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The Potential for AI in Implementing the Green Deal and Ethical Implications

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Given the urgent threat of climate change, the tendency to overcome current economic challenges by increasing the pressure on the environment is not a sustainable option. The question of how we can reset the global economy in a way that could contribute to shaping a greener future is the focus of the EU and US Green (New) Deals. Achieving these goals will require innovative approaches that allow for improved environmental policies that simultaneously transform the economy to promote justice and prosperity. In this Research Brief, we outline the potential for AI-based technologies to affect the goals of the Green (New) Deal and the ethical concerns that might accompany these developments.

1. What is the Green New Deal?

The world's leading climate researchers announced in 2018 that if the global temperature were to rise more than 1.5 °C, it would compromise the safe operating space for humanity. This is likely to occur between 2030 and 2052 if temperatures continue to increase at the current rate (IPCC, 2018). The need to mitigate this threat is therefore urgent, as the timelines are short and the effects are already increasingly visible, such as the greater frequency and intensity of heatwaves, storms, wildfires, droughts and flooding.

In light of these facts, the tendency to overcome current economic challenges by increasing the pressure on the environment is not a sustainable option. Instead, many argue substantive transformational change is required to promote the economy alongside the environment and that societies around the world have to mobilize to respond to the climate emergency, while promoting economic development and stability. The question is how can we reset the global economy in a way that contributes to shaping a greener future? Moreover, how can technological developments contribute to that goal?

In response to these insights, members of the United States Congress proposed a resolution recognizing the duty of the Federal Government to create a *Green New Deal* (named after US President Franklin D. Roosevelt's famous New Deal) in February 2019. This move is a first step in recognizing what the US needs to do to solve the climate crisis. They focus on the question of how to simultaneously tackle inequality and climate change, with five main goals and several mechanisms for implementation (H.R. Congress, 2019).

Achieving these goals will require innovative approaches that allow for improved environmental policies that simultaneously transform the economy to promote justice and prosperity.

Goals of the United States' Green New Deal

- Achieve net-zero greenhouse gas emissions through a fair and just transition for all communities and workers.
- Create millions of good, high-wage jobs and ensure prosperity and economic security for all people of the United States.
- Invest in the infrastructure and industry of the United States to sustainably meet the challenges of the 21st century.
- Secure for all people of the United States for generations to come: clean air and water; climate and community resiliency; healthy food; access to nature; and a sustainable environment.
- Promote justice and equity by stopping current, preventing future, and repairing historic oppression of indigenous peoples, communities of color, migrant communities, deindustrialized communities, depopulated rural communities, the poor, low-income workers, women, the elderly, the unhoused, people with disabilities and youth.

The European Union responded later in 2019 with its own proposed *European Green Deal* (European Commission, 2019). The communication outlines a growth strategy aimed at transforming the EU into "a fair and prosperous society, with a modern, resource-efficient and competitive economy where there are no net emissions of greenhouse gases in 2050 and where economic growth is decoupled from resource use." To this end, they outline eight main goals that include various mechanisms for implementation.

Goals of European Green Deal

- Increasing the EU's climate ambition for 2030 and 2050.
- Supplying clean, affordable and secure energy.
- Mobilizing industry for a clean and circular economy.
- Building and renovating in an energy and resource-efficient way.
- Accelerating the shift to sustainable and smart mobility.
- From 'Farm to Fork': designing a fair, healthy and environmentally friendly food system.
- Preserving and restoring ecosystems and biodiversity.
- A zero pollution ambition for a toxic-free environment.

The adoption of these measures aimed at ensuring sustainable development, while contributing significantly to transforming the global economy, is an ambitious undertaking. To support the delivery of these objectives, the EU has also put in place a plan to mobilize €1 trillion towards sustainable finance over the next decade.[1] Achieving these goals will require innovative approaches that allow for improved environmental policies, which simultaneously transform the economy to promote justice and prosperity.

In addition to these political developments in the USA and EU, the unfolding of the COVID-19 crisis in 2020 and the resulting national shutdowns and travel restrictions yielded a significant decrease in worldwide carbon emissions and air pollution. Thus, the emergency has opened a window of opportunity to seriously discuss transitioning to a more sustainable economy as the economic recovery process begins (Steffen et al., 2020). For example, the EU announced a renewed sustainable finance strategy to ensure that the "financial system genuinely supports the transition of businesses towards sustainability in a context of recovery from the impact of the COVID-19 outbreak" (European Commission, n.d.).

Artificial Intelligence (AI) has the potential to play a valuable role in creating the tools needed to realize the Green Deal. For instance, AI can contribute to the mitigation or lowering of greenhouse gas emissions by increasing efficiency in many sectors such as energy and electricity production and use, agriculture, land use, biodiversity management, transportation and smart mobility. Moreover, AI is increasingly useful for adapting and responding to climate change by providing powerful tools for prediction, resilience and management. However, potential downsides and ethical dilemmas concerning the increased use of AI in environmental/climate related initiatives also exist. In this Research Brief, we outline the potential for AI-based technologies to affect the goals of the Green (New) Deal and the ethical concerns that might accompany these developments.

2. Potential Roles for AI in Implementing the Green Deal

a. Improving Efficiency

i. Smart Grids and Reducing Emissions

While digitalization has reduced consumption in many ways, it has produced a dynamic increase in electricity consumption (Koomey et al., 2011; Osburg & Lohrmann, 2017). Although end devices are becoming increasingly energy-efficient, at the same time, we use them more often and over

[1] Sustainable finance supports economic growth while reducing pressures on the environment and takes into account social and governance aspects. It aims to support the Green Deal by channeling investment into more climate neutral and resource efficient business to complement governmental efforts, while taking social impacts of these changes into account (European Commission, n.d.).

longer periods (Lange & Santarius, 2016). Thus, reducing energy needs remains a challenge for implementing the Green Deal.

AI is already helping communities through **smart grids** that can lower overall electricity needs, improving the matching of regional energy generation with local demand. Unlike existing grids, where electricity generally flows one way from generators to consumers, smart grids allow flows of electricity that can vary their magnitude and direction. This ensures that supply and demand are constantly in balance, therefore elevating efficiency (Ramchurn et al., 2012). The prediction and forecasting of often-fluctuating renewable energy generation output through "Deep Learning" methods is important for improving reliable integration into the power grid. These machine learning (ML) processes collect data in real-time, as well as processing historical data and physical model outputs (Zhang et al., 2018; Rolnick et al., 2019). Due to the complexity of smart grids, as well as the uncertainties surrounding their development and the high volume of data collected in real-time, AI-enabled tools are fundamental for successful development.

The balance between the use of AI in both renewable energy and fossil fuel industries should be a continued consideration

Energy markets will be affected by AI on both the supply and demand side. On the demand side, predictive ML-based technologies can help lower energy costs of industrial systems. Google's application of AI has helped to reduce the amount of energy used for cooling data centers by 40%. Since data centers consume about 3% of global energy, this has the potential to make a big impact (Frank, 2019). AI systems can also help reduce individual energy demand by nudging customers to turn off devices in peak periods or defaulting to low energy settings. ML tools also have the potential to make fine-tuned determinations of what energy products customers actually need and offer a spectrum of green energy options (Victor, 2019). AI-enabled tools can help regulate energy-consuming processes, like heating, by learning about when residents are home or not and automatically adjusting temperatures (Frank, 2019).

On the supply side, ML-based tools can make renewable energy markets more efficient in terms of needed financial resources, but also in terms of energy production. ML systems, for example, can help predict offshore turbine failures on wind farms, allowing for more efficient maintenance and energy production (Frank, 2019). On the other hand, AI also has the potential to make hydrocarbon production more efficient by improving the ability to map and determine the size of deposits, lowering the cost of extraction. Thus, the balance between the use of AI in both renewable energy and fossil fuel industries should be a continued consideration (Victor, 2019).

ii. Smart Mobility

The transportation sector accounts for approximately a quarter of energy-related CO2 emissions globally (Wang & Ge, 2019). Aviation, long-distance road transportation, shipping and many other sectors of transport are highly dependent on fossil fuels. In contrast to electricity production, significant efforts to reduce the CO_2 emissions in the mobility sector are still lacking. Hence, reducing emissions from fossil fuels is fundamental for the transition to a more sustainable, low-carbon economy (Rolnick et al., 2019).

Image by Matheus Bertelli from Pexels

Policymakers and car manufacturers around the world are becoming increasingly interested in the large-scale implementation of **automated vehicles** and their potential to reduce transportation emissions. The recent innovations in the field of interconnected mobility, through smart vehicles and intelligent infrastructure, could contribute to making transport more efficient as well as more environmentally friendly (Pakusch et al., 2018). Autonomous vehicles have the potential to operate more efficiently than traditional vehicles, as they can contribute to the optimization of traffic flow. This has the potential to result in less congestion, shorter commutes, increased street space, more effective transportation for elderly and those with physical disabilities, as well as lower emissions through exchanging data and coordinating driving speeds and distances between vehicles (BCG, 2017; Walker & Marchau, 2017; WEF, 2018).

However, the rebound effects of introducing new technologies have to be taken into consideration (Berkhout, Muskens & Velthuijsen, 2000). For instance, autonomous vehicles have the potential to make driving more convenient and pleasant, which could significantly contribute to higher traffic volumes (Pakusch et al., 2018) or more uncoordinated traffic in the medium term (Acosta, 2018). Thus, it is important to think about coordination and the availability of infrastructure when introducing new technologies in order for them to have positive environmental effects (Inframix, 2020)

AI-based technologies can also help to **lower emissions**, even in traditional vehicles, through reducing traffic and travel routes. ML methods can provide predictions about patterns in mobility sectors (such as aviation or train and naval shipping), improving the operational efficiency of transport models that emit a significant amount of CO2 globally (European Union, 2019; Jacquillat & Odoni, 2018). This can aid decision-makers for planning new infrastructure and travel/shipping routes (Rolnick et al., 2019).

AI-enabled systems can also be used to design computer vision systems that can help with **the efficient flow of traffic,** while at the same time minimizing fuel consumption. Researchers can gather real-time data from the images of vehicles passing through intersections using trained cameras that can identify and estimate the gas mileage based on the characteristics of the vehicle. Moreover, ML algorithms can be trained to control traffic lights. Through applied reinforcement learning, the high-fuel-consuming vehicles can keep moving rather than stopping at traffic signals and consuming more fuel (Suleiman et al., 2019). This has the potential to lower unwanted traffic congestion and reduce wait times.

Lastly, AI algorithms are used extensively in the **ride-sharing** economy to optimize pick-ups and routes, making it easier for people to get around without actually owning a vehicle (European Union, 2019).

b. Developing New Methods

i. AI, Agriculture and Food Production

Drones used in agricultrue, Credit: Image by DJI-Agras from Pixabay

One of the biggest challenges in the agricultural sector is to improve resource efficiency by increasing output while lowering the use of water, fertilizers and pesticides, which are costly and cause enormous damage to important ecosystems. Inefficiencies in food production and transportation are also a growing concern in terms of the environmental footprint.

Entrepreneurs and researchers around the world are using the power of AI to create new opportunities for **replacing animal products** in the food industry. This could have a significant impact in terms of reducing the approximately 15% of global gas emission caused by livestock (Reisinger & Clark, 2018). For instance, the company NotCo is using a ML algorithm called Giuseppe to understand the molecular structure of animal-based products, such as milk and eggs, in order make plant-based alternatives. The company has produced its first eggless mayonnaise with the help of AI (NotCo, 2020).

AI-enabled tools can also aid farmers in **planning and optimization** by analyzing real-time factors such as weather and soil conditions, water usage, temperature and market conditions in order make more informed decisions for increasing output and efficiency (Walch, 2019). Moreover, ML-assisted processes can help optimize and predict food waste by mapping the current landscape of food supply chains, bettering matching supply and demand (Ellen MacArthur Foundation, 2019).

The agricultural sector is characterized by challenges in collecting and sharing data, due to worries about competition. To overcome this problem, Microsoft, for instance, has launched the Agrimetrics Data Marketplace to connect data and organizations across the food and farming sector to help agribusinesses increase their efficiency and sustainability. With this tool, data owners can share and monetize their data with innovators that need access to that data (Microsoft, 2020a).

Precision agriculture provides farmers with powerful tools to improve competitiveness.

Precision agriculture provides farmers with powerful tools to improve competitiveness. For example, AI-enabled technologies allow for the detection of diseases in plants or poor plant nutrition through sensors (Bhatia, 2017). An AI-enabled app created by the Okuafo Foundation uses ML systems that can help farmers in rural areas of Africa to detect diseases in their crops at an early stage in order to reduce crop losses and improve their harvest. The application, which does not require an internet connection, uses images of both healthy and damaged crops to train the system to detect patterns and specific features of diseases. The farmers can take photos of their crops, and the app analyses the image to detect whether or not the crop is healthy (Bissada, 2020).

Moreover, ML-based tools can increase efficiency through intelligent irrigation systems that can save vast amounts of water, and prevent damage caused by bacteria that thrives under excessive moisture (Hawken, 2017). ConserWater, for instance, uses AI to predict how much water is necessary to irrigate the crops by using NASA satellite data and other indicators in geospatial deep learning algorithms that can predict the water needs of the crops at a much cheaper cost than a soil sensor (ConserWater, 2020).

ii. AI and the Circular Economy

AI has the potential to play a fundamental role in helping to **eliminate waste and enhance resource utility** through the circular economy. For instance, several carbon capture and utilization (CCU) technologies could transform carbon emissions into fuels and other chemicals (Sankaran, 2019). Furthermore, AI can be used in waste-sorting improvement and efficiency by increasing the value of recycled and recovered materials. The use of AI-based analytical models can enhance the extension of product lifecycles, by allowing companies to make faster decisions regarding the next re-use cycle of returned products through the collection and analysis of vast amounts of data (Ghoreishi & Happonen, 2020). Furthermore, AI-enabled tools can provide precise data about the availability and location of certain products to facilitate more sustainable and circular models and increase resource efficiency (Antikainen et al., 2018).

iii. AI and Climate Change Adaptation

As climate change is an increasing reality, adaptation (and not just mitigation) is becoming an important topic. AI is a powerful tool that can help **better manage the impact of climate change** by minimizing damage to ecosystems, as well as preventing further harm. ML-based tools can use vast amounts of data to help governments and decision-makers assess options for adaptation more rapidly and with more information. They can also lower the costs and resources associated with sharing the results of adaptation strategies across decentralized localities, allowing potential options to be aligned with local circumstances and lessons learned (Victor, 2019).

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There have been several recent developments in this field that can help calculate climate risks faster than ever before. ML methods are more affordable, as they are faster to train than previously employed climate forecast simulations (Carman et al., 2017). In the context of **resilience and disaster management**, ML tools can be very useful to detect patterns and give insights by processing a large amount of data in a short time, saving lives and enabling more efficient disaster management (Bastani et al, 2018).

For instance, AI-enabled earth observation has the potential to speed up the use of imagery retrieved from satellites for object detection (Doshi et al, 2018) or climate forecasting, which is essential in identifying patterns in long-term trends such as the frequency of drought and the intensity of floods or storms (Meinke & Stone, 2005). This can help decision-makers efficiently prepare disaster response plans (Rolnick et al., 2019).[2] Moreover, data processing through ML-based tools can be used to monitor the risk of famine and food insecurity by predicting the likelihood of near-term shortages, as well as recognizing possible long-term threats (Decuyper et al., 2014).

c. Improving Measuring and Monitoring

i. Emissions and Violations

AI-enabled tools can also expand and accelerate the monitoring of emissions. For instance, the Carbon Tracker Initiative uses AI to automate the analysis of satellite images of power plants in order to monitor emissions. This not only allows for expanded and more regular monitoring, but can also measure the plants' emission impact in other ways by using data gathered from nearby infrastructure (Snow, 2019). The collected data can be used to persuade the finance industry that carbon plants are not profitable or, in the case of a carbon taxing system, help accurately price emissions and identify who is responsible for them (Carbon Tracker Initiative, 2020).

Air quality and pollutants are also a major environmental concern. In another example, Microsoft is developing a system of compact air quality sensors called Breeze Technologies. The cost-effective sensors detect common air pollutants and use a cloud platform to collect data in real-time and ML technologies to increase reliability and accuracy. This enables them to create hyper-local maps of air quality, allowing for more effective facilities management and providing scientists and governments with information to understand and improve air quality (Microsoft, 2020c).

AI can help monitor air pollution, Image by Ralf Vetterle from Pixabay

Moreover, the start-up Hawa Dawa, established at the Technical University of Munich, combines big data and AI systems to measure citywide air quality mapping in real-time. By using AI-based calibration algorithms, they can account for environmental factors in order to increase accuracy (Jordan, 2018).

ii. Biodiversity and Environmental Management

AI systems can aid **water conservation** by enabling the reduction of water use, better managing water resources and monitoring flood potential (Sharma & Gundraniya, 2020). For example, in terms of drinking water management, Clean Water AI deploys convolutional neural networks and computer vision techniques to detect dangerous bacteria or other contaminant particles present in the water in order to provide data on the patterns of water contamination in real-time (Clean Water AI, n.d.). Moreover, AI-enabled algorithms can significantly reduce pollution worldwide by

[2] See the AI4EO project where the IEAI is a partner working on this topic: https://ieai.mcts.tum.de/research/ai4eo/

automatically identifying oil spills and areas at risk of desertification (Vinuesa et al., 2020).

With the rapid pace of the extinction of many **species**, the role of AI in aiding conservational efforts around the world is fundamental. Deep Learning models are enabling the integration of pattern recognition and identification by processing thousands of images, producing real-time crucial information to help manage the earth's biodiversity. For instance, Microsoft's AI for Earth and Gramerner jointly developed a deep learning solution that can process hundreds of hours of video to identify frames with hard-to-observe species. Researchers at the University of Oxford are using ML techniques to obtain accurate bird counts from images. The groups Wildme and Save the Elephants use crowdsourced and aerial photos to uniquely identify herds and individual animals (Arteta et al. 2016; Kesari, 2019). This saves enormous human resources, freeing them up for other use. AI for Earth is also working with partners to develop tools to monitor forest and ocean health and create an interconnected network of environmental data to preserve ecosystems (Microsoft, 2020b.)

> ***Deep Learning models are enabling the integration of pattern recognition and identification by processing thousands of images, producing real-time crucial information to help manage the earth's biodiversity.***

iii. Climate Change Trends and Decision Making

Much of AI modeling and forecasting is based on global scale models that have been downscaled to regional settings. Given the complexity of the factors that determine specific local environments, AI could help improve these downscaled models by supplying real-time and multilevel/-dimension information from diverse sources. Moreover, adapting to the growing impacts of climate change requires hard decisions between two less than perfect options. AI-based technologies and decision-making systems can help policymakers to make these decisions with increased, improved and more accurate information (Victor, 2019).

3. Ethical considerations of the use AI-based tools to implement the goals of the Green Deal

While many AI-enabled technologies have the potential to cut carbon emissions, there is a need to debate how these developments could affect the sustainable development of society as a whole (Osburg & Lohrmann, 2017). Since the Green Deal inherently encapsulates the notion that we can create economic prosperity and justice alongside environmental and climate protection, understanding the trade-offs is of the utmost importance and would benefit from an analysis of the ethical considerations.

AI is a powerful tool that has the ability to amplify positive trends, but also entrench and increase harms and distort justice if not used responsibly. Of ethical importance are the questions: Who will be impacted, when and in what way by AI technology? Floridi et al. (2018) outline these issues and propose five principles to guide AI ethics: **beneficence, non-maleficence, autonomy, justice and explicability**.[3]

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[3] Beneficence can be described as promoting well-being, preserving dignity, and sustaining the planet, or "do only good". Non-maleficence implies "do no harm". Autonomy encompasses the idea that individuals have the right to make decisions for themselves. Justice deals with shared benefit and shared prosperity and relates to the distribution of resources and eliminating discrimination. Explicability is an added concept that focuses on enabling the other principles through making explicit the need to understand and hold to account the AI decision-making processes (Floridi et al., 2018).

These ethical considerations innately involve conflicting values or priorities. Some AI-enabled technologies may have both environmentally positive and negative implications. For instance, how might the same technologies that lead to *beneficence* in the form of improved efficiency of renewables or reduced emissions also violate *non-maleficence* principles by improving the efficiency of extracting hydrocarbons (Victor, 2019)?

Moreover, as Brevini (2020) notes, the discourse on AI focuses on creating ethical, trustworthy and fair AI with very little attention to potential environmental costs. AI is heavily portrayed as a solution for increasing environmental protection while stimulating the economy. However, the large carbon footprint, in terms of energy consumption for training, cloud computing, and cooling systems, is often overlooked. Thus, these trade-offs between energy savings and resource used need to be clarified and examined. The need to actually measure and monitor these trade-offs may also emphasize the requirement to consider *explainability* in AI-enabled technologies used to reduce emissions or improve efficiency.

How do we deal with the workforce related justice issues associated with eliminating the need for environmentally harmful industries or practices with the environmental justice implications of not advancing these "green" AI-enabled technologies?

Managing climate change and protecting the environment with AI-enabled technologies will also have uneven impacts. How do we deal with the *workforce related justice issues* associated with eliminating the need for environmentally harmful industries or practices with the *environmental justice* implications of not advancing these "green" AI-enabled technologies? The US Green New Deal in particular highlights the need to create economic security for all and promote justice and equality for historically oppressed populations, but argues that this can go hand in hand with transitioning to a green economy. Marginalized or underserved populations may be the hardest hit by environmental devastation and climate change. However, AI-enabled technologies aimed at mitigating these impacts could also affect workforce populations in unbalanced or distinct ways that need to be examined and understood in order to deal with them.

Amongst experts in this field, there is still wide disagreement with regard to the effects of digitalization on the labor market, ranging from the argument that these developments will have little overall effect on workforces (Atkinson, 2019), to the theory that the significant social and political effects of increased digitalization will reinforce nationalistic trends and political polarization (Baldwin, 2018).

While the speed or severity are debatable, increased use and promotion of AI-based technologies will cause some disruptions to our current economic system. A socially sustainable Green Deal, incorporating justice considerations into the increased use of new AI-based technologies, would therefore need to devote attention to issues of disproportionate economic implications for distinct or vulnerable populations. Furthermore, it would be worthwhile for experts to consider where *explicability* in AI and transparent impact evaluations of new technologies may help mitigate perceptions of injustice.

AI-enabled smart technologies may be a key to improving efficiency and reducing consumption, but what are the privacy and autonomy implications that accompany these technologies?

Moreover, as the above sections suggest, AI-enabled smart technologies may be a key to improving efficiency and reducing consumption, but what are the *privacy and autonomy* implications that accompany these technologies? For instance, with smart mobility and autonomous driving, ethical concerns related to privacy and cybersecurity arise from the connectivity and external communication needed for operation (Lim & Taeihagh, 2018). Issues of autonomy arise when considering manufacturing designs that limit control over the driving mode (Gogoll & Müller, 2017). Finally, ethical issues related to *accountability* become clear when considering who (or what) would be accountable/liable in the case of accidents, and how to manage possible overreliance on a system (National Transportation Safety Board, 2020). In the case of ML-enabled processing of images and satellite data, the possibility that raw data or the resulting user products with increased accuracy and details might be misused by governments, individuals or companies must be considered in the course of development.

These are just a few indicative cases of how societies will have to consider the trade-offs between (1) improving resource efficiency and mitigating climate change, and (2) the potential losses in privacy or autonomy that accompany new AI-enabled technologies.

4. Final Thoughts

The US and EU Green (New) Deals have introduced a new way to think about the dynamics between economic growth and environmental protection. AI-based tools and technologies have enormous potential to aid in this realization in a variety of sectors. However, the technologies themselves often have multiple potential purposes or the potential to change human activities in ways that could lead to overall negative environmental impacts. Thus, it will be up to developers, users, and policymakers to ensure these tools are used responsibly, with attention to the trade-offs they create and the potential disproportionate effects they may have on vulnerable populations.

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