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Climate Change Research Essay

One of the major problems with humanity is the lack of critical thinking about the sustainability of one's actions. The human mind is designed to only care about what it can perceive with its senses. This causes one to respond to stimulus in the immediate term, with little to no regard to the consequences of one's actions in the long run. Without critical thought, humans will continue to merely respond to the stimulus in front of them, and not take the initiative to understand if they are acting in a sustainable way. The area in which humanity will suffer the most due to its lack of critical thinking is the environment. We are designing a world without critically considering if the things we are making are sustainable. Ever since the industrial revolution, people have been given the tools to make products and services at scale with ease. This revolution of manufacturing has increased the amount of carbon in the atmosphere by 375 billion tonnes, says the World Meteorological Organization. In the modern day, we see this industrialization trend continue in countries like India and China. These other countries are following the leader in their industrialization efforts, without realizing that the path the leader has paved is unsustainable. Due to the industrialization of the rest of the world, the Intergovernmental Panel on Climate Change (IPCC) has been strongly advocating for the reduction in carbon emissions. They offer stark warnings because of the currently projected global temperature metrics, claiming that global carbon dioxide emissions need to reach net zero by 2050 in order to limit the risk for global temperature increases. As the scientific disciplines grow in their understanding of how our industrialization efforts have negatively influenced the environment, other countries have the ability to learn from our mistakes and work as a unified front against climate change. The core problem that needs addressing is how energy is generated and stored, as current methods are displacing too much carbon dioxide into the atmosphere. There are promising developments in engineering disciplines for the development of more sustainable energy, which will be elaborated in greater detail through the essay. Humanity must make strides to overcome the projected negative impacts of climate change, which is directly achieved through the advancement of more sustainable actions and energy.

Before making efforts to generate more sustainable energy, we must understand the problems with the current generation and utilization of energy. The way we utilize the energy in which we generate is quite unsustainable. Due to the materialist culture in the west, and digital advertising movements, those in first world countries are conditioned to crave unsustainable lifestyles. We may have been able to get away

with this in the past, but as the rest of the world catches up, changes in lifestyle must be made. An exercise that can highlight the problem at hand can be found on “footprintcalculator.org.” Here, you can answer a survey about your current lifestyle, and the software will let you know how many earths would have to exist in order to sustain your actions if every single human were operating the same as you. This exercise is enlightening to the problem at hand and should evoke a feeling of responsibility within an individual to change their actions to assist the sustainability movement. In the year 2020, Forbes reported that 84% of the world's energy is generated from fossil fuels (Rapier 2020). Being a vast majority of our energy generation, fossil fuels have an abmishly low efficiency rating. Specifically, Geoff Zeiss reports coal, natural gas, and oil have efficiency ratings of 35%, 45%, and 38% respectively (Zeiss 2010). This research shows that a majority of fossil fuels energy is wasted as heat, and not transferred into usable mechanical or electrical power. As we move towards a more sustainable future, we must prioritize identifying energy sources with higher efficiency.

In recent years, there have been advancements in alternative energy sources like wind and solar. At the moment, these energy generation sources appear to not be the solution to the energy crisis due to their low efficiencies and limitations in regard to how the energy is stored. Solar has an efficiency of 15-22% while wind is in the range of 20-40%. These efficiency ratings are lower than that of fossil fuels, and have the added handicap of storage method. One of the benefits of fossil fuels is that the fuel is stored in a material, often liquid substance, which is easy to transport. The primary issue with wind and solar energy is the storage method. These energy sources need to be stored through batteries. Thankfully, in recent years the cost of battery packs has been on the decline, which makes the argument for wind and solar to strengthen. The most prominent battery design is the lithium ion battery, which has decreased in cost by 87% between 2010 and 2020 (Lee 2020). Specifically, the price of the batteries fell to \$137 per kWh in 2020. The decrease in cost has largely been attributed to Tesla's interest in improving the manufacturing process and producing batteries at scale for their vehicles. Environmentally conscious consumers recognize the efforts of this company and purchase their products to help advance the technologies. This is a prime example of how consumers have the power to vote with their dollar on products and services and push the industry forward, making renewable energy more affordable. Although great strides are being made, these technologies are not where they need to be for a sustainable future. More alternative energies will need to be analyzed in order to identify where the bulk of the engineering efforts need to be dedicated. In the meantime, all humans must become more cognizant of the energy in which they consume, and vote with their dollar to advance the development of more sustainable energy sources.

Out of all the currently researched alternative energy sources, fuel cells are the most promising source for sustainable energy. Specifically, we will be focusing on hydrogen fuel cells. The reason why hydrogen is the most promising element to be used within fuel cells is because it is the lightest, and most available element in the universe. The other element that is required to make hydrogen fuel cells operate is oxygen, which is the 3rd most abundant element in the universe. Hydrogen fuel cells are a much more clean energy source, as their only byproducts are heat and water. Heat will be produced when generating the electrical energy, and water is produced as hydrogen and oxygen combine through the electrochemical reaction. To fuel the device, hydrogen is easily gathered from carbon based fuels, and oxygen is retrieved through the air. Unlike ICE vehicles, fuel cells do not operate under combustion. Similarly to ICE, fuel cell vehicles do require refueling. The key benefit of fuel cells is the fact that they have higher efficiency than the previously covered fuel sources of fossil fuels, wind, and solar. According to Energy.gov, fuel cell systems can generate electricity at efficiencies up to 60 percent. The efficiency rating and more clean byproducts make the hydrogen fuel cell the most promising source of sustainable energy, but it does come at a cost. Currently the raw materials used in the creation of hydrogen fuel cells rack up quite a bill, with Platinum being a prominent material. Depending on the size of the fuel cell, thousands of dollars can be spent in the raw materials alone, before considering the manufacturing process. An engineering challenge that will continue to be faced is the assembly of the raw materials in a more efficient manner in order to produce a less expensive end product. The geometry and quantities of each raw material will be of vivid interest to material scientists and engineers in the years to come as they assemble the future of renewable energy. If the fuel cell can be assembled with reduced material cost, like what is being seen with lithium ion batteries, the next challenge that will be faced is the creation and maintenance of refueling stations. In the present day, there are countless gas stations in the United States that have diesel and gasoline. There will need to be a great deal of infrastructure built to convert parts of these gas stations into hydrogen fueling stations. Compared with EV's, hydrogen refueling times are far superior, being in the range of gasoline and diesel. The main engineering concern will be the transportation of the hydrogen and oxygen to the new gas stations, and the conversion of the pumps and underground storage tanks to support the hydrogen fuel. The next step to advance this energy source will come in the form of consumer interest and government subsidies. Currently EV's are subsidized by the government so automakers have an incentive to produce them, and customers have an incentive to purchase them. There needs to be increased awareness by the public of the potential of this technology, and the early adopters have to purchase the products in order to scale the manufacturing and reduce the material costs. Once the infrastructure begins to be built, we will be on our way to a sustainable future.

The future of this planet is held in the hands of those who currently exist upon it. Those who do not have the technical skills to contribute to the advancement of sustainable energy must exercise their critical thought to ensure their actions are sustainable, and support companies that are pushing the industry forward. Those who do possess the technical skills to contribute to the advancement energy, must do so. One area which requires help is improving the efficiency of fossil fuels, so they do less damage to the environment in the transition period to alternative energy sources. Another engineering priority will be to develop solutions in storing the alternative energy sources, like wind and solar. This is primarily done through the advancement of battery technologies. The last pillar of engineering priority comes in the form of advancing nuclear energy. At this point in time, nuclear seems to be the end solution, but the path to get there is fuzzy with our current scientific knowledge. If generations to come focus upon these priorities and take accountability within their own lives to improve the sustainability of their lifestyles, the future of this planet is promising.

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