

**IMPACTS OF SOCIAL, ECONOMIC, AND REGULATORY INEQUALITIES ON
GLOBAL CLIMATE CHANGE ADAPTATION**

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By

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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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The atmospheric concentration of carbon dioxide, the most harmful greenhouse gas, has been steadily increasing for many decades, contributing to the gradual destruction of the Earth as an inhabitable planet. The current carbon dioxide levels significantly exceed previous records, “peaking at 415 parts per million this year, far above the level during most of human history, around 300ppm” (Milman, 2019, p. 3). This climate crisis presents the urgent need to develop sustainable technologies such as Carbon Capture, Utilization, and Storage (CCUS), a form of technology that enables the removal of nearly 90% of carbon dioxide from gaseous emissions (“What is CCS?”, 2019, p. 6). CCUS involves the use of a chemical solvent to treat the gaseous waste streams from industrial operations, resulting in the separation of carbon dioxide from other components in the gas. In the majority of previous projects, the carbon dioxide is then liquified and stored underground. However, the technical project, which is tightly coupled with the STS analysis, involves additional processing steps to convert the carbon dioxide into diesel fuel that can power a variety of automobiles. Thus, by attacking greenhouse gas emissions directly at the source of the problem, particularly including industrial energy production sites such as power plants and oil refineries, CCUS technology has the potential to halt alarming global warming trends and sustain the environment for future generations.

In order for green technologies such as CCUS to succeed in reducing emissions, the government leaders and engineers of the world’s nations must overcome the lack of effective environmental policy that currently acts as a barrier to progress. Despite the widespread awareness of climate change, the absence of consistent policy implementation across the globe allows consumers and businesses to continue consuming significant amounts of energy, worsening the emissions issue. There are current cultural viewpoints, social structures, and regulatory policies which, as Adger (2009) expresses, “act as limits to public engagement in

adaptation to climate change (and indeed mitigation of emissions)” (p. 336). In addition, there are vast differences in the government structures of developed versus developing countries, creating further obstacles to sustainable change. Individuals in developing countries are viewed as passive victims rather than agents of change, inhibiting the opportunity for these citizens to make necessary adaptations. This widespread problem prompts the research question for the STS analysis: What does an effective climate change policy look like, and how can this approach be implemented on a global scale? This question will be explored through an analysis of an effective environmental policy in Denmark, a country in which green technology has been applied successfully in alignment with societal structure and cultural values. Denmark’s environmental policy system will be mapped using Actor Network Theory, a framework that Callon, Latour, and Law developed, to understand the dynamics of a balanced climate change adaptation strategy that successfully encompasses the goals and beliefs of all groups involved. (Rhodes, 2009, p. 4). In doing so, the paper will evaluate the actions required to achieve environmental sustainability worldwide.

DENMARK CASE STUDY: A SUCCESSFUL TRANSITION TO A GREEN ECONOMY

Despite the widespread presentation of evidence that illustrates the damaging environmental effects of the continuous increase in carbon dioxide emissions, society continues to primarily consume energy sources that heighten the severity of this issue. As proven through demonstrations of activism surrounding climate change, many individuals acknowledge the current energy crisis, and are aware that change is necessary. For example, millions joined the Global Climate Strike, “marching to demand that government and businesses commit to a goal of net-zero carbon emissions by 2030” (Chappell & Neuman, 2019, p. 8). Throughout the globe, environmental policy is the driving force that prompts individual nations to actively commit to a

sustainable future. For example, the United Nations Framework Convention on Climate Change (UNFCCC), which has been ratified by 197 countries, includes the Kyoto Protocol, an international treaty that requires industrialized countries to actively reduce greenhouse gas emissions and report their progress on a regular basis (“What is the Kyoto Protocol?”, 2019, p. 2-3). This agreement has led many of the world’s government bodies to formulate their own policies with detailed emissions reduction targets with deadlines in the near future. In the case of the European Union (EU), a key facet of their energy policy is the 2030 Climate & Energy Framework, which states the minimum goals of a 40% reduction in greenhouse gas emissions, a 32% share for renewable energy, and a 32.5% increase in energy efficiency within the next decade (“2030 climate & energy framework”, 2019, p. 3-5). Denmark, one of the 27 countries that comprise the EU, has taken significant action that demonstrates the nation’s commitment to create significant reductions in their negative environmental impact. The world’s largest successful application of CCUS technology is in Esbjerg, Denmark. As stated in a press release from the European Commission:

Carbon capture and storage technology offers a bridge from our current fossil fuel-based energy system to one that has near-zero carbon emissions. The pilot plant is an important part of research that will help develop better processes for carbon capture, increase public acceptance of the technology and achieve a major reduction in its costs (“World’s largest CO₂ capture”, 2006, p. 1).

While Denmark’s leaders recognize that reducing greenhouse gas emissions is essential, they are fully aware that since fossil fuels will remain the dominant energy source for years to come, transitioning to renewable energy is not an immediate enough solution, which presents the need for green technology.

Building upon Denmark’s nationwide policies, government officials in Copenhagen have committed to the CPH 2025 Climate Plan, aiming to become the world’s first carbon neutral

capital city by 2025. The four pillars of Copenhagen's environmental policy are energy consumption, energy production, mobility, and city administration initiatives ("The CPH 2025 climate plan", 2019, p. 2). The country's leaders aim to combine a reduction in carbon dioxide emissions with changes in infrastructure that enhance growth, development, and increased quality of life for citizens. This goal was exemplified through the construction of the Amager Resource Center, a waste-to-energy power plant with an artificial ski slope on its roof, as well as "hiking and running trails, a street fitness gym, and the world's highest outdoor climbing wall" (Robertson, 2019, p. 2). By effortlessly ingrain green technology into Copenhagen's cultural setting, the nation's leaders inspire citizens to adopt sustainable habits that directly align with their values and lifestyles. This holistic approach has already demonstrated success in reducing greenhouse gas production. According to Frank Jensen, Lord Mayor of Copenhagen, "We are already well underway. In 2011, Copenhagen had reduced CO₂ emissions by 21% compared to 2005" (Nikel, 2019, p. 2). Considering that the city has already met over half of the European Union's intended emissions reduction percentage, Copenhagen's progress serves as a clear example that it is possible to reverse global warming trends by creating sustainable innovations that support the culture of their citizens.

Considering that Denmark has implemented a policy that effectively addresses climate change, their approach can be analyzed through Actor Network Theory (ANT) to shed light on how other communities throughout the world can reduce their environmental impact. ANT, a framework that Callon, Latour, and Law collaboratively developed, outlines the groups of actors and actants, both human and non-human, that form the networks that impact actions relating to a given project or goal (Rhodes, 2009, p. 4). As Rhodes (2009) states, in a successful network, "aligned interests are created through the enrollment of a sufficient body of allies and where the

network is maintained through the translation of interests that bind all actants” (p. 3).

Contrastingly, a network can become destabilized if changes are made without the consideration of the values and behaviors of all actors and actants, inhibiting the success of a project or movement. When tasked with reducing greenhouse gas emissions, the leaders of Copenhagen thoroughly considered the perspectives and possible influences of each actor and actant in the network surrounding climate change adaptation. As depicted in Figure 1 below, the relevant human actors include government officials who lead European countries as a broad group, as well as those who are specifically responsible for creating Denmark’s environmental policies.

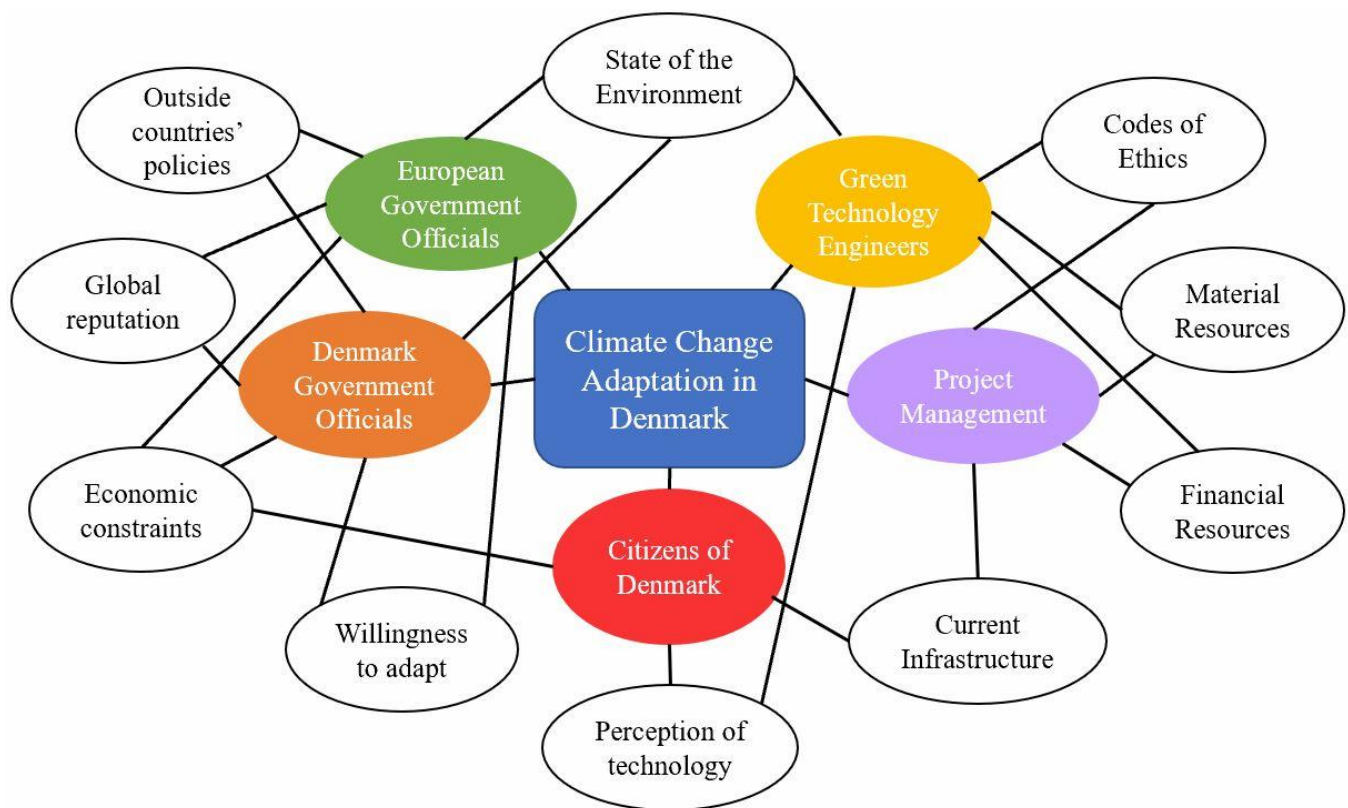


Figure 1: Actor Network Theory Analysis of Climate Change Adaptation in Denmark: In order to successfully integrate green technology into a society, the social, cultural, and economic values of each actor and actant in a given system must be carefully considered (Magner, 2020).

These policies influence the sustainable innovations that are developed and implemented by green technology engineers and project managers. Furthermore, both policy changes and the

introduction of new technologies affect the lives of Denmark's citizens, whose way of life is in alignment with their sociocultural behaviors and belief systems.

In addition to human actors and actants, there are a wide variety of non-human factors that significantly influence policymakers' and engineers' ability to ingrain green technology and sustainable practices into an established society. For example, when designing the Amager Resource Center that was discussed previously, Copenhagen's leaders decided to build a facility that complements the city's preexisting infrastructure and supports citizens' active lifestyles by incorporating recreational elements. Thus, the facility not only effectively converts waste into energy, contributing to the goals of the CPH 2025 Climate Plan, but additionally enhances the wellbeing of citizens, serving as a well-rounded solution to the climate crisis. Additionally, government leaders in Denmark and the broader EU analyzed non-human actors including the state of the environment, economic constraints, and the availability of resources when determining how to address the current energy crisis. Recognizing that action must be taken immediately to reduce emissions considering the world's societal and economic reliance on fossil fuels, policymakers and engineers decided that implementing CCUS technology would be more beneficial than making a shift to renewable energy sources. This required carefully considering all associated codes of ethics, another non-human actor, in order to make morally upstanding decisions when designing and implementing CCUS technology. In addition, while the general public could have potentially argued against government funding for CCUS based on the fear that it would not be successful, the leaders of this project moved forward despite this potential risk, prioritizing addressing the alarming trends of global greenhouse gas emissions. In doing so, Denmark became the home of the largest successful example of CCUS technology, gaining a global reputation as frontrunners in the green technology sector. The nation's

demonstration of an integrated network progressing toward a common goal proves to other countries that implementing sustainable change is possible when all actors and their cultures are supported.

ANALYSIS OF CLIMATE CHANGE ADAPTATION IN DEVELOPING COUNTRIES

In order for global warming to be addressed successfully, individuals in a broad range of economic and cultural climates must have access to resources that are necessary to adapt to sustainable lifestyle practices. It is possible to learn from Denmark's implementation of an effective environmental policy by analyzing the current state of sustainability in developing countries and identifying barriers that are preventing necessary change. While those in developed countries can readily make lifestyle adjustments to reduce their carbon footprint, this is not the case for populations in developing nations that lack the same economic and environmental policy support. For example, 75% of the African population lives in rural areas, and 30% of the continent's GDP is agriculture-based, leading to the use of excess natural resources such as land and water (Thomas & Twyman, 2005, p. 117). In addition, present day narratives describing populations in the developing world are extremely flawed, considering that individuals are viewed as "passive victims of global forces, playing little part in decisions and actions that affect their own livelihoods and well-being, and ignoring their capacity to adapt and build elements of resilience (Thomas & Twyman, 2005, p. 116). Due to their significant lack of government support, "developing countries, despite having contributed least to greenhouse gas emissions, are likely to be the most affected by climate change because they lack the institutional, economic, and financial capacity to cope with the multiple impacts" ("Overcoming the Barriers", 2006, p. 6). These populations are in desperate need of strengthened government policies and economic support, considering that they lack much of the infrastructure and financial resources that are

necessary for recovery following climate-related disasters. In addition, while a given developing country is often viewed as a single body of citizens, it is important to consider that the nation includes diverse groups of individuals with varying levels of access to financial and structural support. Thus, “development is rarely even or equitable, and the poorest members of society are usually the most vulnerable to climate change” (“Overcoming the Barriers”, 2006, p. 6). As a result, in order to adequately address climate change in the developing world, it is crucial to analyze sociocultural and economic statuses on a nation by nation basis, paying close attention to the differences between individual societies within each country.

While citizens of developing countries have already displayed significant motivation to diversify their lifestyles and reduce their reliance on natural resources, it is crucial to provide them with the tools they need to do so. These tools include ‘head room’, defined as tangible, economic, or policy space that provides room for adaptation (Thomas & Twyman, 2005, p. 121). An example includes Botswana’s Financial Assistance Program, which awards up to 90% grants in support of citizens’ business initiatives (Thomas & Twyman, 2005, p. 119). This program provides individuals with the opportunity to explore lifestyles outside of the traditional agricultural realm, enabling citizens to diversify their sources of livelihood. However, although the initiative was successful in some areas, in the remote regions of Botswana, the only approved projects related directly to small stock farming, which was already the dominant practice in the area (Thomas & Twyman, 2005, p. 120). The room for improvement in this program emphasizes the importance of developing strategies to address climate change and the reliance on natural resources that are accessible to people in all areas of the world, regardless of economic or structural limitations. This can be made possible by creating head space and facilitating accessible adaptations while simultaneously considering the social justice issues that are inherent

within any decision-making process in a world with diverse stages of development. The System in Context framework that W. Bernard Carlson developed as an adaptation of the Social Construction of Technology theory, coined by Pinch and Bijker, is depicted in Figure 2. This framework aids in the analysis of how various groups of individuals fit into the system of climate change adaptation.

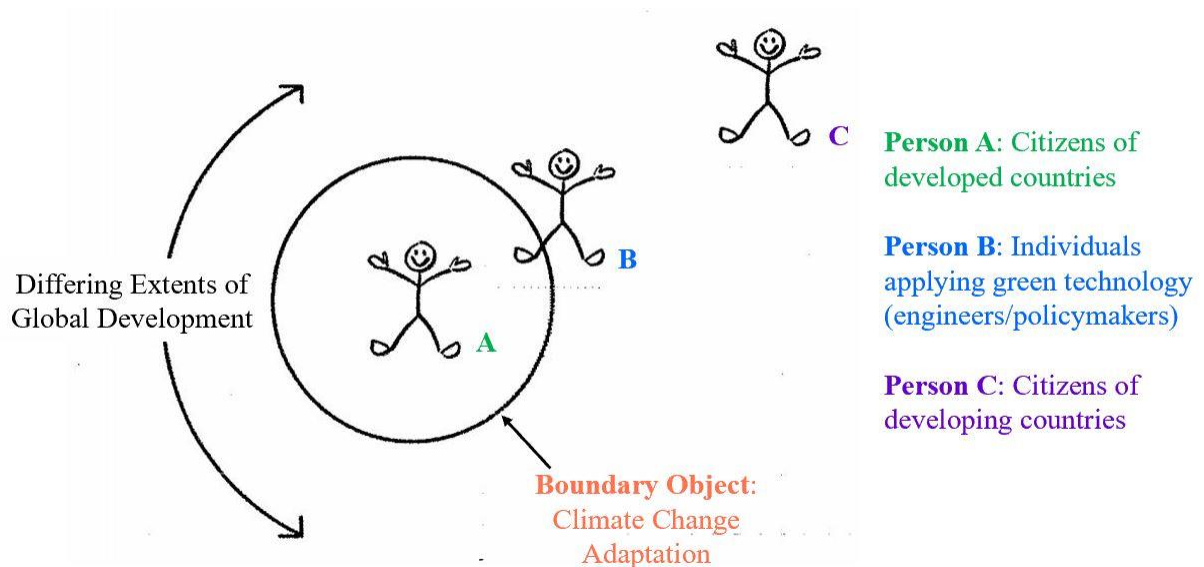


Figure 2: Climate Change Adaptation in the Context of Inequities in Developed versus Developing Countries: Citizens of developing countries face more challenges when attempting to adopt sustainable lifestyles due to a lack of government structure and economic support in comparison to developed countries (Adapted by Abby Magner, 2020 from W. Bernard Carlson).

As shown in Figure 2, the social context surrounding the system is the vast contrast in extents of development throughout the globe. Citizens of developed countries are fully enveloped by the boundary object, climate change adaptation, as they are provided with adequate resources and support to adopt sustainable lifestyle habits. Those who are responsible for implementing green technology, including engineers and policymakers, fall partially within the circle, considering that they have the power to design tools that can aid in widespread societal shifts. However, it is ultimately up to the general public throughout the world to commit to behavioral changes that allow these technologies to succeed in reducing greenhouse gas emissions. Finally, individuals

living in developing countries are outside of the circle due to the flawed societal narrative that currently defines them. This framework provides a visual representation of the necessity of including all relevant groups in the climate change reduction issue to bring about meaningful change.

In order to encompass all nations and individuals in the emissions reduction effort, it is crucial to shift society's view of those in developing countries from passive victims to capable, empowered individuals. As Thomas & Twyman (2005) argue:

Equity in the context of climate change outcomes ought to be much more than simply ensuring that the vulnerable are treated fairly and buffered from unduly bearing the burdens of impacts. It should relate to a wide range of issues including: decision making processes—who decides, who responds, frameworks for taking and facilitating actions, relationships between the developed and developing world, and also to relationships between climate change impacts and other factors that affect and disturb livelihoods (p. 116-117).

This illustrates the importance of intervention from the lawmakers and other leaders who govern and support each of the world's nations. An effective method of empowering marginalized groups is known as the Adaptation Policy Framework (APF), an approach created by the United Nations Development Programme (UNDP) to aid in sustainable shifts within developing countries. This framework was built upon four key notions, the first of which states, "Adaptation to short-term climate variability and extreme events is included as a basis for reducing vulnerability to longer-term climate change" (Lim et al., 2004, p. 1). Next, the APF emphasizes that policy must be the central factor driving sustainable shifts in behavior. In addition, the framework emphasizes that adaptation occurs in a "bottom-up" fashion, beginning at the local stage, and ultimately spreading nationwide. Finally, according to Lim et al. (2004), "Both the strategy and the process by which adaptation is implemented are equally important" (p. 1). The final core facet of the framework emphasizes the importance of engaging all possible

stakeholders in the process of adaptation to climate change, providing an equal opportunity for all individuals to take part in transforming society. In order to achieve each of these guiding principles, policymakers must exercise flexibility, adapting to their citizens' needs and priorities, and considering the pre-existing policy and infrastructure foundations on which they can build.

As Bo et al. (2004), outline:

The APF is comprised of five components: scoping and designing an adaptation project, assessing current vulnerability, assessing future climate risks, formulating an adaptation strategy, and continuing the adaptation process through implementing, monitoring, evaluating, improving and sustaining the initiatives launched by the adaptation project (p. 2).

This approach enables new policies to become integrated into previously established government structures and societies by conducting a holistic analysis of the current state of each affected country. Thomas & Twyman (2005) emphasize the various sources of risk that are crucial for lawmakers to consider, stating:

High levels of vulnerability and low adaptive capacity in the developing world have been linked to a range of factors that include a high reliance on natural resources, a limited ability to adapt financially and institutionally, low per capita GDP and high poverty, and a lack of safety nets (p. 116).

In addition, the APF urges leaders to act proactively by evaluating predicted climate, economic, cultural, and environmental shifts that could potentially occur in the future, incorporating these possibilities into policy changes to achieve long-lasting impacts. The APF serves as a reminder that the citizens of developing countries have demonstrated the willingness to adapt, but the responsibility now lies in policymakers' hands to provide the adequate structure and support that these groups require to make sustainable lifestyle changes. As Thomas & Twyman (2005) state, "Advocating the creation of head room...calls for recognition of the need to create space, and the right kind of space, and to facilitate appropriate, innovative and creative adaptation that retains principles of equity and social justice at its core" (p. 121). Thus, by providing access to programs

and resources that enable the increased sustainability of worldwide lifestyles, the development gap will no longer impede the potential for drastic emissions reduction, and global citizens can support each other in effectively addressing climate change.

CONCLUSION: ACHIEVING GLOBAL SUSTAINABILITY THROUGH ADAPTABLE ENVIRONMENTAL POLICIES

As demonstrated by the example of a highly effective environmental policy that was implemented in Denmark, climate change can be successfully addressed through a thorough consideration of the sociocultural implications associated with a given technology or problem-solving method. When these methods are designed such that they can be gracefully ingrained into the cultural, economic, and structural setting of a given environment, society can adapt to necessary lifestyle changes with greater ease. While this approach can be applied to any area of the world, climate change policies will look different in every country. In Denmark, technologies such as carbon capture and waste-to-fuel facilities must be seamlessly integrated into current infrastructure, paying special attention to the culture and values of the surrounding area. Contrastingly, in areas of Africa that lack a solid foundation of government policy, economic support, and infrastructure, resources must be allocated to provide citizens with an equal opportunity to shift their sources of livelihood in an environmentally sustainable direction. Green technology comes in many forms, some of which fall outside the realm of what is typically viewed as an innovation. In developed countries, it is often reasonable to apply CCUS technology at industrial facilities to reduce greenhouse gas emissions, while in developing countries, green technology can also take the form of adaptation education methods. For example, farmers can be trained on new farming practices that reduce their reliance on natural resources. In addition, when provided with adequate resources and support, citizens can begin to

explore other sources of livelihood rather than solely relying on agriculture. Regardless of location or status, it is crucial to consider each of the actors and actants, both human and non-human, that are involved in climate change adaptation on a case-by-case basis, proactively creating solutions to potential problematic scenarios. In doing so, the world's citizens can collectively contribute to reversing the trends of global warming, thus creating a more sustainable environment for present and future generations.

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