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Carbon Dioxide Emission Rates in Germany

**How An Icelandic Mechanism can solve Germany's Immensely Growing Carbon Crisis**

 Germany is a country located in Western Europe that is filled with a beautiful arrangement of rivers, valleys, mountains, North Sea beaches, and lush forests. With a population of “83.2 million people” (Worldometer, 2024) and over “77% of their population living within cities” (O’Neill, 2024), one finds it easy to imagine the bright and lively city life present throughout the urban epicenters of Germany. A typical family living in these cities consists of “two parents and one or two children” (GlobalData Plc, 2021), with “62% of these families living in apartments and 12% living in small detached houses” (Statista Research Department, 2023). These vast communities in Germany are very prideful of their wide varieties of supermarkets, grocery stores, and local markets that most commonly sell items such as bread, potatoes, and various types of meat (German Food, 2024). The people of Germany are blessed to have what is considered one of the best healthcare systems in the world. They also have a highly rated and well structured educational system known to produce some of the best scholars in the world. Public universities in Germany are also tuition free and publicly funded, causing “over 89% of their population to attend higher education schools” (Kelmendi, 2023).

 From the turn of the century, Germany has consistently produced the most carbon dioxide emissions throughout the European Union. “In 2022, Germany had produced almost 635 million metric tons of carbon dioxide … Germany's amassed emission of carbon dioxide was larger than the combined emissions of the next two largest carbon emitters of the EU - Italy and Poland” (Tiseo, 2023). Knowing the extent of their overbearing emissions, Germany knew they had to do something to protect the atmosphere from the detrimental levels of carbon pollution. On November 14, 2016 Germany approved the joining of the Paris Climate Agreement. The Paris Climate Agreement is an international treaty created to combat climate change with 195 member countries. The long term goal of the Paris Agreement is “to keep the rise in mean temperature to much lower than 3.6° F and preferably limit the increase to only 2.7° F” (Wikipedia Contributors, 2018), if the countries can reach this goal, the effects of climate change will be significantly reduced. Due to Germany's large scale of emissions, they set their own individual goal for limiting carbon emissions: to be carbon neutral by 2045. However, due to their continued carbon releases, this goal is becoming less and less realistic without immediate reduction plans being implemented.

 A small dome located in Iceland’s grand geothermal power plant Hellisheidi, could be the best solution to fix Germany's overbearing carbon crisis. This small dome is just a fragment of Iceland's newest and most efficient carbon capturing system. Although just a small structure on the surface, the underground pipes extend all the way down to the volcanic basalt subsoil layers. This system owned by the company CarbFix works through the process of capturing carbon from the atmosphere along with carbon emitted from Hellisheidi and other nearby power plants. Next, the captured carbon is mixed with water to create a slurry mixture, then eventually this water-carbon slurry is sent down the pipes to be stored within the volcanic basalt subsoil. Ólafur T. Guðnason, the Director of Communications at CarbFix, who is also a prominent Icelandic author and journalist, describes the scientific reasoning behind how this system works. Guðnason explains that once the carbon is mixed with the water within the slurry, “the water acts as a carrier and will naturally kill the buoyancy of CO2” (Slavin, 2023). Guðnason continues to share that the water will naturally speed up the mineralization process that carbon undergoes when in contact with basalt, “In the nine years that the company began injecting the power station’s CO2, 95% was turned into a rock in the subsurface in less than two years … Our technology speeds up processes that normally happen over geologic timescales. Instead of taking thousands of years to mineralize CO2 into rock, we make it happen in two years“ (Slavin, 2023). Another pertinent detail that sets CarbFix apart from other previous carbon capturing systems, is the fact that CarbFix isn’t just holding carbon underground but they are permanently storing the carbon as a mineral with little to no pollution or excess land usage. Currently, CarbFix is working on bringing their newest plan known as “Coda Terminal” to life. Under Coda Terminal the company will create much larger CO2 storages and transporting facilities that will receive large tanker loads of CO2 shipped from Northern European countries, from which Iceland will take the CO2 and pump it into their own subsoil. Although there are a few similar carbon capturing systems available in northern parts of Europe, Iceland's system is the safest, cheapest, and most efficient way of storing carbon. This is due to the fact that “Iceland stores its carbon on land in shallower wells that use less pressure, while the other systems being developed are offshore and supercritical, making them extremely expensive to build and store carbon within” (Slavin, 2023).

 This method implemented by Iceland is crucial to playing a role in solving Germany's carbon emission predicament. Between these two countries, there are many similar factors that would allow the Icelandic system to thrive throughout Germany. Due to these similarities the two largest solutions that can greatly benefit Germany is to establish a connection with CarbFix and have Germany export their captured carbon to the new Coda Terminal plan that is currently in place. Likewise, another and more plausible solution for Germany would be to implement their own carbon capturing system into their country. Through the implementation of their own system, Germany would be able to capture and process as much carbon as possible without having to export any carbon or emit excess carbon during the process of exportation. Furthermore, there are several factors within Germany that allow this similar system to be implemented, including the fact that Germany has a similar geological makeup as Iceland. Hundreds of millions of years ago Germany was filled with volcanic activity throughout the country, although nowadays this activity has gone dormant the effects of these eruptions have altered the landscape of the country forever (Bonanati, 2014). It was through these eruptions that a layer of volcanic basalt subsoil was created. Causing Germany's subsoil to be nearly identical to the subsoil present throughout Iceland, allowing the entire CarbFix system to work and excel against its competitors.

 If done correctly, the presence of carbon capturing systems could change the world in terms of carbon dioxide levels present in the atmosphere. However, many governments and organizations have several drawbacks in terms of implementing these types of systems, the largest counter argument present is that this is only a partial solution that may actually harm carbon emissions as businesses and factories may not feel as pressured to clean up the fossil fuel industries (Weingart, 2023). Furthermore there are several other possible drawbacks about carbon capturing including the extensive cost that is necessary in order to cover the system and all of the technology required for implementation. A team of researchers from The University of Utah found that the technology of carbon capture systems causes a “50% to 80% increase in the cost of electricity in order to pay for the implementation of CCS technology” (Rhode, 2021). Due to the rise in how much electricity is necessary and the cost it would bring, it begs the question of where this excess electricity will be generated from? This exact question is why the Icelandic system is so highly regarded, Iceland is a pioneer in geothermal energy and in fact uses the energy from geothermal sources for “about 66 - 70%” (Angineer, 2024) of their electrical needs. Which is exactly why CarbFix is located directly in the Hellisheidi geothermal power plant as the system can use energy directly from the plant while taking any carbon from the atmosphere along with any carbon potentially emitted from the power plant (Slavin, 2023). However, not every country has the capabilities for geothermal energy as direct sources of power and electricity. Which is exactly why CarbFix created the Coda Terminal, allowing any Northern European countries access to capture their carbon and store it without having to spend the excess money on the technology and installation. On the contrary, many critics argue that this plan would be more harmful than beneficial because through the process of shipping the carbon to Iceland, wouldn’t the countries only just produce more carbon and pollutants? If German policy makers decide that the overall benefits outweigh the costs, it would be most advantageous for them to proceed. However, Germany has many cleaner energy sources they could use to rely on powering the systems necessary for carbon capturing. Although on April 15th, 2023 Germany shut down the last of their nuclear power plants due to fear of accidents and breakdowns, Germany decided it would be more beneficial to focus on renewables with less risks involved (BASE, 2023). Through the increase of other renewable energy sources such as off-shore wind farms, solar panels, biomass, and hydroelectric power (Eckert and Alkousaa, 2024), Germany would be able to generate energy for the people and for any carbon capturing systems.

 Carbon capturing is a solution in the works that could seriously aid in reducing the concentration of carbon dioxide that is present in our atmosphere. Although there are a few current setbacks about the implementation of these types of systems, with more research and developments in this critical field the technology that is necessary will become more widespread and efficient throughout many parts of the world. As of February 26, 2024 Germany has begun plans to enable an underground carbon capture storage system at offshore sites (Moulson, 2024). While this plan was approved by Germany's Federal Cabinet back in May of 2024, Germany plans on hauling its captured carbon to storage facilities underneath the North Sea. The Federal Cabinet has also allowed individual states within Germany to decide whether or not they would prefer to create their own on-shore CCS facilities (Hunt, 2024). Due to the construction of these new facilities, it would be a few years until the systems would be up and running. However, limiting carbon dioxide is an issue that needs to be addressed sooner rather than later. While these projects are being built, a current solution for Germany is to incorporate the options of carbon capturing mentioned within the Icelandic CarbFix systems. Possibilities include encouraging states within Germany to implement the underground Icelandic system as these facilities require less construction time and overall cost. Furthermore shipping their carbon to Iceland under the Coda Terminal until construction has finished is another solution for Germany. However, no matter which solution Germany uses in the long run, any way to reduce the carbon footprint is beneficial for our world as we are actively running out of time to stop and prevent the detrimental effects of climate change.

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