

What Impact Can Financial Engineering Have On Hastening The Transition To Sustainable Energy?

Dondisch, Liam¹; Montañez, Samuel²

- (1) The American School Foundation of Mexico City; dondischl@asf.edu.mx
- (2) Universidad Panamericana Ciudad de México; smontanez@up.edu.mx

Abstract

Growing global recognition of the urgency posed by climate change demands strategies balancing economic growth and ecological sustainability. To limit global warming below 2°C, international accords like the UN's Sustainable Development Goals (SDGs) and the Paris Agreement have set the standards for greener economies. ESG investments are becoming a popular trend in the financial world, embracing climate change and other sustainability concerns across different asset classes. Green bonds in particular are driving the green finance movement, with issuance leaders like the US and China. The size of the green bond market is expected to surpass the trillion-dollar threshold by 2023. Instruments like green bonds can bridge the funding gap for a net zero economy. Financial engineering can develop appealing financial products guided by investment practices focused on sustainability goals. Despite challenges, tax policies and fiscal measures can boost green investment participation and returns, pushing toward a greener future.

Keywords: green finance; green bonds; green loans; sustainable investments

Introduction

The recognition of global warming as a major threat to humanity that requires immediate policy concern among governments has increased the need for strategies that balance economic growth with the assurance of the long-term ecological sustainability of our planet (Butkiewicz and Solcan, 2016). There is widespread consensus that global warming needs to be maintained at levels below 2 degrees °C, ideally at 1.5 °C level. International agreements such as the UN's Sustainable Development Goals (SDGs) and the Paris Climate Agreement marked the first global commitment of several countries towards a sustainable economy by decreasing their greenhouse gas (GHG) emissions (Sachs et. al., 2019). Some of the first projects for transitioning to a green financial system were proposed by the United Nations Environment Programme (UNEP) which has been advocating for the establishment of a sustainable financial system. The primary aim of this program would be to mobilize capital to promote sustainable development and pursue a more environmentally friendly and inclusive economy (Batrancea et. al., 2020). Along these lines, the Principles for Responsible Investment (PRI) were launched in 2006 to promote an investment philosophy that considers environmental, social and governance (ESG) issues when making investment decisions and stewardship activities. The environmental component in ESG investment standards encompasses issues such as climate change, circular economy, biodiversity and deforestation according to PRI Association guidelines. Although financial innovation in green finance has mainly been driven by green bonds, it also includes other vehicles like green stock indexes and green credit (Wang and Wang, 2020).

An OCDE (2016) report on green bonds estimated that annual low-carbon investment needs by 2023 in the most notable polluters (China, US, EU, Japan) at US \$2.26 trillion while current issuance levels have just surpassed the trillion-dollar benchmark signaling a long way to go. Moreover, the International Finance Corporation (IFC) estimated the resources needed could reach US \$23 trillion by 2030 (Ketterer et. al., 2019). However, given the recent growth levels, it's feasible that green securities can finance all the required low-carbon infrastructure necessary for a sustainable future. Drawing from research conducted by Fernandez, Stein, and Lo (2012), we adopt their approach, which utilizes portfolio theory and securitization to finance biomedical innovation for developing cancer cures, for conceptualizing how to mitigate risks and create favorable investment conditions for financing large-scale sustainable projects which would cover the remaining deficit for achieving net zero. The financing of social and public projects is not new, since World War I the Allies and the United States issued five war bonds from 1917 to 1920, called Liberty and Victory bonds, with great success (Butkiewicz and Solcan, 2016). Fernandez and colleagues highlight that debt financing enables the raising of substantial capital compared to public and private equity markets and propose a funding structure comprising equity and research-backed obligations (RBOs). In the context of ESG investments, the use of asset-backed securities, particularly a structured product with tranches that combine green and social development bonds, can attract both institutional and speculative investors seeking to support renewable energy and other social development initiatives. Investors are keen on a broader range of options to diversify their investment portfolios and many of them want their assets to be aligned with their social and environmental values.

Green Bonds Overview

The first green bond was issued by the European Investment Bank in 2007 and a year later, Sweden became the first country to issue one through the Swedish Central Bank and The World Bank (Ketterer et. al., 2019). Since then, the global green bond market has grown up to \$2,159.4 billion dollars and by 2023 it surpassed the trillion dollar threshold (Ferlin and Sternbeck Fryxell, 2020; Climate Bonds Initiative, 2023). Green bonds typically follow a structure similar to that of conventional investment-grade bonds, with one key distinction, these bonds include a clause that specifies that the funds raised will be dedicated to finance or refinance environmentally friendly investments (Maltais and Nykvist, 2020). Another key premise in the development of green bonds was that investors would be willing to pay a premium for financing climate-friendly investments but there is no evidence that this is the case. Green bonds also distinguish themselves from regular bonds by having additional disclosure and certification requirements since the establishment of the Green Bond Principles (GBP) in 2014 by the International Capital Markets Association (ICMA) (Ketterer et. al., 2019).

The above-mentioned OCDE (2016) report argues that while 70% of basic energy, water, and transport infrastructure is financed through debt, most of these projects do not qualify as green investments. The main reason is due to higher costs since it is estimated that low-carbon infrastructure systems have a premium of 4.5% compared to high-carbon investments. However, it is possible that markets and governments can subsidize this cost through green bonds as the market might provide a discount to sustainable projects just because of the long-term social and environmental benefits that derive from these

projects. In addition, it is likely that countries will begin to charge carbon-emission taxes to companies, making the slight cost increase negligible in comparison to high-carbon investments.

According to data from the Bank of International Settlements (2022) debt securities statistics, the number of total debt securities outstanding by the end of 2022 was at US \$141 trillion with domestic debt securities representing the majority of these securities (80%). On the other hand, the government and financial corporations constitute the main issuers with US \$70 and US \$50 trillion dollars by the fourth quarter of 2022. The main countries in debt market size are the US with total bonds outstanding at US \$52 trillion and China with US \$22 trillion. Chasan (2019) estimated that a little over 1% of the bond market consists of green bonds, meaning that there is massive potential for this financial innovation. Sweden being the pioneer and leader in green bonds issuance, only has close to 10% of its total bond market concentrated in green bonds. On the other hand, the US and China lead the green bond market in size with an estimated \$380 billion and \$286.9 billion, respectively, representing 30% of the global green bond market (Climate Bonds Initiative, 2023). Ketterer et. al. (2019) estimated that green bond market issuances could reach US \$5.6 trillion by 2035.

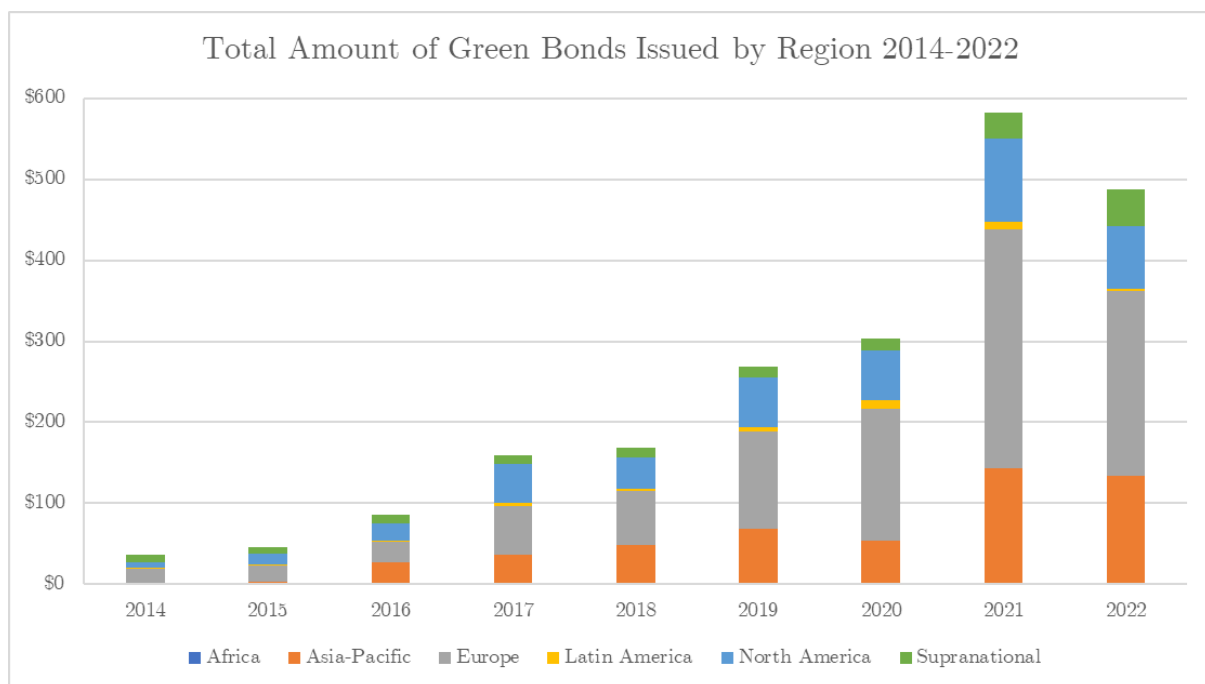


Figure 1. Source: Climate Bonds Initiative (2023), numbers in billions USD

According to data from the Climate Bonds Initiative (2023) covering the period from 2014, the green bond market experienced a singular decline in 2022, primarily attributed to Russia's invasion of Ukraine. This invasion caused energy price spikes due to a decrease in gas and energy supplies, leading to inflation shocks on the supply side and rising interest rates by central banks worldwide in response. Among the groups of issuers analyzed, Europe witnessed the largest decline, primarily due to the significant impact on energy prices resulting from the region's dependence on Russian gas, commodities, and energy. Supranational institutions were the only group that demonstrated a significant increase from 2021 to 2022. Notably, the Latin American region exhibited the slowest growth compared to other regions (excluding

Mexico), likely due to slower GDP growth rates and the emergence of left-wing populist governments, which tend to prioritize traditional hydrocarbon-based energy production at the expense of renewable alternatives.

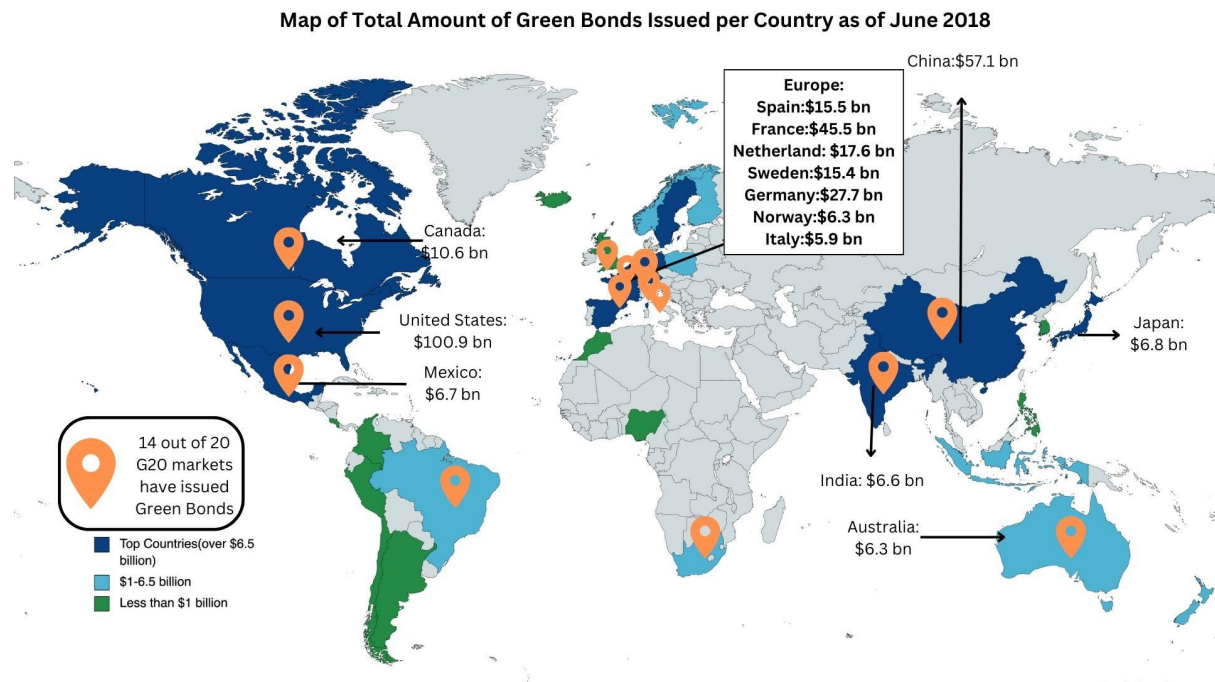


Figure 2. Self-made map created with data and statistics from Climate Bonds Initiative (2023), total amounts of green bonds issued per country since first green bond issuance. Numbers in billions of USD.

As of June 2018, the map above shows that top countries in terms of total green bonds issuance were Mexico, Canada, Spain, Sweden, India, China, Japan, France, Germany, the Netherlands, and the United States, all surpassing \$6.5 billion in green bonds issuance. The United States led with \$100.9 billion, nearly doubling the amount of the second leading country, China, with \$57.1 billion. These top countries exhibited varying strategies for growth. The United States continued investment in green bonds, surpassed \$350 billion by 2023. China experienced accelerated growth, increasing from \$57.1 billion in 2018 to around \$280 billion in 2023. The main driver for China's growth is the fact that Asia has estimated investment needs for infrastructure of \$26 trillion until 2030, US \$1.7 trillion per year (Sachs et. al., 2019). Conversely, countries like Mexico and India showed minimal or even negative growth. India increased from \$6.6 billion to around \$20 billion in the same period, while Mexico dropped out of the top 20 nations for total green bond issuance. Germany, France, the Netherlands, and Japan displayed consistent growth and maintained their top rankings. Latin America and Africa made limited contributions to the green bond market, although Africa showed steady growth in recent years. Developed nations and stronger economies had a greater presence in the green bond market, while developing countries were just beginning to enter or had no participation. Notable exceptions to this trend include nations like Brazil, Australia, and several strong Middle Eastern economies, such as Saudi Arabia. Brazil's limited impact can be attributed to its status as a developing country, although its large economy and natural resources leave room for greater influence in the green bond market. Middle Eastern and North-Saharan countries like Saudi Arabia and Egypt have little incentive to adopt renewable energy, as their economies heavily rely on oil drilling and petroleum, which

contrasts with the shift towards renewable green energy.

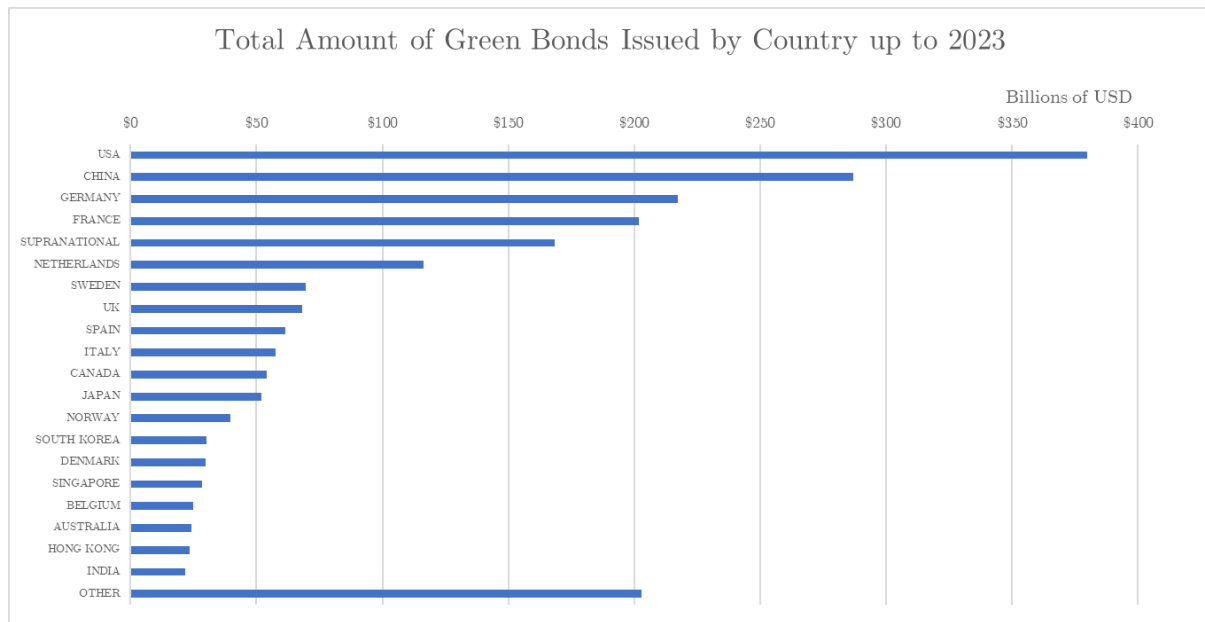


Figure 3. Source: Climate Bonds Initiative (2023), total amounts of green bonds issued per country since first green bond issuance. Numbers in billions USD. “Other” includes 65 countries with amounts of green bond issuance below India’s, including Mexico with US \$3.7 billion.

The United States currently leads in green debt issuance, with an estimated \$360 billion USD, closely followed by China with \$270 million USD. Supranational institutions like the World Bank rank 5th in green bond issuance. There is a notable concentration of European countries in the top 20, including Germany, France, the Netherlands, Sweden, Spain, Italy, Norway, Denmark, and Belgium which is consistent with the data going back to 2018. In addition, North America (Mexico, the US, and Canada) and Asia (China, Japan, Hong Kong, India) are also prominent regions. Other regions such as East Europe, Russia, the Middle East, Africa, and Latin America do not exhibit significant activity. Surprisingly, countries like Australia, despite their size and natural resources, show limited engagement in the green bond market compared to smaller countries like the Nordic countries, all of which rank higher.

Another important aspect of analyzing green bonds is the use of proceeds (UoP), which varies depending on the strategies employed to reduce carbon emissions. According to data from the Climate Bonds Initiative (2023) spanning from 2014 to 2022, the top five UoP categories, as defined by the standard green bond taxonomy, comprise energy, buildings, transport, water, and land use. These categories accounted for nearly 90% of total green debt issuances in 2022, experiencing a slight decrease compared to 2021 levels. Notably, the industry category experienced the sharpest decline (-36.4%) from 2021 to 2022, possibly due to rising energy prices resulting from the Russian and Ukrainian conflict, as well as the increasing inflation worldwide. This hypothesis is further supported by the 5.88% decrease in energy-related UoP during the same period. Conversely, the information, communications & technology (ICT) category witnessed a substantial increase (94.89%), nearly doubling in size (excluding unspecified issuances). This rise in ICT UoP can be attributed to the surge in teleconferencing and remote work practices following the COVID-19 pandemic. Furthermore, the waste and transport categories both experienced double-digit

increases, with 16.54% and 12.92% respectively. We speculate that the growth in the transport category may be attributed to increased mobility as pandemic restrictions eased and global logistics demand surged. Similarly, the rise in the waste category could be linked to increased consumption as people ventured out after prolonged periods of confinement.

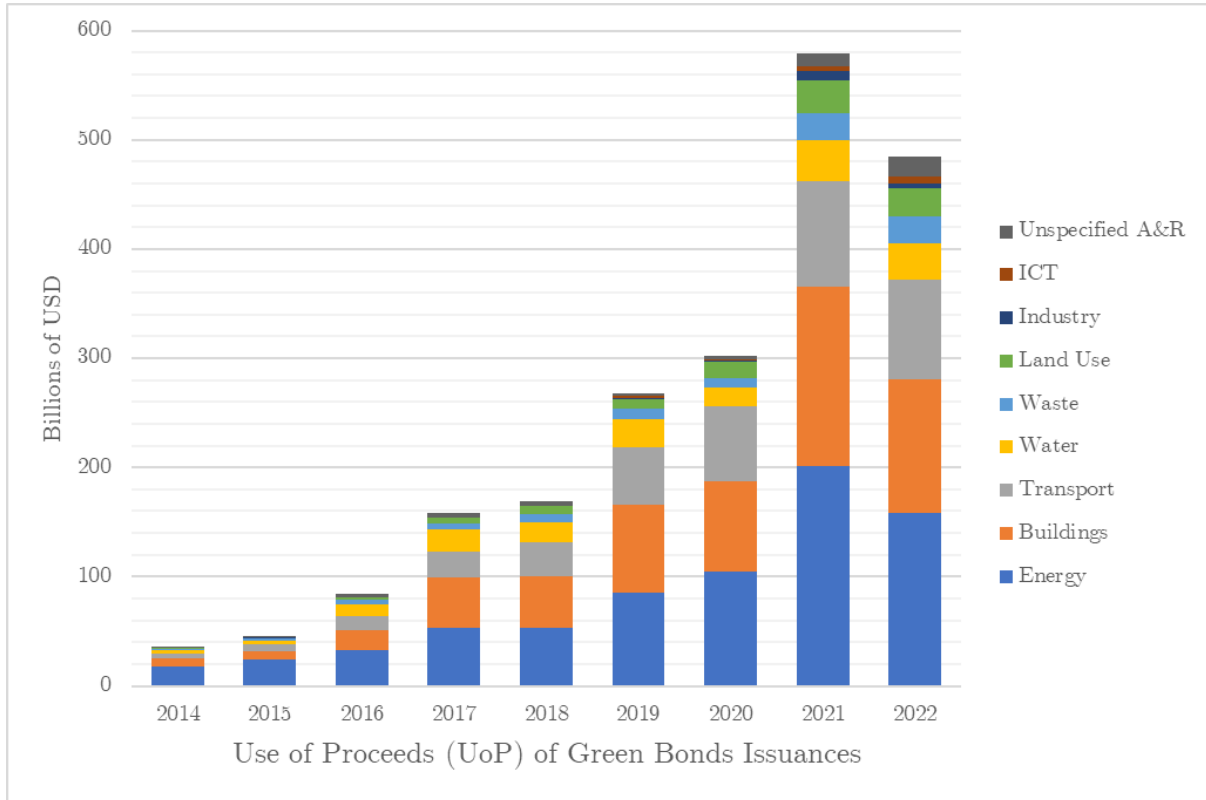


Figure 4. Source: Self-created graph with Climate Bonds Initiative (2023), use of proceeds (UoP) in billions of dollars of total green debt issuances from 2014 to 2022.

The Mexican Case

It is estimated that the green bonds issuances in Latin America and the Caribbean (LAC) reached US \$8.1 billion in 2017. However, green bond issuances in LatAm still represent a small fraction of global green bond issuances (Ketterer et. al., 2019). According to data from the Climate Bonds Initiative (2023), ranking in terms of green bond issuance in the LAC region has shifted, with Chile ranking first, followed closely by Brazil, and then Mexico which has fallen to the 37th position worldwide.

In the case of Mexico, a country that has lagged behind other developed nations in its transition to clean energy, the majority of projects have been financed through private equity vehicles. Nearly a decade ago, the Mexican government introduced an investment security known as Certificado de Capital de Desarrollo (CKD) to facilitate private equity funds in raising capital through public markets. More recently, they also launched a similar investment security called Certificado de Proyecto de Inversión (CERPI), which offers improved terms for international investments and streamlines administrative operations of private equity firms (Deloitte, 2014). These securities enable institutional investors, particularly pension funds, to invest in

private equity funds with long-term investment horizons of 10 to 20 years, providing them with opportunities to diversify their portfolios beyond public securities.

Ironically, related to sustainability and the green bond market, the story of these investment vehicles (CKDs and CERPIs) started with Santa Genoveva, a biotech company in Mexico focused on forestry and growing teak trees given the strength and quality of its wood. The project was financially attractive given the overprice of this type of wood in markets such as Canada or the US, but its cash flow structure was not appealing to short-term investors. The long-term investment horizon consisted of close to a decade of negative cash flows which disincentivize most investors with the exception of pension or sovereign funds.

In 2013, former Mexican president Enrique Peña-Nieto created an oil and energy reform where these industries were de-nationalized and open to international investors. This historic reform changed the landscape of these industries in Mexico; since 1938, they had been nationalized monopolies. This reform, although having its flaws and diminishing the power of Mexican companies in the industry, allowed for modernization through investments in different types of green energy as seen in the 6.7 billion dollars of green bonds issued in 2018. However, according to data from the Climate Bonds Initiative (2023), the total of green bond issuances in Mexico were estimated at \$3.7 billion dollars by June 2023, significantly lower than the \$6.7 billion dollars recorded in 2018, indicating a substantial decrease. Our analysis suggests that the cancellation of the new international airport in Mexico City (known as NAICM) in December 2018 by President López Obrador, who had recently been elected, signaled the government's lack of interest in financial markets, in particular green bond markets since the project was being financed partly through a green bond issuance (Van Bedolla, 2021). Additionally, the green bond issuance to finance the new airport was an outlier that year. At that time, the single green bond issuance of US \$2.1 billion to finance the NAICM represented the largest green bond issuance in the entire LAC region to that date (Ketterer et. al., 2019).

This shift in focus led to the suspension of numerous solar and wind energy projects, under the banner of energy sovereignty, the government aimed to strengthen the state-owned energy utilities, Pemex (oil) and CFE (electricity). These energy policies introduced uncertainty and abruptly halted ongoing and anticipated energy investments, reversing the country's previous potential and regulatory framework, which was now returning to a more nationalized energy sector approach. López Obrador when entering office installed a counter-reform to the previous energy and petroleum reform by president Enrique Peña-Nieto where he nationalized the energy and oil industries as they have been for most of Mexican history.

Examining Mexico as a study case for its role in supporting and fostering sustainable energy is crucial, given the nation's experience at both ends of the spectrum. From 2012 to 2018, during a period of greater openness in the energy and oil industry, akin to the United States and European nations, Mexico emerged as a significant player in the green bond market. However, with the change of administration and a shift towards a closed, nationalized energy and oil industry, there has been a substantial decline in green finance activity. This case study can be extrapolated to a global perspective, suggesting that open market strategies in the energy and oil sectors are likely to drive increased participation in green bonds and facilitate the transition towards renewable energy. In fact, Ketterer et. al. (2019) estimate that close to 50% of green bond

investments in the LAC region are dedicated to renewable energy projects.

Conclusions

Green finance is a class of financial innovation which can accelerate the funding needs of corporations and governments for a sustainable future. From climate change to war to curing cancer, debt capital markets and financial engineering can be the tool to generate appropriate financial incentives for economies to function in a sustainable way. Green finance securities and models such as green bonds, green loans, green banks, and village funds, among others, could fill the investment gap needed to reach the Sustainable Development Goals (SDGs) (Sachs et. al., 2019). Financial engineering can produce new investment products which are more attractive for investors and channel economic resources for sustainable ends. Despite the fact that green bond markets have seen steady growth in several large countries and regions around the world, higher costs for cleaner technologies and additional verification costs translate to similar or lower returns than traditional investment projects (Sachs et. al., 2019). Oil and gas investment projects still dominate the project finance landscape worldwide and this trend has accentuated with the war in Ukraine with soaring energy prices in Europe and other regions in the world. Wang and Wang (2020) analyzed the relationship between companies, government, consumers and financial institutions through an evolutionary game simulation and concluded that tax policy would likely be the key driver to incentivize different stakeholders to increase their participation in green finance. Sachs and colleagues (2019) also agree that a primary aspect for increasing green investment is that fiscal policy increases rates of return for sustainable projects, therefore, making them more competitive against regular investments.

Acknowledgement

I would like to thank my advisor, Professor Samuel Montañez for his generous advice and help throughout the creation of this research paper. His devoted attention towards my goals and ideas for this project were exemplary and his devotion to furthering my knowledge in the topic of sustainable finance are greatly appreciated and made this project possible.

Institutional Review Board (IRB) approval: Non applicable.

References:

- Batrancea, I., Batrancea, L., Maran Rathnaswamy, M., Tulai, H., Fatacean, G., & Rus, M. I. (2020). Greening the financial system in USA, Canada and Brazil: A panel data analysis. *Mathematics*, 8(12), 2217.
- Butkiewicz, J. L., & Solcan, M. (2016). The original Operation Twist: the War Finance Corporation's war bond purchases, 1918–1920. *Financial History Review*, 23(1), 21-46.
- Bank of International Settlements (BIS). (2022). Summary of debt securities outstanding. December 2022. <https://stats.bis.org/statx/srs/table/c1?f=pdf>

Chasan, Emily. 2019. "Bonds to Save the Planet - Bloomberg." April 23, 2019. <https://www.bloomberg.com/news/articles/2019-04-23/bonds-to-save-the-planet>.

Cui, H., Wang, R., & Wang, H. (2020). An evolutionary analysis of green finance sustainability based on multi-agent game. *Journal of Cleaner Production*, 269, 121799.

Deloitte. (2014). Certificados de Capital de Desarrollo (CKDes), Una alternativa real de financiamiento. https://www2.deloitte.com/content/dam/Deloitte/mx/Documents/bienes-raices/CKDes_2014.pdf

Environmental Finance Data. (n.d.). <https://efdata.org/>

Fagnan, D. E., Fernandez, J. M., Lo, A. W., & Stein, R. M. (2013). Can financial engineering cure cancer?. *American Economic Review*, 103(3), 406-411.

Ferlin, M., & Sternbeck Fryxell, V. (2020). Green bonds—big in Sweden and with the potential to grow. *Riksbanken: Economic Commentaries*, 12.

Gilchrist, D., Yu, J., & Zhong, R. (2021). The limits of green finance: A survey of literature in the context of green bonds and green loans. *Sustainability*, 13(2), 478.0

Ketterer, J. A., Andrade, G., Netto, M., & Haro, M. I. (2019). *Transforming green bond markets: using financial innovation and technology to expand green bond issuance in Latin America and the Caribbean* (Vol. 751). Inter-American Development Bank.

Maltais, A., & Nykvist, B. (2020). Understanding the role of green bonds in advancing sustainability. *Journal of sustainable finance & investment*, 1-20.

Market Data. (n.d.). Climate Bonds Initiative. <https://www.climatebonds.net/market/data/>

Sachs, J. D., Woo, W. T., Yoshino, N., & Taghizadeh-Hesary, F. (2019). Why is green finance important?.

Van Bedolla, L. (2021). ¿Qué ganamos al cancelar el proyecto del NAICM?. *Revista Nexos en colaboración con Mexicanos contra la corrupción y la impunidad*.

<https://anticorrupcion.nexos.com.mx/que-ganamos-al-cancelar-el-proyecto-del-naicm/>

What is responsible investment? (n.d.). PRI.

<https://www.unpri.org/introductory-guides-to-responsible-investment/what-is-responsible-investment/4780.article>