**Commercial Drones Potential to Reduce Climate Change in the 21st Century**

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**Abstract –** Since the Industrial Revolution, greenhouse gases have continued to rise causing the Earth’s temperature and sea-levels to rise as well.[[1]](#footnote-1) New drone technology offers an opportunity to reduce the amount of automobile CO2 production. This paper will focus on why the United States should implement policies to expand commercial drones’ utilization to help reduce CO2.

**Introduction**

In November 2018, Volume II of the Fourth National Climate Assessment (NCA4) was released by the United States Global Change Research Program (USGCRP)[[2]](#footnote-2). The report concentrated on climate change impacts, risks, and adaptations occurring in the U.S. and focused on water, oceans, energy, and human health, among other areas.[[3]](#footnote-3) The key findings of this report described the effects of climate change on communities, agriculture, food production, ecosystems, water and the coastlines, and health of the American people.[[4]](#footnote-4) Earlier in the year, President Trump’s administration released an environmental impact statement for a proposed project that asserted that the earth’s temperature will rise seven degrees Fahrenheit (4°C) above preindustrial levels by the end of this century.[[5]](#footnote-5) Currently, most scientists predict that if the trend continues, it will have a catastrophic environmental impact by causing increasingly acidic oceans, the dissolution of coral reefs, a rise of ocean levels leaving parts of the country underwater, and extreme heat waves, causing more natural disasters.[[6]](#footnote-6)

Climate change has been a pressing issue in the United States since the 1980’s; although it was first raised in a 1956 article in *New York Times* which focused on greenhouse gas (GHG) emissions from energy production.[[7]](#footnote-7) Since 1980, weather and climate disasters have become increasingly more damaging.[[8]](#footnote-8) Specifically, there have been 219 weather and climate disasters that have exceeded $1 billion in damages and have cost the U.S. $1.5 trillion dollars to repair the damages.[[9]](#footnote-9)

In 2007, the Intergovernmental Panel on Climate Change (IPCC) conducted the Fourth Assessment Report on climate change.[[10]](#footnote-10) In the study, IPCC used six different scenarios to predict what could happen to the earth if temperatures continue to rise.[[11]](#footnote-11) The A2 scenario described the potential effects of an increase of 3.4 degrees Celsius above 1980-1999 temperatures, in 2090-2099, and predicted a rise in sea level between 0.23-0.51 inches that could leave some parts of Florida under water.[[12]](#footnote-12) The A1FI scenario focused on a temperature increase of 4.0 degrees Celsius from 1980 -1999, in 2090-2099, resulting in a 0.26-0.59 inches increase in sea level.[[13]](#footnote-13) In both scenarios, surface temperatures across the globe would have significant increases, rising over 7.5 degrees Celsius in some areas.[[14]](#footnote-14)

New drone technology is becoming a way to help address climate change by reducing GHG, potentially reducing weather related disasters. Specifically, the use of commercial drones provides for a common-sense solution to supplement truck deliveries to reduce the GHG produced by the U.S. This paper focuses on three main sections: section one will provide the possibilities for reducing GHG emission for commercial small unmanned aircraft (UAS) (Drones); section two will compare the commercial use of drones in the U.S. to that in other countries; and section three will provide recommendations for a more light-touch regulatory approach for commercial drones by the Federal Aviation Administration (FAA).

1. **GHG Reduction by Drones**

Currently, technology has made it possible for companies to utilize drones to deliver packages to people. Many countries have begun permitting commercial drone deliveries, including Iceland, Canada, and Countries in Africa.[[15]](#footnote-15) The U.S. has lagged behind these countries in both drone deliveries and reduction in GHGs because of the current restrictive FAA regulations. Current research supports supplementing truck fleets with drones to reduce vehicle emissions, and positively impacting energy consumption, air pollution, road congestion, and urban planning with less regulations.[[16]](#footnote-16)

**Subsection A: Current FAA Regulations**

On October 5, 2018, President Trump signed the FAA Reauthorization Act of 2018.[[17]](#footnote-17) The new law included several pro-innovation aviation reforms and established new conditions for recreational use of drones.[[18]](#footnote-18) In January 2019, the FAA released a draft Notice of Proposed Rulemaking (NPRM), Operation of Small Unmanned Aircraft Systems over People.[[19]](#footnote-19) Additionally, the FAA released an advance NPRM, Safe and Secure Operations of Small Unmanned Aircraft Systems.[[20]](#footnote-20) The FAA has yet to release final rules and advises drone users to follow current policies.[[21]](#footnote-21) Currently, the U.S. Department of Transportation (DoT) is working with 10 states and local governments as part of an UAS integration pilot program.[[22]](#footnote-22) The DoT is currently testing various drone operations, such as flying at night, flying over people, and delivering packages.[[23]](#footnote-23)

Drone regulations vary from country to country. Some of the countries that have begun allowing drones are Canada, Australia, Asia, Africa, and Iceland.[[24]](#footnote-24) For example, the U.S. and Canada are in the experimental phase, while countries in Africa and Iceland are in the permissive regulation phase.[[25]](#footnote-25) Currently, the U.S. has two different regulations relating to drones, one for recreational and hobbyist use and another for commercial use.[[26]](#footnote-26) For recreational drones, the drone must weigh under 55 pounds, register with the FAA, fly within a visual line-of-sight and away from airports, follow the community-based safety guidelines, and never fly near emergency response efforts.[[27]](#footnote-27) For commercial drone use, an individual must hold a remote pilot certification, register the drone with the FAA, fly in class G airspace, below 400 feet, during daylight hours, and under 100 mph.[[28]](#footnote-28)

**Subsection B: Fuel Combustion Emissions**

In 2015, the U.S. ranked second behind China in total carbon dioxide emissions from fuel combustion with 4997.50 million metric tons, which equates to 15.53 metric tons per capita and ranked second per capita behind Saudi Arabia for carbon emission.[[29]](#footnote-29) In the U.S., transportation and electricity were the largest portion of GHG emission, at 28 percent.[[30]](#footnote-30) Light-duty vehicles account for 60 percent of GHG emission, medium-duty and heavy-duty trucks account for 23 percent, aircrafts 9 percent, other 4 percent, rail 2 percent, and ships and boats 2 percent.[[31]](#footnote-31)

**Subsection C: Gas Emissions From Typical Passenger Vehicles Within the United States**

In 2007, the Supreme Court in *Massachusetts v. EPA* ruled that the EPA (Environmental Protection Agency) had the statutory authority under the Clean Air Act (CAA) to regulate GHGs.[[32]](#footnote-32) At issue in the case was whether the EPA could regulate the CO2 emissions from the tailpipes of new motor vehicles.[[33]](#footnote-33) The Court held that the Agency did have the jurisdiction and that the Agency’s forbearance was not consistent with the requirements of the CAA.[[34]](#footnote-34) Subsequently, the EPA found that GHGs threatened the public health and welfare of current and future generations. The combined emissions of these gasses from new motor vehicles contributed to GHG pollution, and the EPA began regulating light-duty trucks and medium-duty passenger vehicles in an attempt reduce GHG.[[35]](#footnote-35)

Additionally, in the *Center for Biological Diversity v. National Highway Traffic Safety Administration*, the Court found that passenger cars and light trucks produce about five percent of the world’s GHG emissions, primarily CO2.[[36]](#footnote-36) The Court held that NHTSA did have the authority to set fuel efficiency standards for personal vehicles, which emit about 4.6 metric tons of CO2 per year.[[37]](#footnote-37) A passenger vehicle emits 8,887 grams of CO2 per gallon of gasoline (gas) from a tailpipe and 10,180 grams of CO2 per gallon of diesel.[[38]](#footnote-38) These regulations have not had a significant impact on reversing climate change.

**Subsection D: Infrastructure for Commercial Drone Deliveries**

By supplementing medium-duty and heavy-duty truck deliveries with drones, the U.S. could reduce GHG emission.[[39]](#footnote-39) While drones would require a new network of urban warehouses to support package deliveries, it would still reduce GHG emission overall.[[40]](#footnote-40) Drones consume less energy per light-package-km (1.1lb) and would reduce CO2 emissions from trucks.[[41]](#footnote-41)

Nevertheless, drone delivery could increase the United States’ energy uses and add to GHG emission. Specifically, if drone services required too many warehouses or if trucks became more fuel-efficient then, it drone deliveries may not reduce GHG emissions.[[42]](#footnote-42) Current technology supports drone delivery for light packages, while ground vehicles must be used to deliver heavy packages.[[43]](#footnote-43) A secondary effect would be the reduction of total CO2 emission from the 20km long asphalt pavement construction project in China, which accounted for 52,263,916.06 kg of CO2 emission.[[44]](#footnote-44) Drone deliveries would reduce the number of trucks on the road while also reducing the need for additional asphalt for roads, further reducing GHG emission.

**Subsection E: California and Missouri**

Recently, a study was conducted comparing the GHG emissions from trucks and drones in California and Missouri and focused on the next steps for sustainability. In the U.S., truck delivery of a package resulted in about 1 kg of GHG emissions.[[45]](#footnote-45) This study showed that drones would reduce the amount of GHG emission per package. Specifically, a package delivered by a truck in California would result in 0.92kg of GHG, while a drone would produce only a small 0.42 kg of GHG emissions, a reduction of 54 percent.[[46]](#footnote-46) However, in Missouri the improvement would be smaller, resulting in only a 23 percent GHG reduction.[[47]](#footnote-47) Increased drone usage demonstrated a significant reduction in GHG gas emission in California but only a limited amount of reduction in Missouri.[[48]](#footnote-48)

1. **United States Compared to Other Countries**

On December 7, 2016, Amazon had its first Prime Air delivery in the United Kingdom, delivering popcorn and a TV streaming device to a customer.[[49]](#footnote-49) Companies have used Europe and Canada as testing grounds because of the restrictive regulations in the U.S.[[50]](#footnote-50) Many other countries have implemented policies allowing commercial drone deliveries, including Iceland, Canada, and East Africa. Each region provides a case study for the U.S. on which policies have worked and which policies have not.

**Iceland**

In Reykjavik, Iceland, the world’s first operational drone delivery service was launched.[[51]](#footnote-51) In the last five months, 500 deliveries have been completed by this service.[[52]](#footnote-52) Current regulations for drones include: not flying drones over people or large crowds; respecting people’s privacy; not flying higher than 130 meters (427 ft.) or within 2km (1.24 miles) of commercial airports; and only flying in good weather conditions, among others.[[53]](#footnote-53) In Iceland, drone use does not require a permit.[[54]](#footnote-54)

Iceland is already noticing the benefits of drone delivery services. Specifically, Iceland has many large bays and small rivers, making transportation of goods both time-consuming and expensive.[[55]](#footnote-55) There has been a 60 percent cost reduction in deliveries by utilizing drones instead of land and sea alternatives, a reduction in road usage, and a reduction in transportation time from 25 minutes to 4 minutes.[[56]](#footnote-56) Iceland provides insight on how drone delivery could be utilized in the U.S. for cities like Pittsburgh, San Francisco, and Miami, where there are problems with water and bridges, resulting in additional traffic and further delaying trucks.

**Canada**

In Canada’s Transport Departmental Plan (2017-2018) included drones in several transportation priorities.[[57]](#footnote-57) Under Priority four, Canada wants to strengthen the regulatory framework for the safe integration of UAVs into Canadian airspace to support innovation.[[58]](#footnote-58) Additionally, under Priority five, Canada is focusing on how UAVs can reduce air pollution and improve GHG emissions.[[59]](#footnote-59)

On October 4, 2017, Drone Delivery Canada (DDC) and Moose Cree First Nation entered into an agreement to begin commercial programs to provide mail, food, medical supplies, and general goods to Moose Cree, 20 km south of James Bay in Northern Ontario.[[60]](#footnote-60) In Moose Cree First Nation, an indigenous community about 440 miles north of Toronto, there are no roads, so transportation is complicated and expensive.[[61]](#footnote-61) Canada provides insight on how drone deliveries could benefit rural communities and how it could be utilized in rural America.

**East Africa**

Zipeline, a California-based startup, has been working with the government of Rwanda to deliver blood supplies to 21 regional hospitals, launching more than 50 drones a day.[[62]](#footnote-62) The company will begin delivering vaccines and medication to hundreds of clinics in Rwanda and Tanzania, planning to make 2000 deliveries a day.[[63]](#footnote-63) The lack of paved road infrastructure in these countries makes it very difficult to deliver medical supplies. For example, blood would often expire on the shelf before it could be used; now, drones are able to deliver the blood within 30 minutes.[[64]](#footnote-64) Karen Wyrobek, cofounder and head of production and engineering at Zipline, said, “In terms of value to society, there’s not only the loss of a life, but also a child growing up without a mother, so I think we’ve made a big impact on communities.”[[65]](#footnote-65) Countries in East Africa have been forced to look at innovative technology solutions for deliveries and their example should be strongly considered as a public policy solution for those in need.

**Concerns with Drones**

While there are many reasons to loosen current drone regulations in the U.S., there are also many concerns about commercial drone deliveries. These concerns with permitting the use of commercial drones include travel delays, Fourth Amendment privacy issues, access to drugs, cybersecurity, and state rights. The state rights argument for the right to regulate drone activity will likely be subordinate to the FAA, as that agency has generally been granted exclusive authority over air space.[[66]](#footnote-66)

Recently, at the Consumer Electronics Show (CES) in Las Vegas, industry professionals expressed concerns after the incidents that took place at Gatwick and Heathrow Airports.[[67]](#footnote-67) In 2018, England had to shut down Gatwick Airport for more than 30 hours because of a drone that was flying in the air space of the airport.[[68]](#footnote-68) This was not an isolated incident; Dubai International Airport (DXB) had to shut down three times due to unauthorized drones in airport airspace.[[69]](#footnote-69) Each minute that DXB was shut down, it cost the airport $1,007,310 USD.[[70]](#footnote-70) As a response, Dubai has begun testing “drone-hunting” drones, which allows the government to use a drone to track down the user of the drone in a restricted area.[[71]](#footnote-71) The drone-hunter is an additional issue that will need to be addressed in the U.S.

Separately, some critics of drones have cited privacy concerns and questioned whether their Fourth Amendment rights could be violated.[[72]](#footnote-72) The biggest issue that has been raised by those against drones is that drones could be used for warrantless drone surveillance. However, this would not count as a violation as long as drones only capture what is visible from public airspace.[[73]](#footnote-73)

Recently, drug cartels along the Mexico and U.S. borders have used drones to fly drugs into the U.S.[[74]](#footnote-74) This issue has created additional issues for law enforcement and public health. The U.S. is already struggling to combat border related issues relating to drugs, which has become a national issue. The illegal use of drones along the border will present a challenge for the FAA in regard to balancing the use of drones and protecting public health.

Additionally, one of the biggest issues relating to commercial drones is cybersecurity. At this point, this article has discussed the possibility of moving forward with commercial drone use and the considerations of drone operations, but the most pressing issue is how to protect drones from hacking. Literature on cybersecurity has ranged from addressing cybersecurity issues at the FAA to having Congress amend the existing statutes to requiring that the FAA implement privacy protections and cybersecurity protection.[[75]](#footnote-75) These concerns were escalated when the University of Texas at Austin employed “spoofing” to hack a drone and showed that it was not difficult to take control of the drone.[[76]](#footnote-76) Over the next year, additional research should be performed to address this issue.

Despite the concerns regarding commercial drone delivery, these other countries demonstrate many benefits to incorporating drone services into U.S. law. Iceland shows how commercial drone deliveries could provide better and more efficient package delivery in cities surrounded by water. Canada’s laws show an example of how drone delivery could provide safety in rural and snow-covered areas. Finally, Countries in East Africa provides an example where drones could be used in emergency medical situations and rural communities. Additionally, if America wants to remain competitive in the global market, America must deregulate the restrictive policy implemented by the FAA. This would allow businesses to use and create new technology relating to drones while gaining their market share in the multi-billion-dollar global drone market.[[77]](#footnote-77)

1. **Drone Policy Recommendations**

In October 2018, the IPCC declared “the world’s annual carbon dioxide emissions, which amounts to more than 40 billion tons per year, would have to be on an extremely steep downward path by 2030 to either hold the world entirely below 1.5 degrees Celsius, or allow only a brief ‘overshoot’ in temperatures.”[[78]](#footnote-78) The U.S. has an opportunity to become a leader in climate change by easing drone regulations.[[79]](#footnote-79)

**Subsection A: Additional Areas of Impact**

Drones are already being utilized in other countries for commercial use.[[80]](#footnote-80) Amazon introduced “Amazon Prime Air” in December 2013, which is able to deliver goods weighing up to 55 pounds within a radius of 16km.[[81]](#footnote-81) Literature on drones has focused on a number of areas, including how to combine drone delivery services with trucks to reduce CO2 emission,[[82]](#footnote-82) how to improve efficiency of deliveries,[[83]](#footnote-83) and a model to solve the travelling salesman problem.[[84]](#footnote-84) Allowing commercial drones would help reduce GHG, but the degree of impact on GHGs depends significantly upon how the drones will be used.[[85]](#footnote-85) Some secondary effects of reducing trucks on the road include reducing road expansion, traffic congestion, and accidents while also growing American businesses.

Drone delivery offers an opportunity to reduce CO2 emission through the ability to reduce road expansion, which produces 100,000 tons of GHG emission over 50 years for every mile of new highway.[[86]](#footnote-86) With fewer trucks on the road, states will be able to reduce road expansion projects to address traffic patterns.

Additionally, as seen in Iceland, drones provide an opportunity for commercial delivery in urban areas and could reduce traffic congestion. For example, in Seattle, 40 percent of GHG emissions are from road transportation and 41 percent of those emissions are from trips under three miles.[[87]](#footnote-87) Separately, recent research suggests that delivery by drones can help reduce GHG emissions when compared to delivery motorcycles. A study showed that drones are better than motorcycles in the global warming potential (GWP) per 1km delivery and only produce half of the particulates produced by motorcycle deliveries.[[88]](#footnote-88) Thus, in urban and suburban areas, the need to run out to the store could be greatly reduced, helping lower GHG emission.

A separate benefit of drone deliveries would be a reduction in vehicle accidents. According to a study, 77 percent of motor vehicle accidents occur within five miles of the home.[[89]](#footnote-89) That study also showed that just under half of all trips are less than three miles from an individual’s home.[[90]](#footnote-90) Reducing the number of short trips could also have the unintended benefit of lowering car insurance and increasing life expectancy.

While the benefits of approaching drone regulations with a light-touch frame of mind will certainly help reduce U.S. vehicle emission, it will also help U.S. businesses to flourish in the global economy. The policy benefits for drones are endless. Aside from reducing traffic congestion, reducing the destruction of roads, reducing the amount of GHG emission from vehicles, and creating a safer environment for drivers, it will also make consumer’s lives more efficient.

**Subsection B: Current Limitations**

While the U.S. needs to address numerous privacy and safety concerns with drone use, current FAA regulations are hindering the possibility for drones to help reduce GHG. At this point there are limitations on current drone technology, which would affect the ability for drones to deliver packages. These limitations include weather issues, drone malfunctions, and package security.[[91]](#footnote-91) Loosening regulations and allowing the industry to invest more money into research and development to make improvements is the best way to address these limitations.

**Subsection C: Current Drone Testing and Policy Recommendations**

The DoT is currently testing commercial drone use in ten areas, but they should expand that number and work with scientists to study the benefits to the climate. Should the FAA loosen its policies on commercial drones concerning public health purposes, rural deliveries, and use in smaller cities, it would speed up the process for the U.S. to enter a growing market for commercial drones. The FAA still needs to address a number of current drone related issues, including state laws, spectrum, and privacy.

Currently, there are the more than 140 state laws on drones that restrict or regulate drone operations.[[92]](#footnote-92) Separately, as technology improves and drones are able to travel greater distances, they will need their own dedicated spectrum instead of operating on an unlicensed spectrum.[[93]](#footnote-93) Some mobile carriers suggest that their wireless networks could be ideal for drones but no specific spectrum has been allocated at this time.[[94]](#footnote-94) Finally, the FAA will need to continue to update the rules relating to privacy and cybersecurity to protect consumers. The best policy would be to expand commercial drones in limited areas for public health purposes, rural deliveries, and smaller cities while the FAA continues to update and revise drone rules on an on-going basis.

**Subsection D: Special Exception**

One specific exception should be made in order to increase drone usage regardless of whether or not they actually reduce GHG emission, which is humanitarian relief. As in East Africa, commercial drones have significantly helped to provide drugs and antibiotics in third-world countries that would otherwise not be delivered in time to save people’s lives. Drone delivery of medicine must be allowed to continue, regardless of the impact on the environment for public policy reasons. Additionally, others have suggested taking this humanitarian relief carve out further and implementing a carve out for transportation of medicine, blood, and medical devices. By suggesting such a carve out would be ideal testing ground for improving drones and saving lives.[[95]](#footnote-95)

**Conclusion:**

In 2018, the world is on pace to have produced the most CO2 emission ever. By shifting drone regulations, it would help reduce the amount of CO2 emission produced by vehicles in the United States. According to scientists, the world is at a tipping point on climate change and something must be done to stop climate change. By combining commercial drone delivery with truck delivery, the U.S. can reduce its GHG emissions. Current research suggests drones should deliver light-packages while trucks should continue to delivery heavy-packages. Other literature suggests that the focus should be on reducing emissions from trucks until drones become a viable alternative.[[96]](#footnote-96) This approach would take away resources and investment money in return for a possible short-term solution.

Other countries have provided a framework for drone deliveries. Specifically, Iceland provides an example of how drone deliveries have had an impact in an urban setting surrounded by water. In Canada, rural drone deliveries show the benefits of loosening regulations in a rural area for three reasons: speed, easier travel through difficult terrain or over water, and a reduced environmental impact; similar results have been seen in Thailand.[[97]](#footnote-97) Finally, Countries in Africa provides insight on loosening regulations for medical situations. Currently, drone technology for consumer use is limited; however, in the future, improvements to the distance drones can travel and the ability for drones to carry multiple packages during a delivery are likely to decrease the overall emission of GHG. By implementing less restrictive policies for commercial drone deliveries, the U.S. could significantly reduce GHG emission and begin to reverse climate change with common-sense technology solutions.

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