ECE Capstone Project: Temperature Tracking Door Locking System

STS Thesis: Complexity of American Climate Politics and Public Numbness on transitioning to a Renewable Energy Society

A Thesis Prospectus Submitted to the

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Introduction

The automated temperature tracking door locking system designed and constructed by my technical capstone team is a device that denies entry through a door to a person whose body

temperature falls within an unsafe or potentially ill temperature range. A person who wishes to seek entry through a door will first approach the device and place their wrist underneath the scanning-area, which will simultaneously allow a motion detector to awake the system as well as sense the body temperature through a medical grade temperature sensor. After the temperature data is sent to a server via Bluetooth connection to be analyzed and stored in a database, the door will then decide whether to unlock itself to the person depending on their recorded body temperature. In addition to the temperature locking device's ability to deny entry to potentially unwell users, the database will be readily available for system owners to view through a private webpage and will show the number of user entries or denials and their associated temperatures. Societal and ethical concerns largely arise from privacy concerns attached to temperature data for user entry. Privacy laws indicate that temperature systems that deploy facial recognition scanners or collect personal information are privacy breaches, but the system aimed to be created strictly takes in numerical temperature data without a person's name attached. Another societal concern is that the webpage database for system owners could allow data to be traded, but can be alleviated through the fact that personal data is not stored. Finally, since the door locking mechanism requires the door to be locked by default, societal concerns could arise in terms of safety hazards and is a technical issue that should be further examined. The technical subject of the STS prospectus and the technical topic for the Department. of Electrical and Computer Engineering is not related.

Readily available renewable energy technologies whose aim is to reduce rising carbon emissions are not being deployed sufficiently enough to slow the rate of global warming. While the majority of climate scientists and the environmental community around the world have concluded that anthropogenic emissions past the four-degree carbon tipping point will cause irreversible catastrophic planetary impacts, some in society ranging from the public to government leaders globally and namely in the United States have conflicting views and believe that climate change is a hoax and that a renewable energy society is not necessary. Global actors and policies play a large role in influencing US climate decisions, but multilateral agreements such as Paris and Kyoto have only caused more strife in the US climate goals due to political and social complexity within the US and a lack of trust between the US and other nations. With state of the art solar and wind energy systems technically capable of providing clean power to our nation, fossil fuels are still driving electric grids in the US causing a net carbon increase and a standstill in the transition towards a truly clean powered economy. The debate about climate change has been at the forefront of American politics and more debates still need to be had. American politics and social numbness have created a system of complexity in transition to renewable energies. If it is true that clean energy is available to our society now, then what socio-technical factors are impacting US adoption of renewable energy systems today and what is the root cause to the public numbness surrounding energy adoption?

Technical Topic

The aim of the temperature tracking door lock system is to allow businesses and buildings to deny access through a door to people who exceed normal body temperature

measurements. The inspiration for this project arose from COVID-19 and its goal is to increase public health by potentially combating the spread of the coronavirus disease by tracking a large indicator for said illness. The device itself uses a complex system of integrated sensors, software and databases, and a CPU to obtain the temperature data goal. The project relies on four main components: temperature sensor, motion detector, locking mechanism, and a web dashboard. Specifically, a motion detector uses proximity sensing to detect whether a human is within a short range of our device. Once a signal is sent to our microcontroller from the connected motion detector that has detected a figure has entered our device's operating range, it then uses I2C communication to inform the MLX90614 non-contact infrared temperature sensor to awake. The user will then place their unclothed wrist within a five-centimeter range of the outward facing IR temperature sensor, which will accurately sense their body temperature by measuring the intensity of the emitted infrared energy from the user's wrist. After the signal from the temperature sensor is converted to a digital value and sent to the MSP432 launchpad using I2C communication, the microcontroller will determine whether the measured temperature is outside the range of 99.1 °F to 104 °F to allow a fail-safe lock to open. As this information communicated through I2C protocol within the microcontroller is being sent to the locking mechanism, the HC-05 Bluetooth module will use short range wireless communication to send the temperature sensor digital values to a Raspberry Pi server data hub allowing the database to perform real time data analysis on user's temperature values. The locking mechanism uses electromagnetism to pull a solenoid powered by a 12V power supply. If a user's temperature is detected to be within a temperature range, the digital value sent to the microcontroller will then allow the microcontroller to disconnect power from the natural resting locked state of the mechanism to allow the solenoid to release and unlock the door. If the temperature range of the user falls within an unsafe scope, then the microcontroller will not communicate to the fail-safe lock to trigger unlocking.

This project directly uses concepts learned from ECE department courses like Embedded Systems for microcontroller integration, the FUN series for circuit design and implementation, and Introduction to Engineering for CAD designing. While similar works have been created in the past, our device is unique to the fact that it includes direct door entry and denial via connection to the locking mechanism.

Our project has 3 main deliverables: a temperature sensor that accurately records temperatures, a door lock that opens on command, and a web dashboard that compiles the information retrieved by the door lock and the temperature sensor. The sensors will be attached to a custom PCB that connects to the MSP43X microcontroller and controls the locking mechanism. When the motion sensor detects movement, it will send an interrupt to the microcontroller. When the microcontroller detects the interrupt, it will wake up the temperature sensor and await the temperature reading from the sensor. If the recorded temperature is within a certain bound, then the microcontroller will flip a switch and trigger the solenoid, thus unlocking the door. The door lock mechanism, motion sensor, and temperature sensor will all have an adequate power supply, and the unit will be professionally encased in a 3D printed model for housing. Ideally, this would all be powered by a battery, although some may have to be attached to a standard wall outlet.

The entire housing unit and PCB design will be done from scratch - drawing knowledge from previous classes and personal hobbies. This work will be done in parallel with the software implementation of the data flow as described, and the entire unit will be bright together after and alongside rigorous testing, verification, and validation. The total cost estimate of cost is $332.65.

This includes PCB estimates, sensors, communication modules, physical housing, and an allowance for broken parts and other miscellaneous costs.

STS Prospectus

Introduction

The debate on climate change action has been circling around the United States and countries globally for decades and with a clean energy society on the horizon, what does society need to do to help save the environment. Scientists from the NOAA, to NASA, to the IPCC as well as many countless studies conclude that anthropogenic warming is causing rising temperatures through output of emissions causing disastrous effects in the climate via wildfires, sea level rise, destruction of habitats, resource loss, and other extreme weather that will inevitably make the world uninhabitable. According to energy analysts, wind and solar plants can already provide the cheapest source of power to 67% of the world and can their energy can be easily managed on the grid, while being cost-effective, produce millions of new jobs, and displace emissions. If in fact renewable energy is already fully feasibly to replace carbon emitting resources, then it is puzzling to why clean technology has not proliferated globally and even in the United States itself. The complexity of US politics and public perception demands an STS investigation as to what sociotechnical factors are preventing a transition to a renewable energy society. While the technology is in place today, an STS analysis will help uncover what and why American society has shied away from renewable energy adoption.

Research Questions

Given that multilateral agreements in the past have not been fully successful in meeting climate goals, does the US or global actors have a greater impact on global renewable energy adoption and what factors might help future agreements succeed? Despite solar and wind power systems being readily deployable today in the United States, what role does American politics and societal numbness play in preventing a full transition towards adopting renewable energy. Can extreme weather and current events in the United States cause a shift in ideology towards climate and renewable perception?

Literature Review

A transition to a clean energy society has not fully occurred and can be attributed to the complexity of American politics and the public perception of climate change. According to a study done by the Brookings Institute (Kamarck, 2019), it is evident that over the last 20 years, public perception has largely been more positive towards adopting renewable energy and decreasing carbon output, and though there has been progress the main issues lie in party lines, generational gaps, and collective action. It is evident that it takes everyone on board in society domestically and internationally, but it's not feasible to ask everyone to buy an electric car or even just shutting off unused electricity, which means how can we get everyone to adopt the idea of renewable energy? Without a complete trust from the public in one's particular government, which can specifically be seen in the case of the United States, then it may not be possible to transition without some drastic change in time to prevent four degree warming (Buis, 2020), which would cause existential threats to humanity according to IPCC reports. Public perception, though, can be changed by current events and with recent environmental devastations such as the California wildfires in 2020 it is important to examine the nature of changing events and the way the public might view climate policy and renewable adoption. According to surveys from 2017 and 2018 done on the ever-growing hurricanes in the US, no visible change was detected in public opinion regarding "social bases of renewable energy support, and of ACC acceptance, across two very different US regions" (Hamilton, et al. 2019). However, it wasn't until drastic

change highlighted by the coronavirus and California wildfires that finally has caused a large public perception shift towards demanding environmental change and justice. Energy blackouts in California caused by heatwaves and wildfires have been causing the public to blame the state's attempt to push towards renewable energy while shutting down gas and nuclear plants, but "the state has not adequately integrated renewables into the power system." These events in 2020 have shown that while the public have still lacked a certain trust, there is a large progression towards adopting renewable energy. Domestic and global politics need to be examined as well. No country or political figure has been able to 'step up to the plate' in a manner that has the ability to draw attention from everyone. "The compliance gap is the most serious global governance deficit" (Zerrenner, 2020), which is the root cause of failures of international agreements such as Kyoto all the way to Paris and Copenhagen. Evidence shows that while multilateral agreements have been able to form, implementation is the lacking factor. In the context of the US, partisanship in the government have halted political pushes during certain political party rulings (Thakur, 2020), which is a large reason for climate policy stalemate in the US. That is not to blame any particular group of people, but it is evident that there is a lack of direction in terms of governmental stance, which could be a deciding factor in why public perception has fluctuated in the past. As an analyst of renewable energy adoption, it is crucial to discuss the energy industry and domestic and global fossil fuel companies. The economics behind oil and fossil fuels are clear in that dirty energy is cheap and renewable energy is expensive, but advancements in technology over the past decade have proven that solar and wind power can operate at a cost-effective level to feasibly displace oil. Public perception has slowly shifted on fossil fuel usage, but it doesn't look like consumer behavior will change any time soon (Worland, 2020), which combats the idea of a renewable energy transition. Once again, it is evident now that something drastic must occur for this sort of transition to be possible in the light of fossil fuels powering society and carbon tipping points approaching. Maybe looking at individual components of climate change is wrong, and it might be more affective to analyze multiple stakeholders in renewable energy simultaneously. Social and political impacts are key players in renewable adoption and it is thus important to analyze how they are inter-related (Sheikh, 2016). Or maybe the public is influenced by the technology itself making the components of social and technical aspects intertwined (Hamilton, et al. 2018). It is also important to analyze how the US plays a role in the global transition and how our technology can help create a domino effect (Gielen, 2019). It may take drastic change to create a feasible transition to a clean energy society (Kuzemko, et al. 2020). These are all considerations when analyzing the root causes of climate change perception and adopting a renewable energy transition.

STS Framework and Method

The topic of renewable energy adoption and climate change requires a complex examination of multi-stakeholders and many relevant social groups on a macro and micro level. Langdon Wiener's macro theory suggests that social, political, and economic conditions shape science and technology and allows us to see the broader context for why society is not fully adopting renewable energy; are we just rejecting renewable energy itself or a form of life? This theory also begins to uncover the role behind society's economic motive to fund fossil fuels versus transition to clean energy. Society may have to mindfully change their infrastructure, outputs, and habits and each of these problems need to collectively be addressed to reach our

targeted goals. On a micro view, Thomas Hughes and the LTS system suggest that devices are constituted by many sub-systems and can be used to analyze all renewable system builders and the notion of the construction of technology itself. There are many socio-technical components that are not just attributed to societal numbness, but also the complexity of political systems and the renewable company's ability to construct a maintainable system.

My research method will require both primary and secondary data. Firstly, my primary data collection will come from interviewing field experts and professors in the environmental community and also conducting online survey's both of which will categorize political affiliation, age group, and country region to create focus group analysis. Secondly, I will use secondary data collected by other credible climate and renewable based organizations such as the IEA and the NRDC which will allow me to compare current perspectives and professional database trends to the changing views from the past decade. Of course, biases in climate change and renewable energy arise from political affiliated source outlets and even from geographic areas and people's direct experience with global warming, which will all be considered when using information.

Timeline

Primary data collection will be done first as I plan and invite personal interviews for professors and field experts in January to be executed in mid-February. I will also begin making a well-executed survey set of questions to send to my targeted focus groups in January to be sent out in early February. By the end of February 2021, I should be able to collect and analyze all of my primary data. Available political studies and climate databases from credible sources will be collected by the end of February and I will begin documenting necessary trends and areas of data discrepancies by March 2021. In terms of the technical project, the Absolute Chicanery capstone team in the ECE department plans to have the temperature tracking door locking system assembled, tested, and fully completed by December 2nd, 2020.

Conclusion

Climate change has been a center-piece in my interests in life and the aspect of renewable energy transition in the United States has been a question that has been on mine and much of society's mind. Exploring, examining, and analyzing the root cause and the snowball effect for why potentially deep socio-technical issues are halting the effective transition to a clean energy economy in the United States will be important for not only future policies, but also allow society to take a step back and examine the rate of climate change and the impacts it imposes to them and future generations. From my research methods, I hope to discover the truth behind societal numbness towards climate change and the root to the American political complexity surrounding clean energy. In terms of the technical project, I am specifically working on the mechanical CAD design, the temperature sensor read and write functionality, and other software and hardware design.

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