PROJECT SUMMARY

OVERVIEW

There are myriad solutions to the Triple Planetary Crises of climate change, plastics pollution, and biodiversity loss from habitat and global ecosystem impairment. A single environmental derivative market mechanism that allows end users to systematically rank order solutions based on peak utility to cost transparently, and hedge returns on investments (ROI) and/or assets (ROA), does not exist. This mechanism would serve as a solution accelerator imperative for global existential threats. We have a comprehensive compliance environmental derivative market mechanism that could effectively price various greenhouse gases and pollutants, and fund offsets, to redress the Triple Planetary Crises. However, technical work is required before the feasibility is proven.

INTELLECTUAL MERIT

To use the cost and benefit curves for elements representing both the problems and solutions to the Triple Planetary Crises, we must quantify interconnected, if disparate, elements and resources for Global Warming Potential (GWP) values. Our Phase I objective is to broaden and quantify GWP values to both positive and negative (+/-) global warming potential externality values derived from material elements, resources, and activities beyond greenhouse gases (GHGs).

Carbon markets are fragmented and ineffective for the task. Yet, environmental derivatives reach all international capital market end-users necessary for a comprehensive solution. A +/- mirror of GWP values representing harmful and beneficial externalities act as a cost benefit bridge via carbon (CO_2e) markets for all environmental externality internalization.

BROADER IMPACTS

Given the long-standing legal principle of polluter pays and the global scale of derivatives in international capital markets, the global infrastructure already exists and is quite favorable. Remediating the Triple Planetary Crises yields more profitable and productive global resource allocation and grows rather than shrinks the $100 trillion global economy.

Commercialization of more efficient resource allocation, opportunity cost savings, and economic growth is broad by nature. But Environmental derivative trading, structuring, sales, and domain expertise consulting with Climate Finance are 10-figure annual markets.

Intellectual Merit

The Technical Solution

Sustainable finance has become a pivotal element in the global financial landscape, especially as companies and investors increasingly prioritize environmental, social, and governance (ESG) factors[1,2]. This shift is driven by the recognition that long-term investments in sustainability can yield significant economic benefits and contribute to a more stable financial future. As reported by KPMG and Morgan Stanley, the integration of sustainable practices is not only reshaping investment strategies but also aligning with regulatory expectations and stakeholder demands for greater corporate responsibility and transparency[3,4].

For companies, the necessity to adopt sustainable finance practices is underscored by mounting regulatory pressures and the evolving preferences of investors who are increasingly directing capital towards businesses that demonstrate a commitment to sustainability. The growth in the sustainable finance sector, marked by a significant increase in the issuance of green bonds and the proliferation of sustainability-themed funds, reflects a robust investor appetite for instruments that support environmentally and socially responsible activities. However, to effectively participate in this market, companies need appropriate incentives[5,6]. These could include fiscal advantages like tax breaks or subsidies for sustainable projects, regulatory frameworks that mandate certain sustainability standards, and potentially higher valuation premiums from investors for demonstrable ESG compliance.

Encouraging companies to engage in ESG practices through sustainable finance not only helps bridge the significant funding gap necessary to achieve global sustainability goals but also enhances their competitiveness and resilience against environmental risks[2,6]. The trajectory of sustainable finance suggests a dynamic future where both environmental and social governance will be integral to the core strategy of companies worldwide

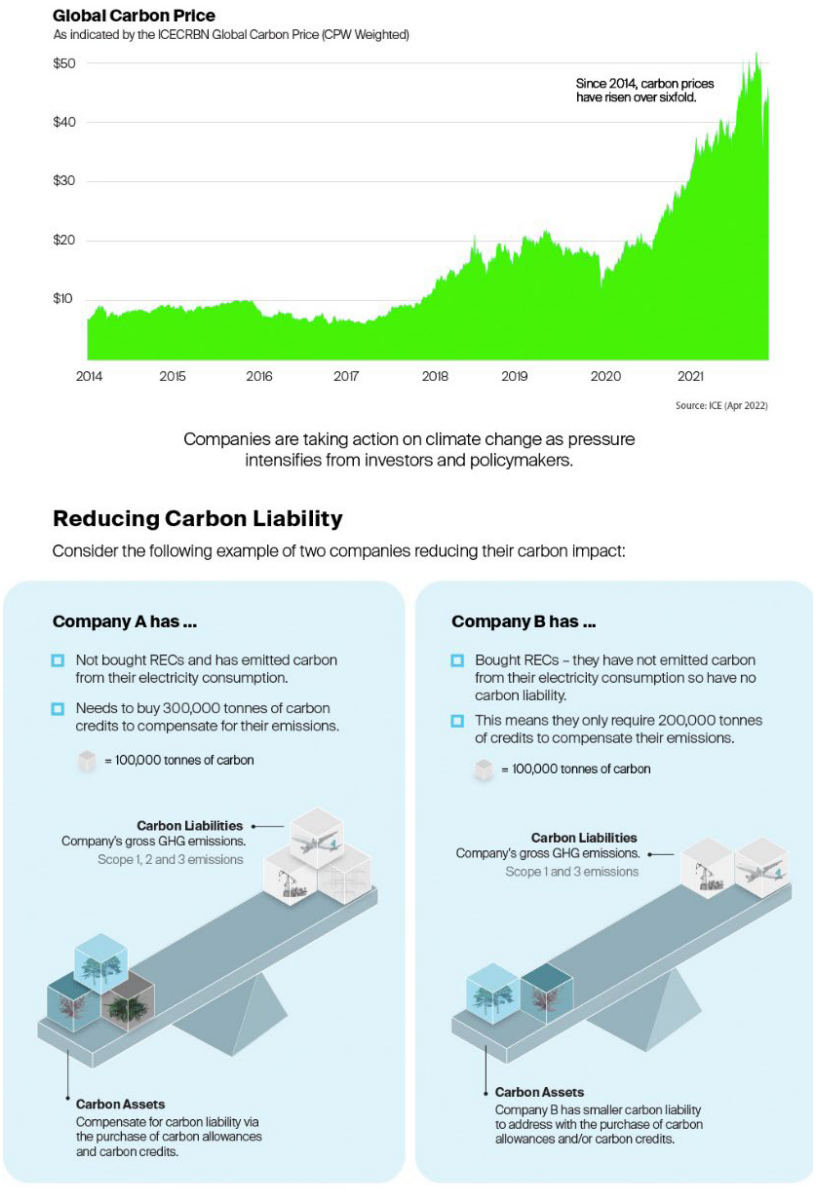

Figure 1. As companies increasingly recognize their carbon emissions as liabilities, the demand for mechanisms to manage and mitigate these liabilities grows.

The expanding role of sustainable finance in promoting environmental and social governance aligns closely with the development of the environmental derivatives market. As companies increasingly recognize their carbon emissions as liabilities, the demand for mechanisms to manage and mitigate these liabilities grows[7]. This recognition is driving the demand for carbon allowances and carbon credits, which serve as key instruments in regulatory and voluntary environmental markets. Carbon allowances are typically granted by governments under a cap-and-trade system where companies are allotted a certain amount of emissions; if they exceed this limit, they must purchase additional allowances from other entities who have surplus allowances due to emissions lower than their cap. Carbon credits, on the other hand, represent a reduction of emissions through projects that capture or reduce greenhouse gases outside of the company's direct emissions (**Fig.1**).

The rising demand for these environmental attributes leads directly to the need for more sophisticated financial products like greenhouse gas derivatives. These derivatives allow companies to hedge against the risk of future price fluctuations in the cost of carbon credits and allowances. As investors and companies increasingly prioritize ESG principles, driven by regulatory pressures and market demands, there's a growing influx of capital into markets that can offer verifiable environmental benefits. This trend enhances the viability of the environmental derivatives market, where financial instruments are tied to the performance of ESG metrics. ***Such instruments allow companies to hedge against environmental risks while providing investors with opportunities to support sustainability initiatives through market-driven mechanisms.*** As sustainable finance grows, it feeds directly into the liquidity and diversity of the environmental derivatives market, making it a crucial component of global efforts to finance a transition to a more sustainable and resilient economy. Environmental derivative markets, designed to mitigate greenhouse gas (GHG) emissions and other environmental externalities, have existed for decades. However, they have largely failed to address the escalating problem of global warming. Since 1990, NOAA's annual GHG index has shown a 40% increase in atmospheric greenhouse gases, illustrating that these markets have not only underperformed but also allowed the problem to worsen. This rise in GHG emissions translates into more severe impacts on global ecosystems, human health, and economic stability. With an estimated 37 billion metric tons of carbon dioxide released globally in 2023 alone, the failure of current systems represents a massive shortfall in achieving necessary decarbonization goals. The cost to society, particularly in terms of climate-related damages such as extreme weather events, rising sea levels, and biodiversity loss, is projected to rise into the trillions of dollars annually.

The Commodity Futures and Trading Commission (CFTC) regulates the U.S. derivatives markets, including OTC markets, commodity futures, options, and swaps. CFTC also regulates the trading of the underlying assets related to these derivatives. *CFTC established its first-ever guidelines for trading voluntary carbon credit derivative contracts on September 24, 2024 and this was a crucial step for the nascent market, providing much-needed oversight and integrity*[8,9]. The largest global derivative market – interest rates with over $20 trillion in notional outstanding – transitioned after the 2007-08 Credit Crises and enhanced Basel III bank capital and liquidity standards. Global capital market base interest rates changed from the former “interbank offered rates (IBORs) to risk free rates (RRF). In the US, it was the transition from London Interbank Offered Rate (LIBOR) to the Secured Overnight Financing Rate (SOFR)[10]. In a move of such size and importance, little is discretionary. Conformity and compliance are essential to maintaining a unified, liquid, market fair to both the long and short party. Voluntary carbon markets have non-binding guidance under the CFTC and loosely regulated underlying utility of contracts that undermine coherence and market support.

A significant issue with current environmental derivative markets lies in their fragmented nature[11]. These markets, while created with the intention of incentivizing GHG reduction, lack standardization and are limited in their ability to address diverse environmental challenges. For instance, various market systems may only cover specific sectors, pollutants, or regions, resulting in incongruent approaches that fail to address the full scope of environmental externalities. This inefficiency not only limits the effectiveness of these markets but also results in increased complexity and higher transaction costs for participants. *Without an integrated system, the current approach exacerbates market fragmentation, creating barriers for meaningful global cooperation on climate action*[11,12]. The application of the Coase theorem in environmental economics suggests that private parties can solve the externality problem through negotiation, provided property rights are well-defined and transaction costs are minimal. However, in practice, this approach in the context of GHG emissions has proven insufficient for achieving significant emission reductions without stringent regulatory frameworks. For instance, the compliance systems in China and Europe, where the government controls the issuance and auction of emissions permits, aim to offer a more robust mechanism for reducing emissions. Nevertheless, these systems have been critiqued for not fully utilizing the revenues generated from emissions trading for environmental restoration or achieving the potential scale of emission reductions.

The proposed Greenhouse Gas Permit Allowance Trading System (GHG-PATS) aims to address this problem by simplifying and unifying the existing market structure. In regions like Europe, about 24% of the revenue from carbon trading is redirected into the general budget rather than being reinvested into environmental initiatives, while in California about 65% of the revenue can be redirected into the general budget. Thus there is a significant missed opportunity to maximize the positive externalities. The GHG-PATS project aims to address these shortcomings by ensuring that 100% of the revenues from environmental derivative trading are allocated towards environmental restoration and sustainability projects. This allocation strategy is designed to optimize the utility to cost ratio, ensuring that funds are used where they can have the greatest environmental impact. At

its core, the GHG-PATS introduces a single compliance environmental derivative system that would streamline the trading of GHG emissions by using carbon dioxide equivalent (CO2e) as the standard unit for all transactions. CO2e allows different types of greenhouse gases to be compared and traded based on their global warming potential (GWP), with carbon dioxide having a GWP value of 1.0[13]. This standardization would increase market efficiency, reduce administrative costs, and make it easier for businesses and governments to participate in emissions trading, ultimately leading to more effective decarbonization. The technical innovation behind the GHG-PATS lies in its ability to "defragment" existing environmental markets. Currently, markets for carbon credits, water rights, and biodiversity offsets often operate independently, leading to missed opportunities for cross-market synergies. By expanding the fungibility of environmental assets across all major externalities, GHG-PATS would allow for the trading of both positive and negative GWP values, creating a more flexible and responsive market. This would enable entities to trade a broader range of environmental credits, such as those related to deforestation, ocean acidification, and other environmental impacts, thereby creating a holistic approach to managing climate risks.

In terms of economic impact, the GHG-PATS has the potential to significantly reduce the costs associated with climate change mitigation. A more efficient and integrated market would lower the cost of achieving emissions reductions, both for private companies and governments. According to estimates, meeting the goals of the Paris Agreement could cost between $1.6 trillion and $3.8 trillion per year globally by 2050[14]. The GHG-PATS could help reduce these costs by providing a more streamlined, market-based approach to emissions trading, making it cheaper to reduce emissions on a large scale.

Thus, the current environmental derivative markets, as they stand, are insufficient to address the global challenge of climate change. The rise in GHG emissions, coupled with the fragmentation of existing markets, highlights the need for a more efficient and integrated approach. The GHG-PATS represents a promising innovation by unifying these markets using CO2e as a common metric and expanding the scope of tradable environmental externalities. By simplifying and harmonizing the market structure, GHG-PATS could reduce the costs of climate action and accelerate the transition to a low-carbon economy.

Stage of Development

1. Establishing an environmental derivative franchise sales, trading and structuring desk would not take long (6-12 months) We have a very experienced team in this area. Collaborating with Global Capital Finance would be a natural part of a functioning desk. Each institution works around the world to ensure transactions are made at every FX rate,
    a. The work up front relating to the interconnectedness of positive and negative externalities is likely to take 6-12 months. This involves various calculations using Principal Component Analysis (PCA), Google Earth Engine, NASA’s Earth Observing System Data and Information System (EOSDID), OpenAQ, and or Climate TRACE.
    b. The PI is meeting with some global exchanges in the United States to discuss the specifics of the new futures contract that fits the market. The voluntary futures they adopted post 2020 has faced significant criticism, with the potential of greenwashing with major polluting companies buying carbon credits from smaller companies, without contributing to activities that might benefit the environment or create an offset. The exchange has their own quant staff to check the match to the 5th of a basis point (0.002%).
2. Phase I of the project is essential to moving everything forward. The cost of the research versus the economic outcome is perhaps impossible to quantify. The proposal is put forward by derivative leaders and based on environmental science. This bridge is quite difficult to build without the cooperation of both. It is logical to focus on the derivative mechanism to remediate GHGs and pollution and rejuvenate and restore the environment and biodiversity.

Key Technical Challenges

To successfully develop the GHG-PATS technology, several technical risks and barriers need to be addressed across different phases of the project.

1. **Data Accuracy and Availability**: One of the primary risks is the accuracy and availability of environmental impact data required to expand GWP values. This includes data on non-CO2 emissions, plastic pollution, and biodiversity impacts, which are crucial for recalibrating and enhancing the GWP framework. In Phase I, we aim to tackle this by partnering with environmental databases and conducting comprehensive data gathering efforts to ensure robust model development.

2. **Modeling and Computational Challenges**: The complexity of environmental systems introduces significant modeling challenges, particularly in simulating interactions between various pollutants and ecological systems. The risk here involves developing predictive models that can accurately reflect the real-world impacts of these interactions. Phase I will focus on developing initial computational models and refining these models based on preliminary testing. More sophisticated modeling techniques and additional refinements will be scheduled for Phase II, utilizing advanced machine learning algorithms to enhance prediction accuracy.

3. **Integration into Existing Market Structures**: A technical barrier is the integration of expanded GWP values into existing environmental derivatives markets. This involves not only technical integration but also compliance with market regulations and acceptance by market participants. Phase II will address this by initiating pilot projects in select markets to test the integration of the new GWP framework into real-world trading scenarios.

4. **Scalability**: The scalability of the technology to handle global environmental data and interactions on a large scale presents a significant challenge. Ensuring that the system can operate efficiently and handle large volumes of trades without compromising on speed or accuracy is critical. This will be addressed in the later stages of Phase II and beyond, focusing on optimizing system architecture and enhancing processing capabilities.

5. **Regulatory and Compliance Risks**: There are significant go/no-go risks associated with regulatory and compliance hurdles. If the expanded GWP values and the new trading mechanisms fail to align with international regulatory standards, or if they are not accepted by governing bodies, the project might not achieve its intended impact. This risk is planned to be addressed continuously throughout Phase I and II by closely working with regulatory experts and engaging in early dialogues with relevant authorities.

Each of these barriers requires careful planning and execution, with specific milestones and checks incorporated into both Phase I and Phase II to ensure that each risk is managed effectively and that the project progresses towards its goal of creating a robust and impactful environmental derivatives market (overview in **Fig 2.**).

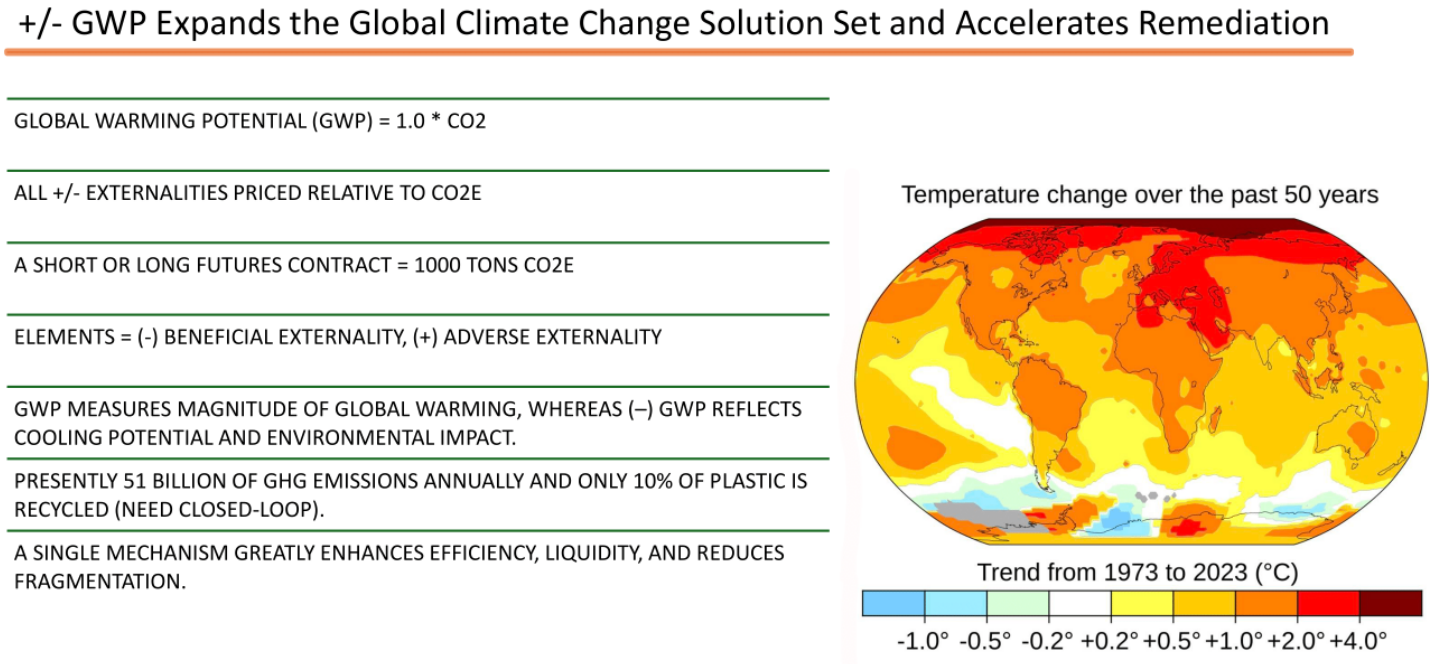

Figure 2. GHG-PATS proposed model to develop a single integrated derivative metric to address climate change.

Technical Discussion and R&D Plan

Preliminary Data

The GHG-PATS innovation centers around a modified approach to the Coase Theorem[15] (**Fig. 3**), which traditionally posits that if trade in an externality is possible and there are no transaction costs, parties will bargain to correct the market failure caused by externalities. GHG-PATS introduces a mandatory permit system that integrates both market-based and regulatory elements to address the complexities of climate change. This system utilizes calibrated and certified allowances as tradable units within a market framework that spans over-the-counter (OTC) and exchange-based transactions.

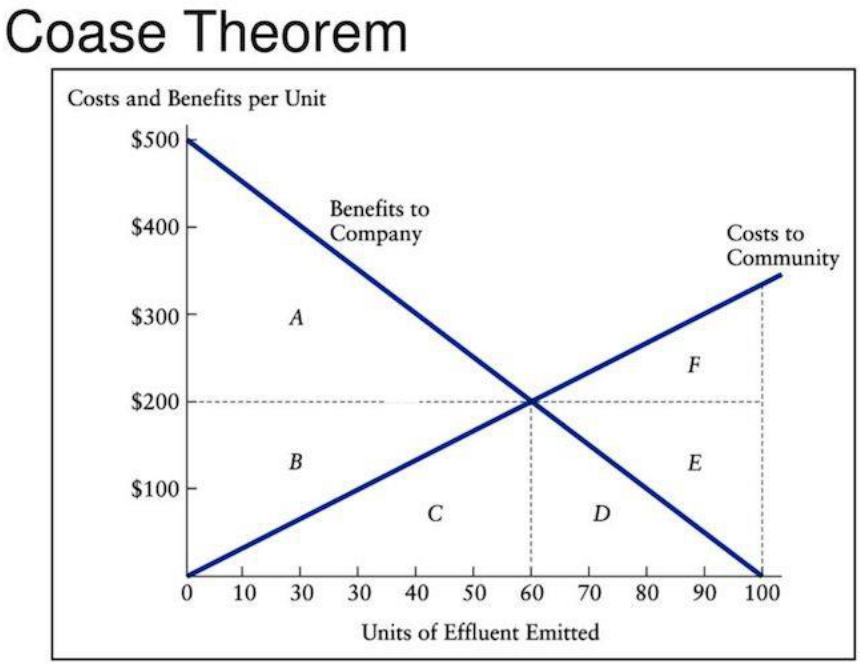

Figure 3. Overview of Coase Theorem.

The GHG-PATS could utilize this framework to establish a single market standard index, simplifying the trading process across different jurisdictions and enhancing liquidity in international capital markets. This system would be akin to the European Union Emissions Trading System (EU ETS)[16] but would potentially offer greater flexibility by incorporating both over-the-counter (OTC) and exchange-traded mechanisms. Such a design would support the phased reduction in net supply of allowances to encourage decarbonization, while simultaneously promoting technological innovations and ecosystem renewal projects that generate offsets.

Furthermore, the system's design would allow for the dynamic adjustment of allowance supply and the integration of emerging technologies and practices that prove effective in reducing GHG emissions. This could include advancements in renewable energy, carbon capture and storage technologies, and more efficient waste management practices. By providing a clear and consistent valuation of carbon emissions and their offsets, GHG-PATS would facilitate a more predictable and stable environment for investors and operators in the carbon market.

Overall, adapting the Coase Theorem in this way for GHG-PATS could dramatically improve the market's ability to contribute effectively to global decarbonization efforts, aligning financial incentives with environmental outcomes in a manner that is both economically viable and ecologically sustainable. This structured market approach ensures that environmental costs are internalized by those who pollute while rewarding entities that engage in environmentally beneficial practices, promoting a balanced and gradual transition towards a low-carbon economy.

R&D Plan

The primary goal of the Phase I project under GHG-PATS is to expand the range and applicability of Global Warming Potential (GWP) values to encompass a broader set of environmental elements. This expansion aims to enhance the efficacy and coverage of environmental derivatives markets, integrating GWP as a universal scalar for pricing derivatives that are linked to both positive and negative environmental externalities. The ultimate objective is to refine the trading mechanism such that it aligns with global efforts to reduce greenhouse gas emissions from the current 51 billion tons to a target of 10 billion tons.

Technical Objective 1: Expanding GWP Values for Diverse Environmental Factors

Rationale: Currently, GWP values, primarily calculated by groups such as the IPCC, are restricted to greenhouse gases (**Fig. 4**) and are recalibrated annually[17]. However, a multitude of other environmental factors—such as plastic pollution, ocean acidification, and biodiversity loss—also have significant impacts on global ecosystems and climate change but are not yet quantified in a comparable manner. Expanding GWP values to these elements using a common scalar will allow for a more holistic approach to environmental derivatives trading, thereby enabling a more efficient market mechanism where detrimental impacts are mitigated by funding beneficial environmental actions.

GHG	Second Assessment Report (SAR)[4]	Fourth Assessment Report (AR4)[5]	Fifth Assessment Report (AR5)[6]	
			without climate-carbon feedback	with climate-carbon feedback
CO_2	1	1	1	1
CH_4	21	25	28[b]/30[f]	34
N_2O	310	298	265	298

b: Methane
f: Fossil methane

Figure 4. 100-year GWPs published by IPCC revised every year.

Experimental Methods: Compliance environmental derivative markets only need to be defragmented and coherent to methodically achieve global environmental requirements[13]. This requires translating all negative and positive externalities to a common utility:

EUA = 1000 tons of CO2 or equivalent = 1000tCO2e,
where e = GWP scalar factor and the GWP for CO2 = 1.0

There will be no need for subjective assessments of environmental impact as market pricing will reflect the true economic price of resources. The Conference of the Parties (**COP**) sets the downward slope for annual CO2e emissions (now quantified as 56 billion tons CO2e).One objective of COP should be to employ their Subsidiary Body for Scientific and Technological Advice (**SBSTA**) and Subsidiary Body for Implementation (**SBI**) to broaden the calibration and monitoring of GHGs, Pollutants, and Biodiversity Component Risks to the utility of CO2e using (+/-) GWP factors to determine environmental debits and credits for a) Climate Change, b) Petrochemical Pollution and c) Biodiversity loss. A logical environmental permit allowance trading system:

1. Debits negative contracts (**short position**) equal to the consolidated weighted-average GWP factor to entities based on the scientifically calibrated utility of disparate pollutant emissions translated to 1000 CO2 tons.
2. Credits positive contracts (**long position**) equal to the consolidated weighted-average GWP factor to entities based on the scientifically calibrated utility of disparate pollutant offsets translated to 1000 CO2 tons.

Such an ETS is based on the fungible utility of the translated elements impacting the Triple Planetary Crisis. This is critical for economic efficiency, and logical to accelerate environmental restoration. The key mechanistic principles of operation: The key **Mechanism** elements are:

- The longstanding legal framework of "**Polluter Pays**" provides the funding source and financial incentive for entities to implement peak utility to cost solutions to increase profitability, efficiency, and productivity after embedded negative externalities clarify choices[18].
- Primary market short contract positions can be covered at the market price to permit pollutant emissions or long-term transitional closed-loop projects can be financed and hedged with OTC derivatives and futures contracts in concert with Climate Finance to lock in project IRR[19].

- Primary market long positions for offsets provide quarterly revenue with environmental futures contract expiration, ensuring utility does not fall materially short of contract credits[20].
- Primary and secondary environmental futures and OTC purchases or sales will have a variable factor applied to the notional by maturity consistent with the COP SBSTA and SBI downward slope trajectory for decarbonization.
- Long-term forecastable adverse environmental exposure would be carried below the line in Accumulated Other Comprehensive Income (**AOCI**) as unrealized losses, providing the financial incentive to aggressively minimize realized cost while avoiding income distortion in transition[19,21].
- Once all externalities are included in the market price of pollutants and offsets and progress is monitored, micromanaging resource options would be the exception.

Analysis plan: The proposed GHG-PATS project utilizes advanced data collection, computational modeling, and statistical methodologies to enhance GWP calculations, incorporating a broad range of emissions sources, including non-CO2 pollutants.

- **Data Collection**: This phase involves an extensive gathering of global environmental data, focusing on diverse pollutants like sand, land, plastics, and greenhouse gases. Data sources include high-resolution satellite imagery, environmental impact reports, and specialized databases like those provided by NASA's Earth Observing System and Google Earth Engine. The data will cover various aspects such as land use changes, pollution levels, and GHG emissions, crucial for assessing their environmental impacts accurately. We plan to utilize a combination of satellite imagery, AI algorithms, and data analytics to measure and analyze various emissions and pollutants, thereby contributing to our understanding of environmental impacts and aiding in decision-making for sustainability efforts.
- **Computational Modeling**: The project will develop sophisticated models to simulate the environmental and climatic impacts of these pollutants. These models will integrate large-scale geospatial data processed through platforms like Google Earth Engine to analyze land cover changes and their effects on GHG emissions. The aim is to accurately estimate GWP values for a range of environmental interactions, including those influenced by albedo effects, carbon sequestration, and specific land use practices.
- **Statistical Techniques**: Utilizing advanced statistical and machine learning techniques such as regression analysis, PCA, and potentially AI algorithms supported by platforms like Microsoft's AI for Earth, the project will refine GWP calculations[21,22]. These techniques will help in discerning patterns and validating the impact of various pollutants on global warming, ensuring the robustness of the GWP values.
- **Controls and Sample Sizes**: The control variables will include established GWP values of well-characterized greenhouse gases, serving as benchmarks for new measurements. Sample sizes will be carefully determined to capture the variability and distribution of pollutant data effectively, ensuring statistically significant results. This approach will be critical in establishing reliable baselines for the newly included pollutants.
- **Statistical Analysis Plan**: The data will undergo rigorous multivariate analysis to confirm the reliability and significance of the newly proposed GWP factors. This includes sensitivity analyses to test the stability of the GWP values under different environmental scenarios and controls. The plan will ensure that the new GWP factors are not only scientifically sound but also robust enough to withstand varied environmental conditions.

In particular, radiative forcing calculations are integral to understanding the impact of greenhouse gases and land use changes on global warming and will play a pivotal role in the experimental methods used to refine GWP assessments[23,24]. These calculations measure the change in energy balance within the Earth's atmosphere attributable to different environmental factors, such as greenhouse gases, aerosols, and land surface changes, which include albedo effects and carbon sequestration capacities of various land types. By quantifying how much extra energy is retained in the Earth's atmosphere due to these factors, radiative forcing provides a scientific basis for estimating the warming or cooling influences of specific gases and surface conditions. This information will be used to enhance the accuracy of GWP values for GHG-PATS, enabling more precise and effective pricing of carbon credits in the derivatives market. Understanding the interplay between land characteristics—like the heat absorption of dark soils or the reflective properties of sandy areas—and atmospheric changes enables more robust and dynamic modeling of climate impacts, essential for the project's goal to implement a scientifically grounded, market-based approach to carbon emission reduction.

Expected Results and Alternative Approaches: Establishment of validated GWP values for a range of environmental impacts not previously quantified, ready for implementation in market trading systems.

If initial models fail to provide clear insights, alternative approaches like deep learning algorithms for pattern recognition and predictive modeling will be employed. These methods are particularly useful in handling complex and non-linear data typical of environmental studies.

Milestones

- **M1**: Data Acquisition Complete - Month 2
- **M2**: Initial Model Development - Month 4
- **M3**: Preliminary Testing and Refinement of GWP Factors - Month 5
- **M4**: Final Validation and Report Preparation - Month 6

Timeline: The GHG-PATS project is geared towards transitioning from an initial 6-month Phase I development (**Fig. 5**) into Phase II, focusing on the enhancement of the business and trading models. This progression comes at a critical time as the effectiveness of voluntary carbon markets has been under scrutiny since 2020. These markets have faced challenges such as low trading volumes and inadequate incentives for companies to genuinely reduce their carbon footprints, often resulting in superficial commitments to sustainability—commonly referred to as greenwashing. For Phase II, GHG-PATS plans to expand and refine the system by incorporating a broader range of environmental externalities and improving the market structure to incentivize real, measurable environmental improvements. This phase will focus on enhancing the trading platform's ability to support dynamic and effective environmental governance, moving beyond mere compliance to foster genuine ecological restoration and innovation in greenhouse gas management.

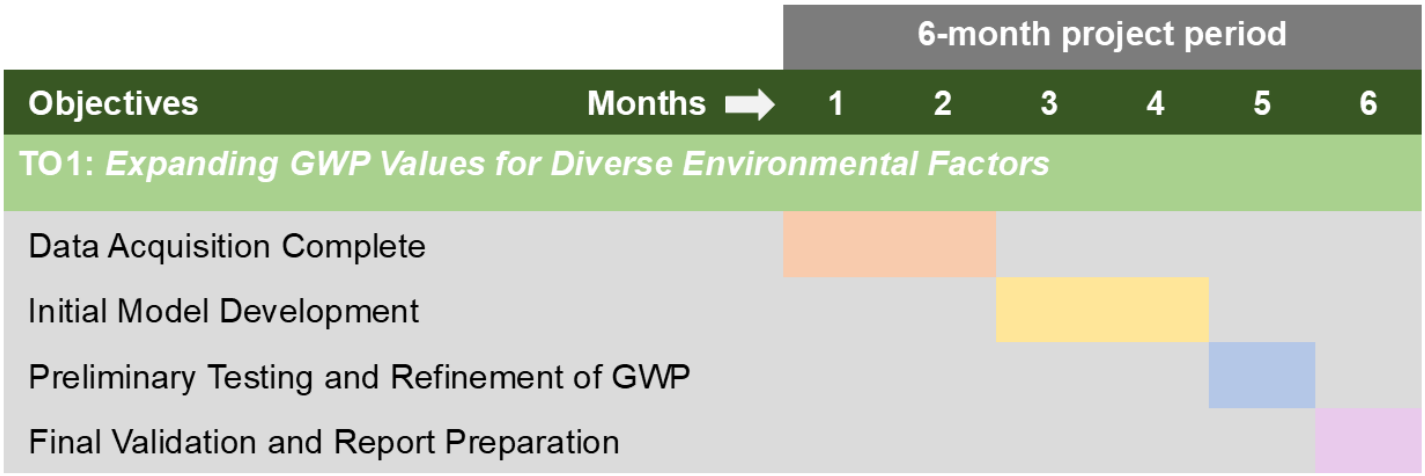

Figure 5. Anticipated timeline of GHG-PATS Phase I SBIR project.

Company/Team

GHG-PATS was founded to address the urgent need for a unified, compliance-driven emissions trading system (ETS) capable of tackling the global Triple Planetary Crisis: Climate Change, Petrochemical Pollution, and Biodiversity Loss. The company is headquartered in [location], with a mission to create a single environmental derivative framework that leverages compliance ETS structures as defined under Article 6 of the Paris Agreement. GHG-PATS has rapidly gained traction among international stakeholders in climate finance and sustainable development, advocating for a transparent, economically efficient trading system that connects environmental externalities directly with market dynamics. The company is currently advancing Phase I, aimed at expanding Global Warming Potential (GWP) metrics and validating the efficacy of a universal compliance trading framework.

Team: Leading GHG-PATS is CEO Anthony Hamer, a seasoned financial markets expert with deep expertise in global capital markets. A former Managing Director at JP Morgan Chase and Bank of America, he brings significant experience in interest rate derivatives and proprietary trading to GHG-PATS. His work aligns closely with climate finance mechanisms, guiding the company's strategic vision to establish a unified environmental market. His background in finance and derivatives trading is essential in structuring the GHG-PATS framework to handle diverse market risks and variations.

Frank Tarulli is the company's Senior Structuring and Pricing for Securities, specializing in derivative pricing and environmental metrics, with expertise in GWP calibrations critical to Phase I. Mr. Frank Tarulli has extensive experience in international capital market trading, portfolio risk management, structured transactions, derivative sales, and accounting policies. During his thirty-two years at JP Morgan Chase & Co., Frank held positions as Executive Director of Foreign Exchange Derivative Trading, Non-Dollar Derivative Structuring Specialist, Latin American Derivative Trader, Fixed Income Derivative Salesperson, Controller of Capital Markets Group and Accounting Policies and Procedures Specialist focusing on Capital Markets and Treasury products. Prior to joining JP Morgan Chase & Co., Frank worked as a Certified Public Accountant (CPA) for four years in the financial audit area. Mr. Tarulli holds a BBA degree in accounting and an MBA in corporate finance from Baruch College. Frank is a CPA in New York state and has held several securities licenses including the Series 7 and 63.

The team will continue to collaborate with Global Climate Finance (GCF) and international market regulators, ensuring the system aligns with legal frameworks and is ready for phased implementation. Their combined experience in environmental finance and market regulation is crucial for commercializing GHG-PATS, ensuring it meets both scientific rigor and regulatory standards in preparation for broader market adoption.

GHG-PATS will also continue to work with RiskSpan, a technology firm that provides cloud-native analytics and data management solutions tailored for structured finance investments, loans, and mortgage servicing rights. They offer a comprehensive suite of tools that integrates asset and market data with proprietary models and analytics, facilitating efficient management and analysis for investors and risk managers. RiskSpan's platform is designed to support a broad array of asset types, helping clients navigate and optimize loan and private credit data, credit loss accounting, and climate risk assessments, among other financial complexities.

Vision: GHG-PATS aims to redefine global environmental finance by establishing a compliant, unified emissions trading system, positioning itself as the first comprehensive trading structure to integrate climate, pollution, and biodiversity impacts. Over the next five years, the company envisions a major global footprint in both compliance and over-the-counter (OTC) environmental markets. GHG-PATS plans to scale its infrastructure, enabling the seamless integration of additional environmental metrics, such as petrochemical pollutants and ecosystem services, into its trading system. As environmental crises evolve, the company will continue refining its ETS platform to address emerging issues, leveraging cutting-edge technology and real-time data analysis.

The anticipated impact over the next five years includes substantial contributions to reducing GHG emissions and mitigating pollution while supporting ecosystem preservation. GHG-PATS aims to stimulate sustainable practices across industries and nations, contributing to the development of a thriving, low-carbon economy and fostering international collaboration on environmental remediation. With structured partnerships and a focus on scalable technology, GHG-PATS is set to drive substantial environmental and economic benefits, supporting sustainable development goals globally.

Role of SBIR/STTR Project in Existing Activities

GHG-PATS takes a lean startup model approach to building this derivative product: we build a minimum viable product (MVP) and bring it to market to both drive early revenue and to get early feedback from the market about what does and doesn't work, and – most importantly -- what they want next. Because of this approach, we will be able to bring a product to market with this SBIR grant alone. **This SBIR grant allows us to immediately scale our R&D efforts from data collection to data analysis and data-derived solution productization.**

Broader Impacts

The motivation for this project arises from the pressing need to streamline and optimize environmental markets to effectively tackle global climate crises, especially as current systems remain fragmented and inefficient. Given the Triple Planetary Crises—climate change, biodiversity loss, and pollution—it's clear that existing environmental markets, while well-intentioned, lack the cohesive framework needed to yield meaningful impact on a global scale. By focusing on the extension of Global Warming Potential (GWP) valuations to a wider set of ecological factors, this project aims to establish a single, integrated environmental derivative market to address these crises. The anticipated outcome is a standardized, compliance-driven market for trading environmental assets, which will support various industries in mitigating environmental risks more efficiently while creating robust incentives for governments and private entities to adopt sustainable practices.

This project has broad potential to enhance both societal welfare and economic stability. By creating a unified GHG Permit Allowance Trading System (GHG-PATS), the framework aims to accelerate decarbonization efforts, ultimately benefiting communities affected by pollution, climate instability, and resource scarcity. In the U.S., regions vulnerable to extreme weather and those reliant on agriculture could see the positive impacts first, as more effective emissions reductions reduce climate-related damages. Economic benefits would be measurable within a decade, marked by reduced costs in disaster recovery, improved health outcomes, and bolstering local economies through sustainable industry practices. Tracking metrics include reductions in GHG emissions, biodiversity preservation, waste reduction, and ecosystem restoration, using benchmarks aligned with international standards and monitored in collaboration with environmental agencies and financial institutions. Remediating the Triple Planetary Crises yields more profitable and productive global resource allocation and grows rather than shrinks the $100 trillion global economy.

To minimize unintended consequences, the project will adopt a rigorous, phased approach, ensuring that each step is validated against potential economic, social, and ecological risks. By leveraging a single, transparent environmental derivative market, it aims to avoid disruptions in industries and communities, ensuring a balanced transition where industries can adapt gradually and affordably. Furthermore, the system encourages collaboration between governments, industries, and innovators, establishing safeguards to prevent inequities in market access or undue burden on low-income communities. The phased rollout, beginning with pilot testing of GWP metrics, will enable feedback loops to address any emerging issues, setting the stage for a responsible and sustainable global response to environmental degradation.

Commercialization Potential

Market/Addressable Market

The EU (EEX) raised 317.2 euros in their environmental tax in 2022 (compliance scheme). In the US the revenue was a fraction. The EU EEX is part of the way toward getting it right, so the addressable market would be more than double that figure. Environmental revenue must be understood to be distinct from profit. Derivatives trade in trillions with only a basis point (0.01%) for profit. There is less than a basis point (>0.01%) profit in futures. The objective is to circulate environmental revenue toward restoration, rejuvenation, and preservation. The net profit of the market could be estimated at about $400-600 million, distributed within global capital markets, plus revenue from Global Climate Finance. The technology embodied by GHG-PATS is that it is a private solution that involves private channels regularly used for managing global business risk. All infrastructure already exists to quantify, manage, hedge, collateralize, and finance environmental exposure. From a polluter end user standpoint, Other Consolidate Income (OCI) treatment with Global Climate Finance enable the polluter to make the transition from a commodity company to a technology company in the best way possible.

GHG-PATS is positioned within the global environmental markets sector, specifically targeting the multi-trillion-dollar carbon markets and emerging environmental derivative segments. The total addressable market includes compliance-based emissions trading systems (ETS), voluntary carbon markets, and the rapidly growing offset market for environmental services like biodiversity and ecosystem restoration. According to recent market analyses, the global carbon market is expected to reach approximately $100 billion by 2030, with high growth rates projected due to increasing regulatory pressure and the urgency of addressing climate change. Compliance ETS and associated markets are growing rapidly, driven by international climate agreements like the Paris Agreement and new regulatory frameworks in major economies, including the EU and China, that require stricter emissions reductions.

External factors driving this market growth include rising GHG emissions, widespread ecological degradation, and the resulting regulatory push to curb these issues. Heightened awareness of petrochemical pollution and biodiversity loss further compounds this need, expanding the demand for an effective and integrated compliance ETS. The limitations of current products and systems, however, are apparent: traditional carbon markets are fragmented, suffer from price volatility, and often fail to address a broader array of pollutants and ecological risks beyond GHG emissions alone.

GHG-PATS aims to address these limitations by introducing a single compliance environmental derivative mechanism capable of integrating GHG, plastic, and biodiversity impacts into one market structure. Using scientifically validated Global Warming Potential (GWP) factors, GHG-PATS expands market functionality by creating fungible offsets for both positive and negative externalities, thereby increasing market liquidity and reliability. This solution offers a unique ability to comprehensively internalize and monetize environmental impacts, making it ideally positioned to capture significant market share within the carbon and environmental derivative markets.

Validation of Market

GHG-PATS has validated its market position and potential through several key indicators. First, substantial interest has been expressed by international institutions, such as those involved in global capital markets, eager to implement a functional compliance ETS. These institutions recognize the benefits of a unified trading system that streamlines disparate environmental markets into a single, effective mechanism. Second, rising demand within both compliance and voluntary carbon markets, along with feedback from key stakeholders, supports the need for a more integrated and scalable market solution, with GHG-PATS directly addressing these concerns by incorporating additional environmental elements like biodiversity loss and plastic pollution.

Third, positive feedback from leaders in sustainable finance and climate policy, along with collaborative efforts with global entities, underlines GHG-PATS's value proposition. Endorsement from climate finance organizations highlight the importance of GHG-PATS's market innovation, particularly for transitioning industries and nations with high ecological footprints and the need for such a product. Additionally, similar technologies and ETS mechanisms developed internationally—such as the EU's Emissions Trading System—demonstrate market growth and an increasingly receptive regulatory landscape for unified compliance systems, further validating the opportunity for GHG-PATS's solution in the market.

Business Model

The GHG-PATS system aims to revolutionize the environmental derivatives market by incorporating a more comprehensive and scientifically validated set of GWP values into financial instruments. With Anthony Hamer's experience at J.P. Morgan Chase and his deep understanding of global capital markets, GHG-PATS is poised to integrate its advanced environmental derivatives into mainstream financial platforms, leveraging existing infrastructures within these institutions.

GHG-PATS plans to operate primarily through partnerships with major financial institutions, such as Chase Bank, to utilize their extensive networks and established market presence. The business model involves developing and providing the framework for trading environmental derivatives that are tied to the expanded set of GWP values. This framework will be integrated into the existing trading and risk management systems of these financial institutions.

Partnering Strategy: The partnership strategy is critical, given the complexities of regulatory processes and the need for widespread market acceptance. GHG-PATS would provide the technical backbone—the environmental derivative products—while the partner institutions like Chase would handle market access, customer relations, and compliance. This collaboration ensures that the innovative financial products designed by GHG-PATS gain traction and legitimacy in highly regulated financial markets.

Infrastructure and Expertise: GHG-PATS would leverage the existing infrastructure of its partners, which already have the capabilities for handling complex financial products. Any necessary changes or enhancements to the infrastructure, such as integrating specific environmental data tracking or expanding derivative processing capabilities, would be managed collaboratively with the partner institutions. The GHG-PATS team brings expertise in environmental science, financial product development, and regulatory compliance, ensuring that all aspects of product integration are covered efficiently.

Proof of Concept and Market Entry: The initial proof of concept will demonstrate how the redefined GWP values can be effectively used in derivative risk management. Following successful validation, the model involves engaging with any interested financial dealers to set up operations that incorporate these new derivatives, moving beyond traditional models towards a more integrated approach to environmental financial products.

Regulatory Considerations: Given the innovative nature of these derivatives, navigating the regulatory landscape is pivotal. GHG-PATS and its partners will work closely with financial regulators to ensure that the new products comply with existing financial regulations and contribute positively to environmental goals. This collaborative approach not only facilitates smoother market entry but also supports ongoing adjustments to regulatory frameworks that accommodate new types of environmental risk management tools.

In conclusion, the GHG-PATS business model is built on strong partnerships with major financial players, leveraging existing market structures and expertise, while introducing innovative environmental financial instruments to drive global sustainability goals.

Competition

Current approaches in the environmental derivatives market primarily revolve around existing carbon trading schemes such as the EU ETS and the Regional Greenhouse Gas Initiative (RGGI) in the United States. These systems allow companies to buy or sell emissions allowances as a means to comply with caps on the total amount of greenhouse gases they are allowed to emit. While these systems have been pioneering in incentivizing reductions in greenhouse gas emissions, they possess inherent limitations. Notably, they typically cover only a subset of emissions sources and types of greenhouse gases, and they operate within regional, rather than global, frameworks. This leads to a fragmented market approach, limited scalability, and potential leakage where emissions are simply relocated rather than reduced.

The GHG-PATS system aims to overcome these limitations by offering a globally integrated, comprehensive trading system that includes a wider range of environmental impacts beyond traditional greenhouse gases, such as biodiversity loss and petrochemical pollution. By expanding Global Warming Potential (GWP) values to include these impacts, GHG-PATS provides a more holistic and scientifically grounded basis for environmental derivatives. This approach not only addresses the fragmentation seen in current systems but also enhances the financial viability of investing in environmental outcomes. *The competitive advantage of GHG-PATS lies in its ability to provide a standardized, global market that simplifies transactions and increases transparency, thereby attracting a broader range of investors and stakeholders interested in genuine environmental improvements.*

Key Market Risks

One important objective in establishing a single, well-functioning, compliance environmental market is to enable companies to easily manage their environmental risk just as they manage all other corporate risks. The more fragmented derivative markets become, the less valuable and reliable they become as risk hedging vehicles. The downward slope of net CO2e supply would make the price unstable without a compliance market that incentivizes technological and process innovations in reducing GHGs and petrochemical pollutants and increases the available supply of long CO2 contracts from global ecosystem restoration and rejuvenation. Long-term forecastable adverse environmental exposure would be carried below the line in Accumulated Other Comprehensive Income(AOCI) as unrealized losses, providing the financial incentive to aggressively minimize realized cost while avoiding income distortion in transition. Transitional closed-loop projects undertaken to improve efficiency, productivity and profitability that reduce emissions and pollutants can be financed through GCF and hedged using OTC environmental derivatives. **This quantifies expected environmental exposure, while Value at Risk (VaR) models and Monte Carlo simulations provide short- and long-term exposure ranges, avoiding the subjective nature of ESG and VCM.**

Commercialization Approach

GHG-PATS intends to adopt a phased commercialization approach to maximize market impact and ensure scalability within the rapidly expanding global environmental markets. Initially, GHG-PATS plans to commercialize its environmental derivatives independently, leveraging the team's extensive experience in international capital markets and regulatory compliance. CEO Anthony Hamer brings considerable expertise from his tenure as Managing Director in interest rate derivative trading at JP Morgan Chase, which is invaluable in structuring and launching the GHG-PATS framework. The company also collaborates closely with entities specializing in climate finance and environmental policy, establishing a strong foundation for market entry.

As the product gains market traction, GHG-PATS will consider strategic partnerships with established exchanges and capital market institutions, such as the New York Stock Exchange (NYSE) or other major global financial exchanges, to enhance market liquidity and access. These partnerships are anticipated post-Phase I validation, enabling GHG-PATS to leverage existing financial infrastructures to scale trading activities and reach diverse global end-users. The partners, with proven expertise in financial product management and deep market knowledge, would support GHG-PATS in expanding its market reach and facilitating seamless global compliance integration.

Economic benefit: The GHG-PATS system provides substantial economic benefits by creating a stable and scalable compliance mechanism for addressing environmental externalities. By incentivizing both polluters and offsetters through a transparent, single-market structure, GHG-PATS enhances resource allocation efficiency, reduces pollution, and promotes biodiversity preservation. This efficient market structure not only encourages corporate and governmental compliance but also generates significant revenue from environmental offsets and restoration activities. It will promote long-term, sustainable practices that contribute to economic resilience, while also reducing the volatility and price instability prevalent in fragmented carbon markets today.

GHG-PATS expected revenue prediction based on developing this financial derivative product and implementing it broadly are outlined below (**Fig. 6**).

2026	2027	2028	2029	2030
$ 375,000	$ 750,000	$ 5,250,000	$ 8,500,000	$ 14,500,000

Figure 6. GHG-PATS anticipated revenue post execution of this grant.

Intellectual Property

GHG-PATS does not plan to protect this innovation with a patent. Unlike other products, it is not in the interest of developers of derivative contracts to hold patents. On the contrary, the interest is in promulgating the idea to spread interest broadly. Additionally, it is not currently possible to patent or intellectually protect derivative contracts as they are considered financial instruments, not inventions or original works of authorship like a book or software. This would be the case for an environmental derivative. *The massive volume ensures profitability in the general case. A proprietary derivative would find adoption difficult, undermining the goal.*

Resources Required to Bring Technology to Market

After this NSF SBIR Phase I project, the system integration and pilot testing will be funded by a combination of NSF SBIR Phase II grants and potential venture capital, aimed at integrating the new GWP values into the trading platform and conducting controlled environment tests. This phase is crucial for preparing the system for real-world application and regulatory scrutiny, which is expected to require additional funding from venture capital and strategic partnerships with established financial institutions like Chase Bank. As we progress towards commercial launch, the focus will shift towards obtaining necessary regulatory approvals, ramping up marketing efforts, and preparing for global market entry, necessitating an estimated $750,000 for commercial launch activities followed by $2 million for scaling and expansion. The financial strategy includes leveraging revenue from early pilot programs and pursuing Series A and B funding rounds to support these later stages. The leadership team's expertise in finance and their extensive network, including connections to key venture capital firms and strategic partners in the environmental and financial sectors, are instrumental in navigating the funding landscape. This comprehensive approach ensures that GHG-PATS is well-positioned to transition from a promising technology into a viable commercial product that addresses the pressing needs of the environmental derivatives market.

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