511,888, and the remaining $968,281.60 would be for the panels on the Chase Athletic Center (see Figure 7).

Figure 7.

Bryant University Solar Panel Cost Calculations									
Building	Roof Area	Setback	Suitable Roof Area	Panel Area	Number of Panels	Power per Panel	Total Power Produced	Cost Per Watt	Total Cost
Bello	14,870	0.75	11,152.50	20.9	535	320	171,200	$ 2.99	$ 511,888.00
Chase	28,125	0.75	21,093.75	20.9	1,012	320	323,840	$ 2.99	$ 968,281.60
Total	42,995		32,246.25		1,547		495,040		$1,480,169.60

Based on all of the above calculations and Bryant's electrical usage and cost data, we were able to calculate how much money Bryant could save on electricity and the payback period for the solar panels. Because the panels produce 320 watts per hour of peak sunlight, we turned to solarreview.com, where we found that on average, Rhode Island receives about 4.4 hours of peak sunlight per day.[38] The entire array of 1,547 solar panels would produce about 495,040 watts per hour of peak sunlight, which converts to 495.04kWh. We multiplied the number of kilowatt-hours (495.04), the average number of peak sunlight hours per day in Rhode Island (4.4), and 365 to calculate how many kilowatt-hours the array could produce each year. According to our calculations, the array could produce 795,034.24kWh per year. According to Bryant's sustainability report, the school spent $1,771,884 on 16,639,022.08kWh of electricity,[39] which is equal to $0.1065 per kWh. By multiplying Bryant's cost per kilowatt-hour ($0.1065) by

[37] Sara Matasci, "How much do solar panels cost in the U.S. in 2019?," Energysage, SunShot, 2019
[38] Aditya Gautam, "How many peak sun hours do solar panels need?," Solar Reviews, 2019
[39] Bryant University Sustainability Committee, "Bryant University Sustainability Plan," *Bryant University*, 2015

the amount of electricity the panels could produce each year (795,034.24kWh), we found that the school could save $84,662.94 per year on electricity. By dividing Bryant's cost purchasing solar panels ($1,480,169.60) by the annual saving ($84,662.94), we found the payback period for the solar panels to be about 17.5 years. If Bryant wanted to use solar electricity to power the entire campus, it would require about 32,377 panels and it would cost about $30,978,313.60. While the cost to power the entire campus with solar power is extremely high, another challenge would be finding a spot on the campus to put them.

In short, it would cost $1,480,169.60 to implement 1,547 solar panels on Bryant's campus on top of the Chase Athletic Center and George E. Bello Center. The school would save about $84,662.94 each year on electricity, and the panels would pay for themselves in 17.5 years. In order to power the entire campus with solar electricity, it would cost about $30,978,313.60. While there was a lot of information that went into all of the above calculations, they did leave out other important factors. In calculating how many panels could fit in the roof area, we did not account for the fact that most of the time, solar panels are installed at an angle.[40] Furthermore, there were additional costs that were not included in the calculations such as the cost for installation. Also, the calculations left out additional benefits, such as tax incentives.[41] Based on all of our research and calculations, we found that solar panels are feasible on Bryant's campus, and they would be worth it for the school to implement them, as there is minimal downside other than the upfront costs.

[40] Farhin Zaman and Elizabeth Norton, "A Case Study: Solar Panels at Boston College," *Boston College,* 2014
[41] Sara Matasci, "How much do solar panels cost in the U.S. in 2019?," Energysage, SunShot, 2019

Conclusion

The research presented in this study is extremely useful when considering investing in renewable energy, and implementing it on a college campus. The findings and recent market behavior point to this investment in renewable and clean energy being worthwhile and beneficial. The several New England schools surrounding Bryant (Harvard, Brown, Boston), are setting an incredible example in regard to doing their part to help the environment and adding value to their university. Upon observing the notable and ambitious work of other universities, we as the Bryant community have the responsibility of recognizing we are behind in terms of playing our role in being sustainable and switching to renewable energy. As growing global concern about carbon-dioxide emission and sustainability policies develop, the renewable energy sector correlates positively, and is expanding. The emerging government policies, increasing investor interest and advancing technologies are all responsible for this growth. This paper dove into this worldwide relevant trend and issue and draw conclusions and insights from current studies and research. In conclusion, committing to sustainability, becoming a carbon-neutral campus, investing and installing renewable energy greatly benefit a university and set an important example for other universities and institutions to progress towards being more environmentally sustainable.

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