Introduction

Electricity is often described as one of the most important inventions of modern society, as it has revolutionized the way people travel, live and communicate with one another. Due to the decreased availability and negative externalities of fossil fuels and other nonrenewable resources, sustainable energy has become more prominent. Renewable resources amount for the largest percentage of energy production ever, as of 2018 (U.S. Energy, 2019). These changes are due to new legislature and a more dynamic shifts in the societal views of climate change and its urgency, affecting the use and marketing of electricity, crude oil and carbon emissions. This prospectus outlines technological, economical and political challenges that the United States will face when integrating more sustainable resources in the near future, using the scientific construction of technology (SCOT) framework to define these issues. Because of the rate of carbon emissions, climate change, and various other environmental factors, the end of Earth's life is speculated to be exponentially shorter than originally anticipated. By overcoming the deeply rooted issues faced when changing the energy consumption industry, in essence, the life of Earth and all living creatures on it can be extended to some degree.

Theory

The historical analysis of industrialization in the United States aids in understanding the root issues in converting the country's main source of energy production. The rise of organizations plays a key role in the energy industry as it stands today. Beginning with the American Industrial Revolution, the roles of the working class began shifting from independent craftwork and artisanship to hierarchical wage work that eventually rendered the working class dependent on its employers (Perrow, 1991). The continued dependency of employers led to a hoard of externalities, including child labor, low-income housing, transportation, over-working and wage limiting.

Other organizations began using these externalities as business opportunities, creating more externalities of similar and sometimes different form. This has continued on ad infinitum until, presently, the web of organizations posing as solutions are simply spun around an even deeper problem.

By applying this framework of evolving business to the energy industry, it is simpler to understand what issues will be prevalent in the transition to sustainable energy. In general, there are hierarchies of companies that thrive off the work of each other. For example, the homeowner consumes energy through electricity in his or her home. Real Estate companies and contractors provide planning and detailing on how to design the home in order to best receive the electricity. Land developers and land owners must install power lines so that homes can receive electricity. Manufacturing companies that create power lines, batteries and transformers must adhere to specific guidelines and regulations when using and producing materials. Then at the very top, utility companies produce the energy that will be transformed into electricity for all other

stakeholders to use. Changes made at the top, in terms of energy production, will have a domino effect on the rest of the stakeholders below it.

In the same strand, grid services are very encapsulated in American electricity use. The grid is a general term used to describe the connectivity of electric utilities to houses and businesses alike in the United States. It is, in essence, a form of infrastructure that has grown with more urban development, and is efficient through the use of transformers, breakers and other quality control products that have been created to aid in safety and quality of electric movement (Koenig, 2019). Because the grid is such a universal aspect of American electricity, it is difficult to gauge the residual effects of different energy resources on grid applications. There is a small possibility that a shift to solar and storage could lead to an obsolete grid system, as more and more homeowners begin to become self-sufficient. This can be driven by the increased need in California for self-sufficiency, as there have been multiple purposeful power outages by utilities like Pacific Gas and Electric (PG&E) due to forest fires that could potentially damage power lines (Morris, 2019). In other instances, such as more centralized and larger hydroelectric farms are produced, electricity becomes more expensive for individuals that live far from a centralized grid service. The future of grid applications depends largely on the movement of state legislatures and what type of energy production and storage method they emphasize.

Aside from societal and political issues, economics also plays a large role in the change of energy forms. Right now, sustainable energies like solar, wind and hydroelectric is either inconsistent or not plausible. In order to use inconsistent energy sources, individual homeowners must buy storage facilities, and utilities attempting to produce sustainable energy must restructure much of its production and distribution process. Individual homeowners generally have no monetary incentive to purchase the high cost storage facilities like batteries and energy production technologies like solar panels. There is little payback in the short-run and no concrete idea of the lifespan of the technologies in the long-run (Koenig, 2019). For utilities, most all are some sort of publicly traded company with shareholders. The actions of utilities are typically conservative so as to not lose money in the short run or make bad investments. According to Koenig, the actions the utilities take are limited with very minor short term effects. For example, utilities may buy out small companies with extensive research in a specific aspect of sustainable energy in order to expediate timelines and provide more funding without making drastic changes to its current strategy.

In order to alleviate the risk and difficulties with change, various legislative acts from state and federal governments must take place, as well as voluntary lifestyle changes in homeowners and companies. Some already promising action has been taken – legislature in multiple states has is issuing incentives for switching to more sustainable and less grid-reliant energy sources. The California Self-Generation Incentive Program is a great example of such legislature that has been executed and is currently in motion through four major utilities in California (Self-Generation).

This shows some positive implication for the future of sustainable energy, but there is still much more progress to be made.

Data

In order to more thoroughly analyze the topic of changes with electricity, more information will be needed. Most data will be qualitative, with information on environmental policies and their impacts as well as other general legislature, more historical analysis on electricity integration, and the current condition of technology. Some qualitative data will be needed as well, mainly costs for a number of different items like electricity per kilowatt-hour, production costs, cost for battery storage devices and break-even points for sustainable and self-sufficient energy. Much of the information will be time-related, as there is inevitably a timeline to the progress of sustainable energy. The majority of the qualitative and quantitative data will come from government agency websites, expert interviews and scientific journals or published research. A few websites detailing a bias for the most impactful environmental acts enabled, but all other sources will be deemed credible.

Use of Data

The of the researched information will enlighten individuals of the many steps necessary to make great changes in a well established society and, thus, expound the challenges found in the dynamics of the energy industry. Most biases regarding this topic will be in filtering out information. Since there are so many policies, acts, and legislative laws, it will be extremely difficult to single-handedly read through and filter the most important ones. Therefore, the biases will occur most often when using secondary sourcing to try decipher notable legislature. In general, the majority of the information for the thesis paper will be organized in a similar fashion to this prospectus. There will be an introduction that is detailed but brief, in comparison to the rest of the paper. It will then be followed up by a historical analysis of electricity, policies, and laws that popularized fossil fuels, as well as note networks and organizations that support modern societal function and its makeup.

Research Plan

The entirety of the thesis will take until the end of the spring semester to finish (May 2020). Research will be continued around the capstone project, which is primarily a topic on electricity arbitrage and the need for energy storage in residential communities. As the capstone project progresses more, so will the thesis paper that is related to it. All funding should come derivative of the capstone project, as this is related more to design, and research is inevitable when designing and prototyping a product. More interviews will be conducted through the continuance of the paper, by multiple experts located at the University of Virginia – most notably David Slutzky – as well as other experts in related fields located within close proximity of the University of Virginia and those within reach by phone call. These include employees at Argonne and employees of utilities in California and the Northeastern region, generally. Other

research is necessary to fully understand topics in electricity, energy production and policy. Many recommendations have been made on researchers to study on these general topics – including Jay Whitacre and Jeremy Michalik of Carnegie Mellon, who focus primarily on sustainable energy policy and its impacts. Linda Gaines of Argonne was also recommended when studying the carbon emissions produced during manufacturing.

Conclusion

The prospectus outlined plans to introduce the historical background of popular energy uses and the modernization of electricity, including environmental laws and other political or economical factors that evolved the use of energy. After establishing historical information, the paper will assess the modern health and direction of energy consumption and generation, using data from government agencies and expert interviews for more specialized perspectives. Once the current climate of the energy industry is detailed, the paper will focus on implications for the future, in what changes will be necessary given the current condition of climate change as well as the specific social, economic and political challenges that will be involved in these changes. Specifically the paper will be directed toward sustainable and renewable energy sources and their impact in certain geographical regions such as California.

Citations

U.S. Energy Facts Explained. (28 August 2019). [Web]. Retrieved from https://www.eia.gov/energyexplained/us-energy-facts/

Perrow, C. (December, 1991). A Society of Organizations. In *Theory and Society* (Vol. 20, pp. 725-762). Springer.

Koenig, G. (October, 2019). Interview with Gary Koenig at the University of Virginia in the Chemical Engineering Building.

Morris, J.D. (27 October 2019). PG&E Outages: Historic Blackout Under Way, 1.3 Million in Bay Area without Power [Web]. Retrieved from https://www.sfchronicle.com/california-wildfires/article/PG-E-outages-Over-3-million-people-blacked-out-14566085.php

Self-Generation Incentive Program. [Web]. (n.d.). Retrieved from https://www.selfgenca.com/.