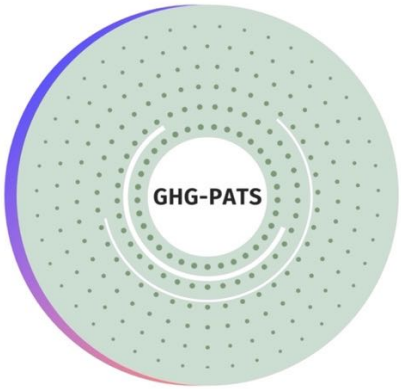
Greenhouse Gas (GHG) -
Permit Allowance Trading System (PATS)

GHG-PATS, INC



United Nations Climate Change

Article 6.4 Mechanism to
Accelerate Decarbonization,
And Mitigate Plastic Pollution,
To Fund Rejuvenation and Renewal of
Global Ecosystems to Stem Loss of Biodiversity

Remediate Triple Planetary Crisis
Through a Single Standardized Utility
Compliance Environmental Derivative Contract

Tony S. Hamer, May 22, 2023

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Mission Statement

A mechanism to accelerate the reduction of Green House Gas emissions methodically and with certitude by driving efficient economic resource allocations through internalizing both negative and positive externalities materially impacting climate change.

This expands the scientifically calibrated decarbonization solutions to the wealth of ***Greenhouse Gas*** *("****GHG****") emission reduction innovations and technologies in equal merit to funding the rejuvenation of global ecosystems and restoring rain forests; protecting marine mammals, biodiversity, and nature preserves; removing and enzymatically biodegrading plastics from the oceans and landfills; reversing oceanic acidification and stratification; and remediating the aridification of populous lands.*

This will be achieved by the introduction and proliferation of a standardized utility compliance environmental contract designed to enable participants to effectively hedge and manage ***GHG emittance and offsets*** *while operating on a sustainable financial basis providing profitable growth and increasing value for all stakeholders.*

Executive Summary

There will be tens of thousands of solutions to reduce **GHG** emissions and increase offsets, suggesting the **Paris Agreement needs a systematic environmental pricing mechanism** to methodically approach optimal resource allocation and decarbonization in a $100 trillion global economy.

The Greenhouse Gas Permit Allowance Trading System ("**GHG-PATS**") has corrected the conceptual errors and design flaws critical to internalizing GHG externality pricing, with a compliance derivative pricing and hedging mechanism working with **Global Sustainable Finance** ("**GSF**") to rapidly decarbonize methodically based on peak utility to cost solutions

Existing emission trading schemes and compliance carbon taxes lower GHG levels, but the revenue from such initiates goes to governments, and 80% or less of the revenue is directed to subjective environmental programs which may not provide peak utility to cost efficiencies. The carbon tax itself discourages adoption by major multinationals that can hasten decarbonization.

Current voluntary environmental financial exchange markets are fragmented, fractured, regional, conceptually flawed, and ill-designed. Certified GHG offsets have a 95% discount to the global market price of GHGs, amounting to **ESG-**style virtue signaling, without the scale, market liquidity or efficient flow of funds necessary to reduce GHG emissions materially.

Climate change stems from pollution freeloaders not yet incented to cooperate for sustainability. If environmental markets as presently constituted could have attenuated climate change, they would have by now. But the National Oceanic and Atmospheric Administration's ("NOAA") Annual Greenhouse Gas Index has increased 40% since 1990.

The **Greenhouse Gas Permit Allowance Trading System** ("**GHG-PATS**") has corrected the conceptual errors and design flaws critical to internalizing GHG externality pricing, with a compliance derivative pricing and hedging mechanism working with **Global Sustainable Finance** ("**GSF**") to rapidly decarbonize methodically based on peak utility to cost solutions.

Allowance = **1,000 tons** ("**t**") of **carbon dioxide** ("**CO2**")

equivalent ('**e**") = **100-Year Global Warming Potential** ("**GWP**") **factor**

CO2 GWP factor = 1.0

GHG Permit Allowance = **1000tCO2e debit for negative externality, credit for equal utility positive externality**

GWP factors expanded and assigned to disparate industrial, commercial, petrochemical pollution (e.g., plastics in oceans, lakes, landfills, etc.), natural resources (trees, whales, phytoplankton, etc.), and global ecosystems.

The compliance Permit Allowance covers all material first and second order negative and positive externalities for human activities materially impacting climate change. GHG-PATS does not bifurcate certified GHG Permit Allowances and certified GHG offsets defined to be of equal utility.

Global Sustainable Finance ("**GSF**") would finance **long primary market positions** in **Permit Allowances** with additional capital for modernization and transition to incentivize early adoption (reducing **GHG emissions expense and cost of carry**), while funding permanent natural and technological offsets to expand the optimal mix of responses to avert climate change.

The GHG Permit Allowance Trading System ("**GHG-PATS**") hedging infrastructure coupled with **Global Sustainable Finance ("GSF")** is accessible to all nations and industries. **GSF** finances primary market **Permit Allowances** over long maturities for GHG emitters to extinguish the debt before it is due, funding both GHG offsets and GHG emission reductions.

The revenue from GHG emission allowances (negative externalities) drive the most efficient, high productivity, circular, closed loop industrial processes, technological innovations, and ecosystem preservation and rejuvenation, to enhance economic efficiency and environmental conditions to achieve net zero carbon and beyond with certitude, using the highest utility to cost solutions.

Efficient closed-loop industrial processes, research and innovation in biosciences, advanced technology and productivity, and costs avoided from calamitous global warming unimpeded (loss of biodiversity, droughts, floods, famines, pollution, rising sea levels, etc.) are the dividends from the methodical investment in sustainability and modernization.

GHG-PATS and **GSF** will avoid the worst disasters of climate change to come, modernizing industrial processes to elevate efficiency and productivity, enzymatically biodegrade plastics in the oceans and landfills, chemically recycle plastics at the molecular level without degradation, and revitalize nature to protect and restore life on Earth.

This generation can and must engineer a paradigm shift in the global economy based on investment, technology, innovation, restoration, and efficiency.

A Paris Agreement mechanism to systematically internalize negative and positive externalities impacting climate change through a single global environmental market in fungible **GHG Permit Allowances** and offsets - combined with **Global Sustainable Finance** - creates an internationally accessible flow of investment funds to methodically guide resource allocation and industrial processes to peak efficiency.

Problem – Current Emissions Trading Systems Must Evolve

Voluntary Carbon Markets ("VCM"), carbon taxes, and compliance emission trading markets have been around since the early 1990s, but GHG concentrations in the oceans, land, and atmosphere have only become worse. These systems are not only conceptually flawed, but inelegantly designed to be complex, fractured, and exclusive.

Voluntary Carbon Markets have existed for decades, based on the **1991 Nobel Prize winning Coase Theorem,**[1] the legal and economic framework for idealized conflict resolution in a case of conflicting property rights stemming from a negative externality. [**See Appendix C**]. **Voluntary Carbon Markets** ("**VCM**") are conceptually flawed, as they lack the pre-conditions for successful application to global markets. They have empirically been proven not to work for decades.

Cap and Trade and ETS compliance markets do limit **GHG emissions**, but fail to maximize natural preservation and rejuvenation, technological or other innovations to foster **GHG offsets**. Revenue is absorbed into government budgets with set asides for specific environmental projects. The breadth of factors impacting climate change are not scientifically calibrated and integrated, limiting the wealth of benefits from decarbonization.

GHG emission externalities are not consistently or precisely internalized; and cashflow from adverse GHG externalities does not fluidly and dynamically fund peak utility-to-cost GHG offsets for expanded GHG capacity to allow gross emissions to decline or grow against the net cap,

[1] Dr. Ronald H. Coase, University of Chicago, Professor of Economics, Editor of *The Journal of Law and Economics,* (1964-82), Author of *The Nature of the Firm* (1937) and *The Problem of the Social Cost* (1960)

limiting economic growth in order to ensure net GHG emissions decline along a scheduled timeline with certitude.

Yet, in September 2020, the **Task Force on Scaling Voluntary Carbon Markets** ("**TSVCM**") and the **Voluntary Carbon Markets Integrity Initiative** ("**VCMI**") were launched to scale carbon markets in support of **The Paris Agreement**.

Voluntary markets are fragmented, regional, and lack the elegance of a methodical, holistic, theoretically sound, single fungible contract design with embedded scientific calibrations of utility and targets to reach a pro-climate, pro-business objective with certitude.

The National Oceanic and Atmospheric Administration's ("**NOAA**") Annual Greenhouse Gas ("**GHG**") Index has increased over 40% from 1990 to 2022 despite modest declines in carbon dioxide, methane, and nitrous oxide. This is due to the 90% increase in the **100-year Global Warming Potential** ("**GWP"**) weighted fluorinated gases ("**F-gases**"), specifically due to the 284% increase in emissions of **hydrofluorocarbons** since 1990, as a substitute for ozone depleting substances.

The HFCs are released through the leakage[2] of refrigerants used in vehicle air-conditioning systems and have an extremely high GWP factor weight. But dysfunctional environmental markets lack a methodical Paris Agreement mechanism to remediate the issue effectively.

This underscores the necessity of **measuring GHG**, **calibrating GWPs**, and **permitting GHG emissions** using systems such as Climate TRACE, while **certifying GHG offsets systematically**, modifying the underlying

[2] Leakage can be reduced through better system components and alternative refrigerants with lower global warming potentials than those presently used.

law and economics Coase Theorem used to establish voluntary GHG markets decades ago.

The complexity of remediating climate change and the short timeframe for meaningful action require a conceptual adaption of the Coase Theorem for its application to climate change remediation.

The compliance and voluntary environmental markets, as presently constituted, would have worked if it could have worked by now. Yet the problem has accelerated instead.

Climate change stems from pollution freeloaders not yet incented to cooperate for sustainability, with the implemented solutions far too fractured and fragmented to be useful.

Solution: Greenhouse Gas - Permit Allowance Trading System

GHG-PATS Evolutionary Theoretical Foundation

The way to instill order in the unworkable chaos of present day fragmented, fractured environmental financial markets is through sophisticated designed simplicity.

A **GHG-PATS Permit Allowance contract**[3] is an exchange traded **global compliance derivative contract** designed for certified GHG offsets to be fungible with, and be funded by, certified GHG Permit Allowances, eliminating the gap in market pricing between two identical activities of equal utility[4].

Permit Allowance contracts fund the technological innovation and ecosystem preservation and rejuvenation to achieve net zero carbon and beyond using the **highest utility to cost solutions**. A single global environmental market in **GHG-PATS** over the counter ("**OTC**") derivatives and exchanges, cover all negative and positive externalities in all activities materially impacting climate change around the world.

The scientifically calibrated, internationally recognized, **100-Year Global Warming Potential** ("**GWP**") factors are applied to the applicable GHG emitted or offset as a utility curve for internalizing both positive and negative externalities (as per **modified Coase Theorem**) for systematic, efficient, high productivity global resource reallocation.

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[3] 1 GHG-PATS Permit Allowance Contract = 1,000 tons (t) of carbon dioxide ("CO2") or equivalent ("e") = 1,000 tCO2e

[4] The utility of a GHG emission or offset is equated to Permit Allowance contracts by multiplying the tonnage of GHG by the relevant scientifically calculated 100-Year Global Warming Potential ("**GWP**") and dividing by 1000

GHG-PATS is a fully conceived compliance permit allowance trading system based on a sound conceptual foundation – internalizing both positive and negative externalities involved to decarbonize methodically with peak utility to cost using market-based solutions, driving the underlying economics of global resource allocation to:

1. Engineering higher productivity, zero waste, closed loop industrial processes
2. Transforming planet waste into valuable products
3. Rejuvenating global ecosystems and mitigating before remediating the carbonization of oceans, lands, and the climate
4. Reversing aridification and the loss of biodiversity
5. Mitigating and remediating decarbonization leading to floods, draughts, hurricanes, and other extreme and destructive weather

GHG-PATS is not a tax scheme, but a direct means to fund the innovation, technology, nature preservation and global ecosystem rejuvenation by internalizing both the positive and negative externalities impacting climate change.

The negative and positive externalities impacting climate change are methodically and scientifically calibrated and internalized through the purchase of certified **GHG Permit Allowance** contracts or the sale of **certified GHG offsets**, with **a flexible market-based price cost curve with long-term primary market financing through Global Sustainable Finance,** elevating the highest utility to cost solutions to meet Paris Agreement pledges without an onerous burden.

In fact, all nations, industries, and entities benefit from the **Global Sustainable Finance** mechanism in the primary markets to realize high productivity investments and monetization of assets, resulting in elevated standards of living, better health, a stronger economy, and the restoration of the planet to a far more pristine and sustainable condition.

This disabuses the popular notion that addressing climate change must come at the expense of economic and population growth and standards of living. The systematic enhancements of efficiency, productivity, biodiversity, and the environment are a paradigm shift resulting from a methodical plan to internalize externalities using precise utilities and market pricing – for a paradigm shift in more efficient global resource allocations.

GHG-PATS Benefits

Both the **Coase Theorem** (**Appendix C**) and the **Ostrom Theory** (**Appendix D**) shed critical light on the path forward to implementing an effective supplemental **Paris Agreement mechanism** to:

1. **decarbonize** the oceans, land, and atmosphere to remediate climate change along a specific path with certitude
2. **rejuvenate** global ecosystems
3. **preserve** nature and biodiversity
4. **grow** the economy, enhance productivity, and protect populations
5. **fund** low and high-tech innovation
6. **build circular, closed loop, zero-waste industrial processes**
7. **finance** biotechnology processes to quickly biodegrade plastics in oceans and landfills, and convert GHG to inert gases
8. **transform** waste to valuable products

The Sophistication of Simplicity

Solutions to solving climate change are fragmented, regional, and lack the elegance of a methodical, holistic, theoretically sound, single fungible contract design with embedded scientific calibrations of utility and targets to reach a pro-climate, pro-business objective with certitude.

GHG-PATS started with a sound conceptual foundation – internalizing both positive and negative externalities involved in climate change to decarbonize methodically with peak utility to cost.

As mentioned, voluntary carbon markets and cap and trade have been around since the early 1990s, but GHG concentrations in the oceans, land, and atmosphere have only become worse. They are not only conceptually flawed, but inelegantly designed to be complex, fractured, and exclusive. Meanwhile **GHG-PATS** can be calibrated to cover activities in the oceans, land, and climate to govern the commons[5] to improve resources and habitats, not enforce a dystopian scarcity through a lack of innovation.

It is profound to note that implementing a mechanism that internalizes the negative and positive externalities impacting climate change also works to eliminate plastic waste in oceans and landfills, protect marine mammals such as whales that feed the ocean's phytoplankton supplying 70% of the Earth's oxygen, improve health and living standards by rejuvenating global ecosystems, and protect biodiversity.

The circular, closed loop, high productivity, industrial processes, enhanced environmental conditions, and technological innovations from vastly improved global resource allocation and transparency will be a paradigm shift in efficiency and human civilization.

[5] A common is a public resource

Modified Coase Theorem

However, a modified **Coase Theorem** with relaxed constraints would comport with the **Ostrom Theory (Appendix D)** modified to scale to address global commons – a market-based methodical access to the atmosphere, oceans, and land with a predetermined net decarbonization trajectory - cascading from 51 billion tons of CO2 emissions or equivalent ("**GWP-weighted**") **GHG** to zero[6], and past modern carbonization and degradation of the environment.

Some leaders of nations, industries and companies believe win-win Pareto-optimality is either impossible or improbable, that it will be too costly to avert the foreseeable dystopian future. They will support the status quo as they will likely not be amongst the dispossessed, or those lost to famine, war, drought, hurricanes, or other foreseeable climate change related losses. But such odious and myopic thinking is erroneous.

Most experts have resigned themselves to a dystopian sustainable planet with lower growth, depopulation, etc. Yet, the tremendous investment ($100 trillion plus) in high productivity, zero-waste industrial processes and rejuvenated global ecosystems will create an abundance of prosperity, improve health and welfare, and solve the climate crisis.

GHG-PATS can leapfrog the fragmented regional approaches, and contentious negotiations and systematically reprice and elevate the highest utility-to-cost GHG emissions to GHG offsets - to further economic growth with higher standards of living if the latter negates the former on schedule. The market pricing function to internalize negative and positive externalities ensures this is the case.

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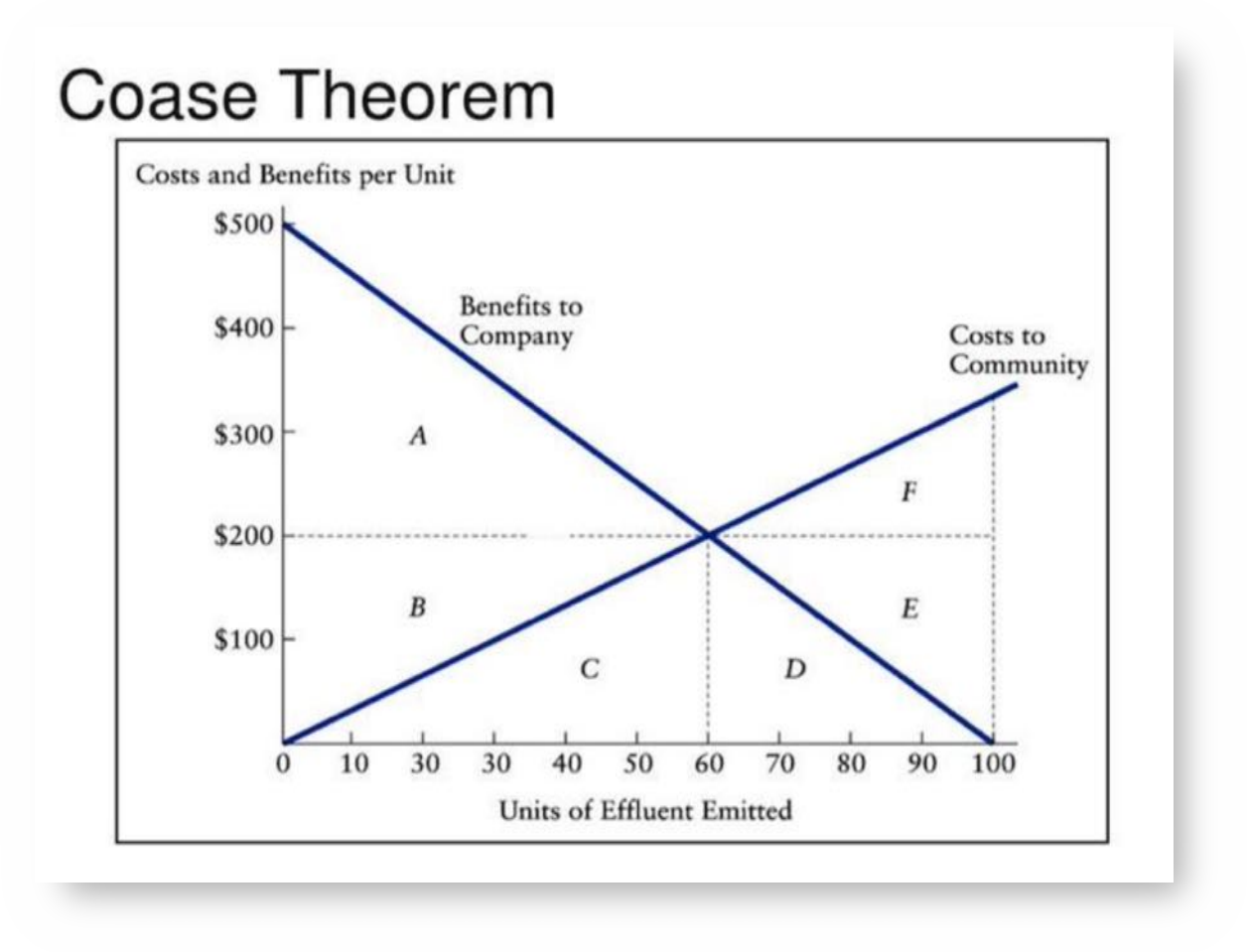
[6] **The Intergovernmental Panel on Climate Change** provided a 2018 report on the impact of global warming of 1.5 C to the **United Nations Framework Convention on Climate Change** ("**UNFCCC**") and the **Paris Agreement, Conference of Parties** ("**COP**")

GHG-PATS Scientifically Calibrated Utility and Dynamic Market Cost Function



When the **Coase Theorem** narrow constraints are modified to apply to unbounded negative and positive climate change externalities, the objective of economic **Pareto optimality** will be attained, with global resource allocations, ecosystems and industrial processes optimized such that one dimension cannot be improved without worsening another.

GWP Factor Weighting – Utility Curve

100-year Global Warming Potential ("GWP") factor = scientifically calibrated utility function for certified GHG emissions and offsets.

Using internationally calibrated **GWP** factors systematically weights the global warming potential of various categories of greenhouse gases ("**GHG**") and **ozone depleting substances** ("**ODS**"), to equalize the impact on climate change of **GHG emissions** and **offsets** relative to a **GHG**.

GHG Permit Demand versus GHG Offset Supply Clears Market Cost Curve

GHG-PATS spot index and forward contract prices represent the dynamic, market-derived clearing **GHG cost curve**, a function of **downward sloping NET GHG Permit Allowances** and **upward sloping supply of fungible certified GHG offsets** that increase **GROSS GHG Permit Allowances.**

The **net supply** of GHG emissions must decline from 51 billion tons (2022) to zero by 2050 to hope to keep global warming below 1.5 C[7], though meeting this milestone by 2040 would increase the probability of success considerably with far less environmental damage.

GHG-PATS not only modifies the unrealistic constraints underlying the current decarbonization efforts such as voluntary carbon markets and

[7] International Plant Protection Convention ("**IPPC**"), "***Mitigation Pathways Compatible with 1.5 C in the Context of Sustainable Development***," "Limiting warming to 1.5°C implies reaching net zero CO_2 emissions globally around 2050 and concurrent deep reductions in emissions of non-CO_2 forcers, particularly methane (*high confidence*)"

cap and trade, but we recognize the full support of all stakeholders is necessary to galvanize global support.

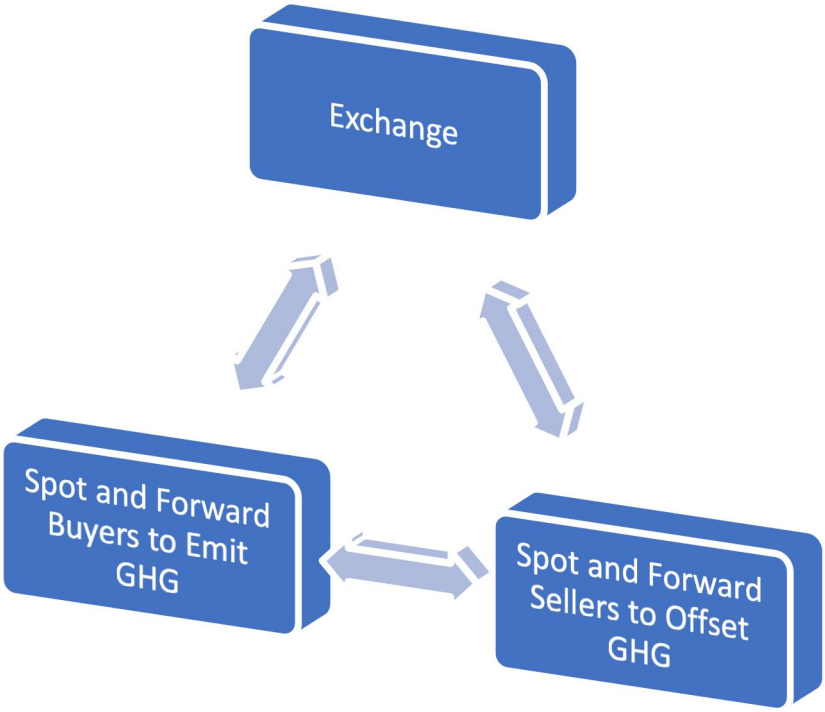
But because the solutions proposed have focused on demand constraints, slower economic and population growth, and reductions in standards of living, large, vested interests find such solutions untenable and actively work to slow progress on decarbonization.

By funding the growth of natural and technical GHG emission offsets directly with fungible GHG Permit Allowance revenue, the growth in GHG offsets would allow the established decarbonization schedule to be met in part or full by the growth in offsets, as internalizing both positive and negative externalities related to climate change establish the true economics of global resources.

The GHG-PATS' scientifically calibrated utility curve and the dynamic, market-based cost curve work together to drive optimal global resource allocations to power a growing, high productivity economy far more efficiently, mitigating climate change with requisite criticality, while simultaneously ushering in a new era of circular, zero waste, high productivity, clean, restored, and healthy environs.

GHG Permit Allowances Contract Settlements

GHG-PATS Exchange provides spot and hedging infrastructure for over-the-counter ("**OTC**") and exchange trading for **Global Sustainable Finance** internal rate of return structuring of **GHG emission mitigation** projects and **GHG offset funding** of global ecosystem rejuvenation, nature and biodiversity preservation, and technological climate change remediation.



The Exchange and GHG-PATS earns fees for each traded contract

The primary market purchase of **GHG-PATS Permit Allowances** required to emit 1000tCO2e internalizes the adverse externality with respect to climate change. Nations, industries, or companies that generate permanent or transitory **certified GHG offsets create new Permit Allowances** that are sold for 100% of the revenue at the market price, internalizing positive climate change externalities.

All global entities will be incentivized to develop technology and industrial innovations to cut GHG emissions and related pollutants or improve the natural capacity of the planet to transform GHG (offsets).

GSF access to positive IRR investments and cost of carry accelerates decarbonization.

Primary Markets

GHG-PATS Permit Allowance contracts must be purchased on the exchange (or through the over-the-counter market) in order to permit activities that **generate GHG emissions** or **reduce GHG offsets**. The contract price is set by global capital markets based on the known downward-sloping supply of **NET GHG Permit Allowance contracts** and the expected upward-sloping increase in permanent fungible GHG offsets over time. The revenue from certified **GHG-PATS Permit Allowance contracts** is not tax revenue, but rather is **direct funding** for reducing GHG emissions.

The **GHG-PATS** exchanges price the **GHG Permit Allowances** and offsets spot and forward markets for extended maturities, working together with **Global Sustainable Finance** from the UN, World Bank, IMF, and international capital markets.

Primary end-user buyers of **GHG Permit Allowance** contracts are **GHG emitters** that internalize the calculated weighted utility of GHG in industrial processes or other activities that adversely impact climate change, such as oil and gas energy, cement, landfills, electrical grids, etc. The relative impact of different activities (e.g., oil refining, gasoline usage, auto fuel efficiency, etc.) would be rigorously calculated to not under or overestimate externalities, and GSF coupled with GHG-PATS hedging would provide risk managed long-term investments to increase efficiencies and productivity in business while decarbonizing.

Example – Primary Market GHG Permit Allowance Buyer

In a common case where parent oil and gas companies emit GHG, and produce gasoline for retail buyers that emits GHG, dependent on the fuel efficiency of the automobile using gasoline, the net GHG produced by the oil and gas producer, the automobile producer, and the gasoline purchased, establishes the **GHG Permit Allowances** required to internalize all GHG at the source – incenting more efficient industrial processes and products based on technology and economics.

Primary end-user sellers of fungible GHG contracts are GHG offsets that internalize the calculated weighted-utility of GHG in the preservation of nature, protection and rejuvenation of global ecosystems, and the development of technologies such as advanced chemical plastics recycling, quick enzymatic plastic biodegrading, GHG transformation through biotechnology, and other high-utility innovations.

Example – Primary Market GHG emission offset seller

Brazilian rain forests provide a common utility to the globe, but the nation does not receive revenue for its preservation. **GHG Permit Allowances** would provide revenue to the nation in perpetuity based on its calibrated utility and market price in exchange for preservation and rejuvenation.

Internalizing both positive and negative externalities materially impacting climate change creates more efficient resource allocation, and the massive flow of investments into modernizing industrial processes and rejuvenating global ecosystems create a virtuous cycle of global repair.

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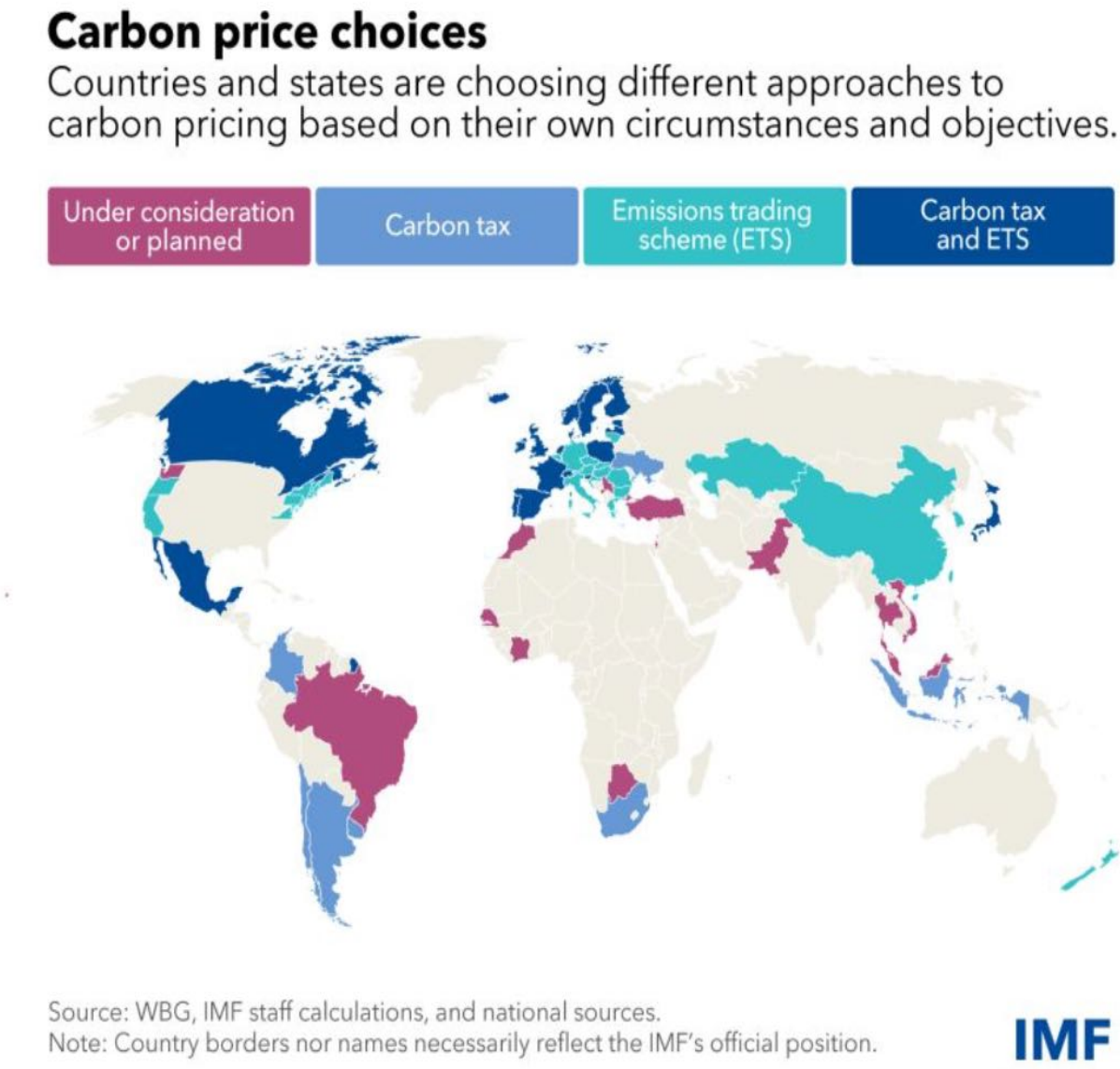
As the world gears up to avoid a climate catastrophe by limiting global warming to 1.5-2 degrees Celsius, more countries are putting carbon pricing at the center of their mitigation strategies. Yet countries designing w… ...see more



GHG-PATS & Global Sustainable Finance

Global Sustainable Finance in international capital markets provides flexible structuring and hedging to unlock access to optimal positive internal rates of returns on transitional and perpetual GHG reduction project financings with global blockchain transparency.

GHG Permit Allowances and certified fungible offsets in OTC and exchange-traded markets in international capital markets will transform ad hoc, fragmented regional markets into a robust, liquid global market to structure and hedge **Global Sustainable Finance** transitional and perpetual **GHG Permit Allowance** and offset projects.

GHG-PATS hedging and structuring lock in **GHG Permit Allowance** and offset returns on investments ("**ROI**") and returns on assets ("**ROA**") over various extended maturities to flexibly manage the economics and cash flow of decarbonization transition with certitude.

The rising cost from the declining supply of net certified **GHG Permit Allowances** will be counterbalanced by the rising supply of certified fungible **GHG emission offsets**, as the revenue from the former funds investment in rejuvenation, innovation, and technology for the latter.

A **Paris Agreement legal framework and pricing mechanism** ratified by multilateral treaty stimulates a cohesive and systematic market for greenhouse gas ("**GHG**") offsets to methodically decarbonize the planet with requisite speed and certainty.

The Paris Agreement would benefit from a **supranational command center** operating under the auspices of the UN Climate Change Conference of the Parties ("**COP**") to adopt an environmental law and economic framework with a scientifically calibrated GHG compliance pricing mechanism that aligns financial incentives with global imperatives.

Command Center to Embrace Computational Sustainability Methods

This climate change computational center would track and course correct the most material factors related to global warming through computational sustainability methods to quantify and allocate at a granular level GHG emissions and offsets and related climate change environmental disorders with rigor and precision.

Internalizing all negative and positive material externalities in a single environmental derivative contract ends the bifurcation of GHG emissions and offsets, increases the efficiency of global resource allocation, and systematically expands the highest utility to cost solution set to front load and accelerate decarbonization substantially.

Only by clarifying and making transparent the utility to cost of the tens of thousands of solutions to redressing climate change will "the invisible hand" of the market wisely help guide our 2022 Moonshot to organize and measure the best of our energies and skills – for this and all future generations to follow.

Just like the Moonshot we can't afford to be 1 degree off...

SUMMARY

In law and economics, the Coase Theorem describes the economic efficiency of outcomes in the presence of externalities and conflicting property rights.[8] His work is illuminating, but his message was often not interpreted correctly.

Dr. Coase clearly prefaced the numerous constraints that would prevent entities in free markets from voluntarily internalizing negative externalities (e.g., no transaction or legal costs, transparent information, etc.).

It is self-evident that environmental pollution has a social cost that ripples throughout the waters, grounds, populations, and industries. The time for pollution freeloaders to just move on down the road has long passed.

Planet Earth is experiencing mass extinctions, oceanic acidification, aridification in populous productive lands, rising ocean levels, destructive weather, requiring a paradigm shift to productive, efficient, circular, zero waste industrial processes.

Dr. Albert Einstein noted, “In the midst of every crisis, lies great opportunity.”

Since Dr. Coase wrote about externalities over 3-score ago, interdisciplinary computational sustainability methods have advanced in sophistication to effectively drive down the transactional costs in allocating positive and negative externalities with precision at a granular level, to align financial incentives with the global imperative of averting

[8] Dr. Ronald Coase, “The Nature of the Firm” (1937) and “The Problem with Social Cost” (1960)

further climate warming and the related loss of biodiversity, and degraded ecosystems.

Past carbon charge rates do not adequately capture climate risk, but voluntary environmental “carbon markets” have not worked to reduce GHG concentrations empirically for decades, nor should they work conceptually.

The present constitution of compliance markets is more effective, but not designed with the sophistication necessary to address the complexity and magnitude of climate change in a $100 trillion global economy.

GHG emissions can be remediated with certitude under a GHG compliance system with a properly designed GHG environmental contract that has a scientifically calibrated utility function and a market cost function with a command control computational center working under the auspices of a UN COP supranational to implement the Paris Agreement with certitude, backed by Global Sustainable Finance.

The net result will be a methodical decarbonization of the oceans, lands, and atmosphere as a result of GHG exchange traded futures funds flowing to high productivity, closed loop industrial processes, transformation of and quick biodegrading of GHG and waste in oceans and landfills using biotechnology and biochemistry, etc. – remediating climate change, rejuvenating global ecosystems, and reversing losses in biodiversity.

To happen this takes only an understanding there is a win-win solution for all stakeholders to methodically create a more efficient, cleaner planet with higher living standards and a stronger economy.

Appendix A – Greenhouse Effect

GHG in Oceans, Land, and Atmosphere

Most of the global warming since 1950 has been caused by human emissions of greenhouse gases.

Greenhouse gases come from a variety of human activities, including:

1) burning fossil fuels for heat and energy
2) clearing forests
3) fertilizing crops
4) storing waste in landfills
5) raising livestock
6) producing some industrial products
7) destruction of global ecosystems
8) cement and construction
9) depopulation of whales and other marine mammals

Appendix B – GHG Volume Emissions * GWP Factors = GHG Permit and Offset Permit Allowances

Certified GHG Permit Allowance and Offset =

GHG volume * Applicable GWP Multiplier * Certified Permit Allowance Tenor Price

100-yr Global Warming Potential ("GWP")

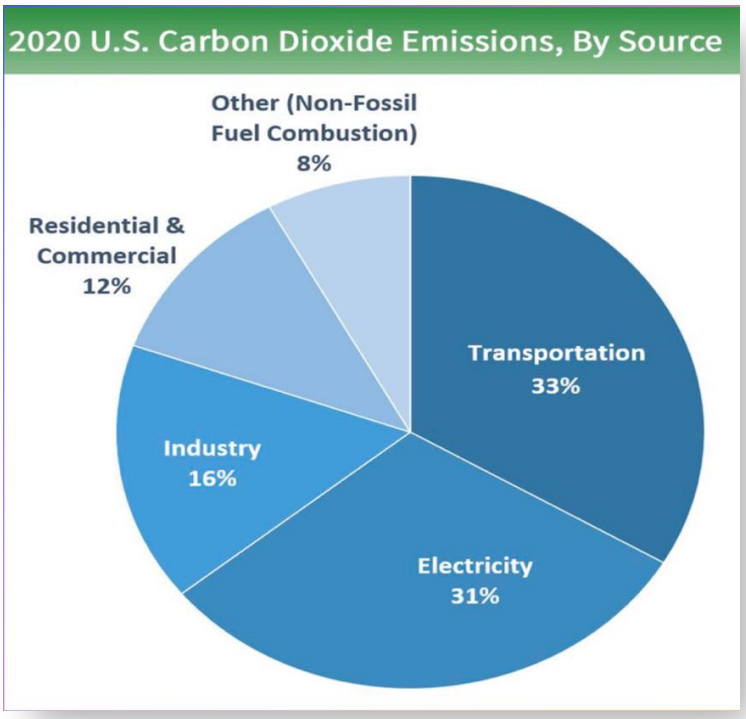
carbon dioxide ("**CO_2"**) = 1
methane ("**CH_4"**) = 25
nitrous oxide ("**N_2O"**) = 298

fluorinated gases (**F-gases**)

("**HFCs"**) = 140 to 14,800
("**PFCs"**) = 6,500 to 12,200
("**NF_3"**) = 17,200
("**SF_6"**) = 22,800

Greenhouse Gases ("GHG") Industries and Emission Trends

1) Carbon Dioxide ("CO_2")



Emissions and Trends

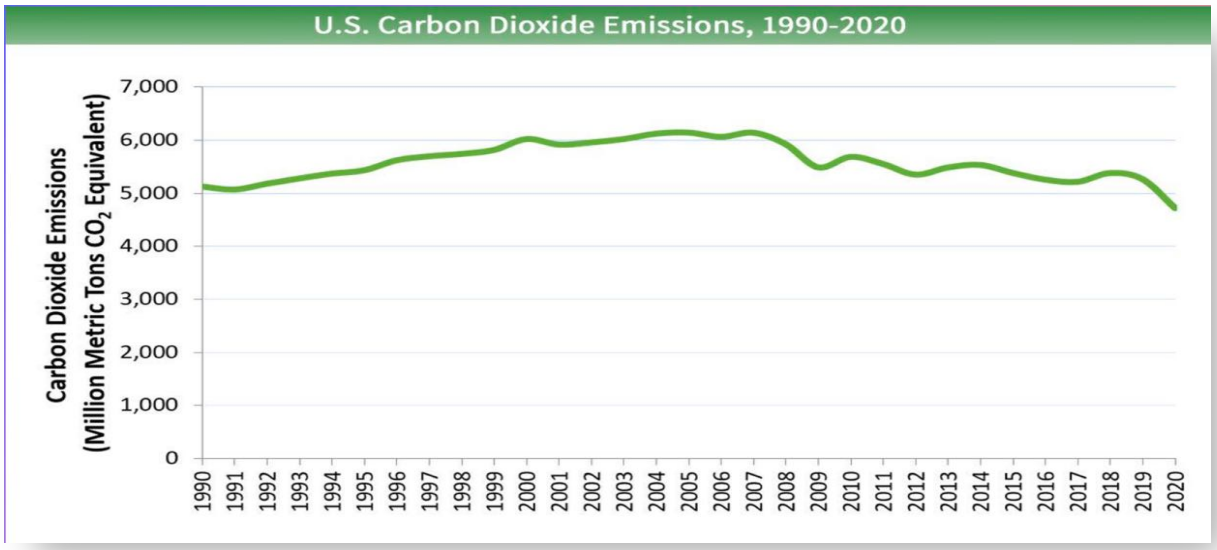
Carbon dioxide emissions in the United States decreased by about 8% between 1990 and 2020.

Since the combustion of fossil fuel is the largest source of greenhouse gas emissions in the United States, changes in emissions from fossil fuel combustion have historically been the dominant factor affecting total U.S. emission trends.

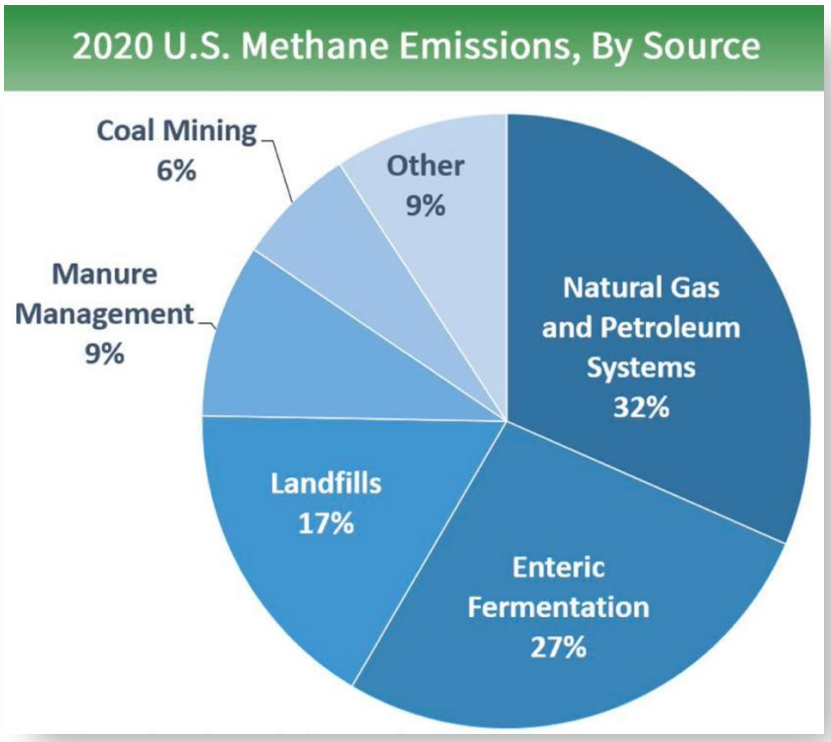
Improving the insulation of buildings, traveling in more fuel- efficient vehicles, and using more efficient electrical appliances are all ways to reduce energy use, and thus CO_2 emissions.

Producing more energy from renewable sources and using fuels with lower carbon contents are ways to reduce carbon emissions.

Carbon dioxide capture and sequestration is a set of technologies that can potentially greatly reduce CO_2 emissions from new and existing coal- and gas-fired power plants, industrial processes, and other stationary sources of CO_2.



2) Methane (“CH4”)



Emissions and Trends

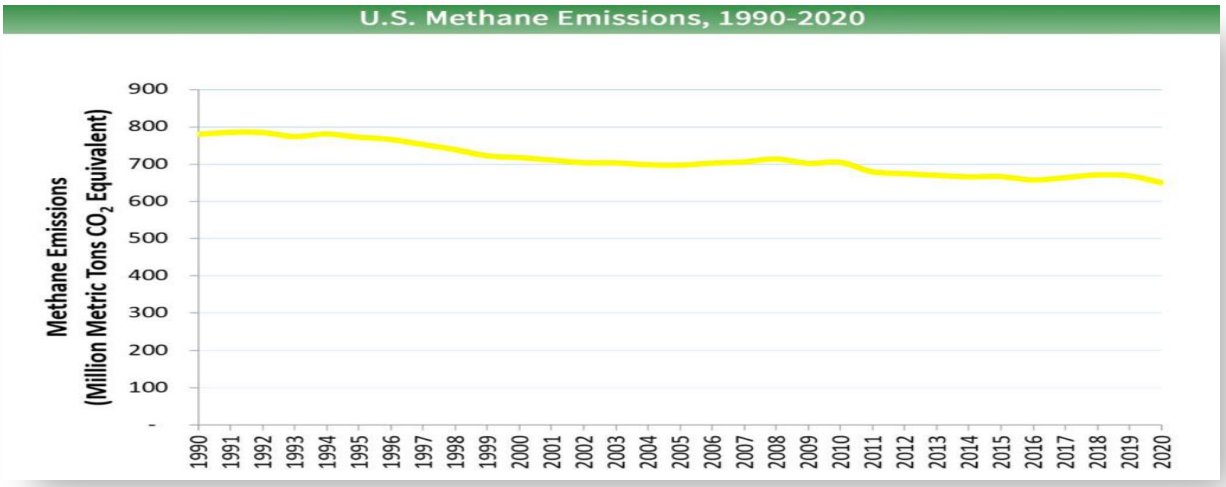
Methane emissions in the United States decreased by 17% between 1990 and 2020.

During this period, emissions increased from sources associated with agricultural activities, while emissions decreased from other sources including landfills and coal mining and from natural gas and petroleum systems.

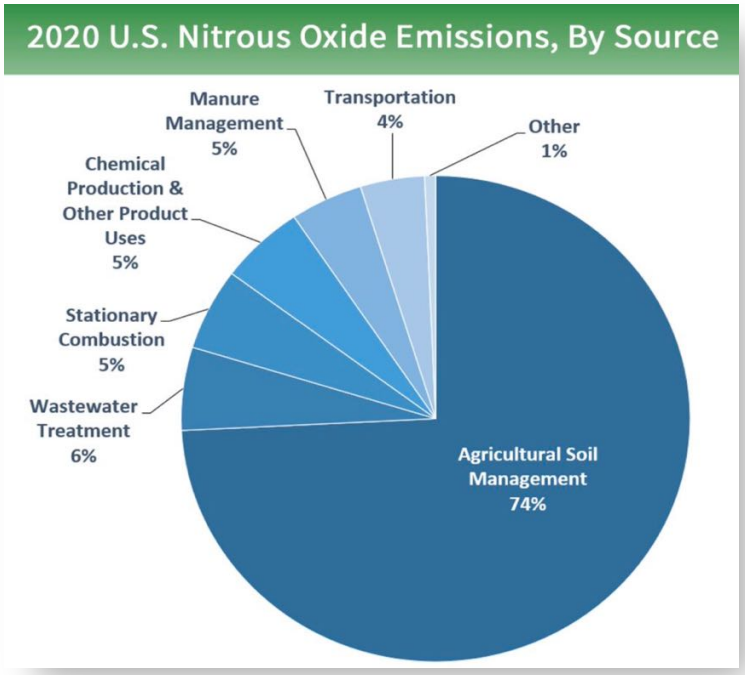
Because CH_4 emissions from landfill gas are a major source of CH_4emissions in the United States, emission controls that capture landfill $CH_4$are an effective reduction strategy.

Upgrading the equipment used to produce, store, and transport oil and natural gas can reduce many of the leaks that contribute to CH_4 emissions.

Methane from manure management practices can be reduced and captured by altering manure management strategies. Additionally, modifications to animal feeding practices may reduce emissions from enteric fermentation.



3) Nitrous Oxide ("N_2O")



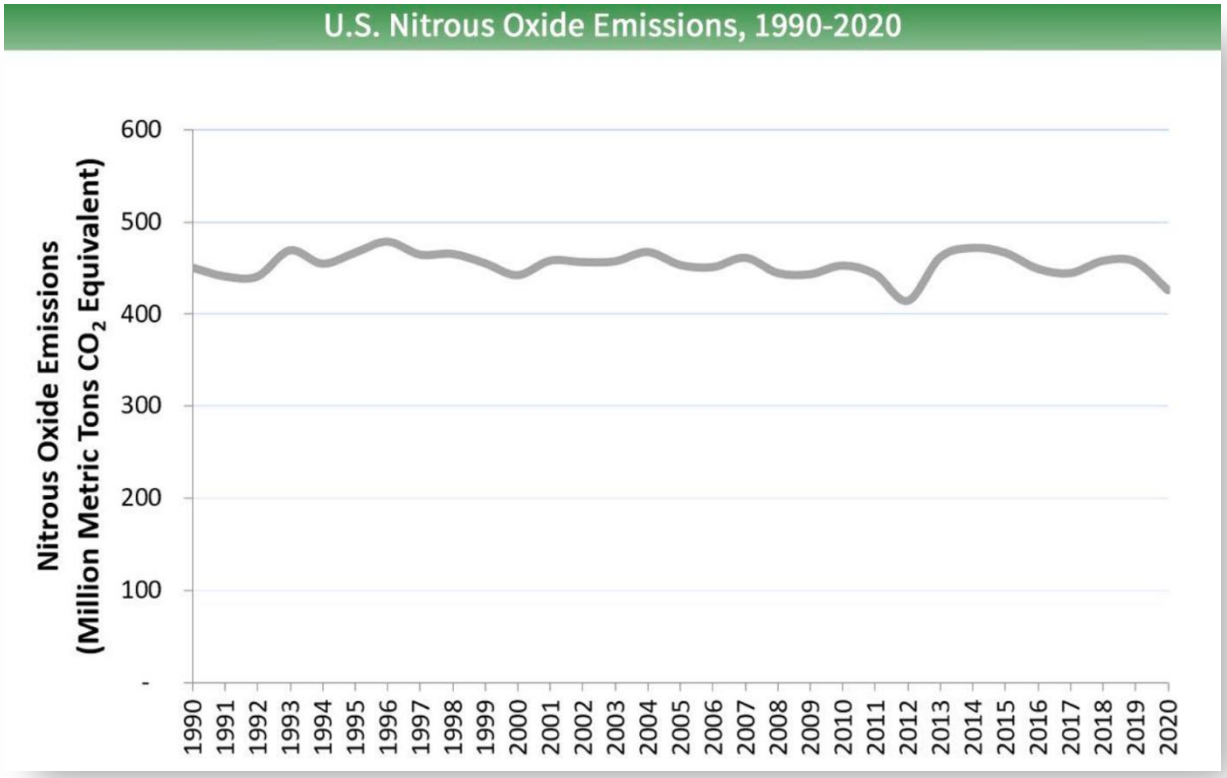
Emissions and Trends

Nitrous oxide emissions in the United States decreased by 5% between 1990 and 2020.

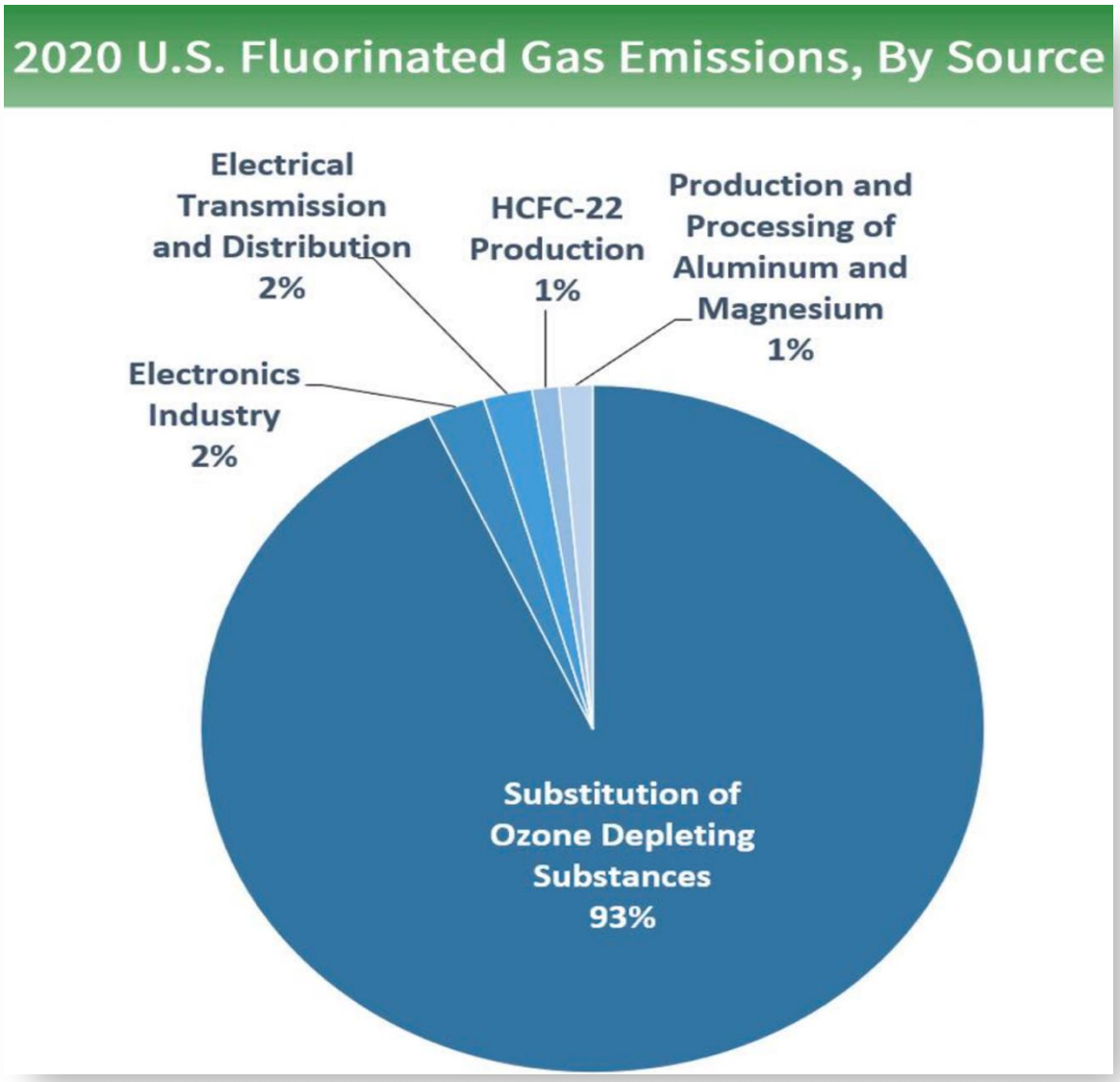
During this time, nitrous oxide emissions from mobile combustion decreased by 61% because of emission control standards for on-road vehicles.

Nitrous oxide emissions from agricultural soils have varied during this period and were about the same in 2020 as in 1990.

Nitrous oxide is generally emitted from industry through fossil fuel combustion, so technological upgrades and fuel switching are effective ways to reduce industry emissions of N_2O.


U.S. Nitrous Oxide Emissions, 1990-2020
Nitrous Oxide Emissions
(Million Metric Tons CO_2 Equivalent)
600
500
400
300
200
100
-
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020

4-7) Fluorinated Gases – F-gases ("HFCs", "PFCs", "NF3", "SF6")



Note: All emission estimates from the *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2020 (excludes land sector).*

Emissions and Trends

Overall, fluorinated gas emissions in the United States have increased by about 90% between 1990 and 2020. This increase has been driven by a 284% increase in emissions of hydrofluorocarbons ("HFCs") since 1990, as they have been widely used as a substitute for ozone-depleting substances.

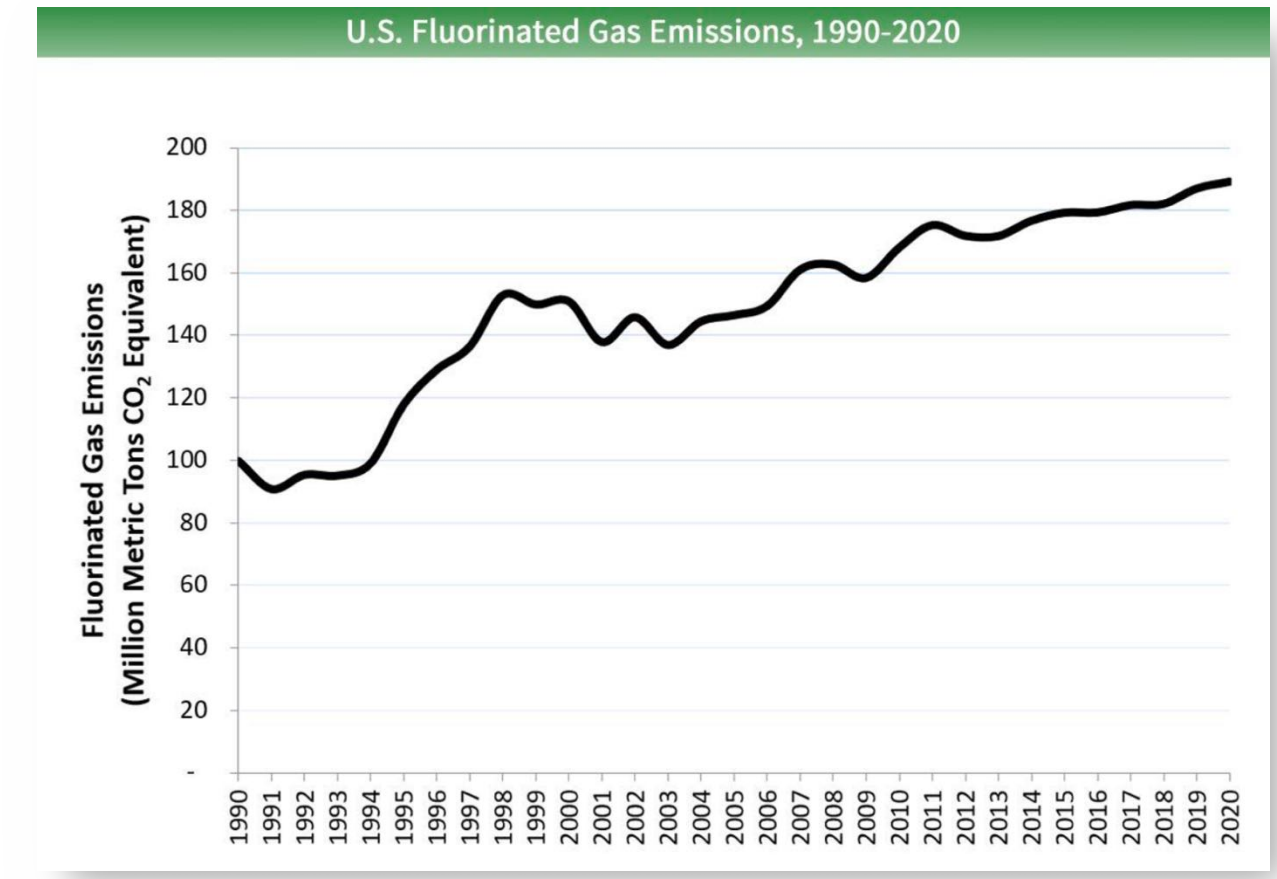
Hydrofluorocarbons ("**HFC**s") are released through the leakage of refrigerants used in vehicle air-conditioning systems. Leakage can be reduced through better system components and alternative refrigerants with lower global warming potentials than those presently used.

Refrigerants used by businesses and residences emit fluorinated gases. Emissions can be reduced by better handling of these gases and use of substitutes with lower global warming potentials and other technological improvements.

Industrial users of fluorinated gases can reduce emissions by adopting fluorinated gas recycling and destruction processes, optimizing production to minimize emissions, and replacing these gases with alternatives.

Sulfur hexafluoride is an extremely potent greenhouse gas that is used for several purposes when transmitting electricity through the power grid.

See F-gas emissions, GWP-weighted, below:



Ozone Depleting Substances ("ODS")

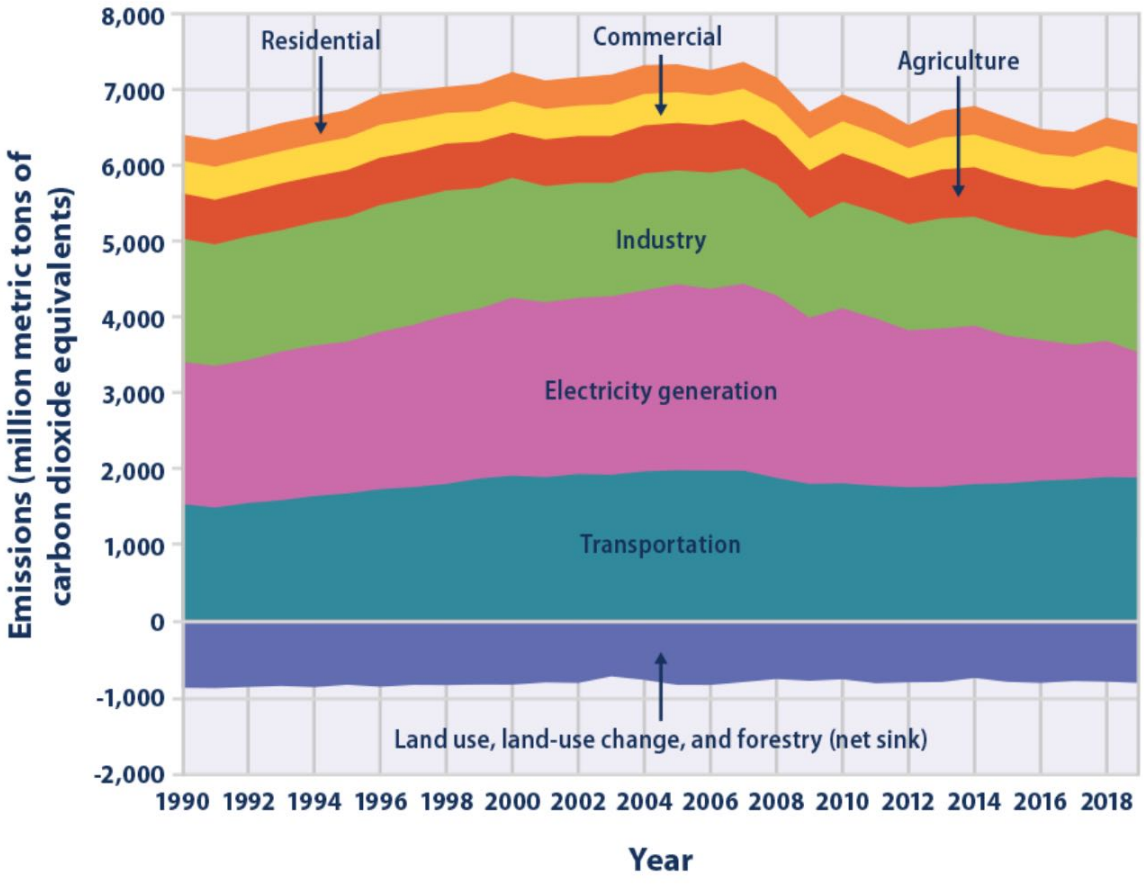
Chlorofluorocarbons; halons; carbon tetrachloride; 1,1,1-Trichloroethane ("**methyl chloroform**"); Hydrochlorofluorocarbons

("**HCFC**s"). They are used in refrigeration and air-conditioning systems, and heat pump and fire protection equipment.

Climate Change Indicators: U.S. Greenhouse Gas Emissions

This indicator describes emissions of greenhouse gases in the United States.

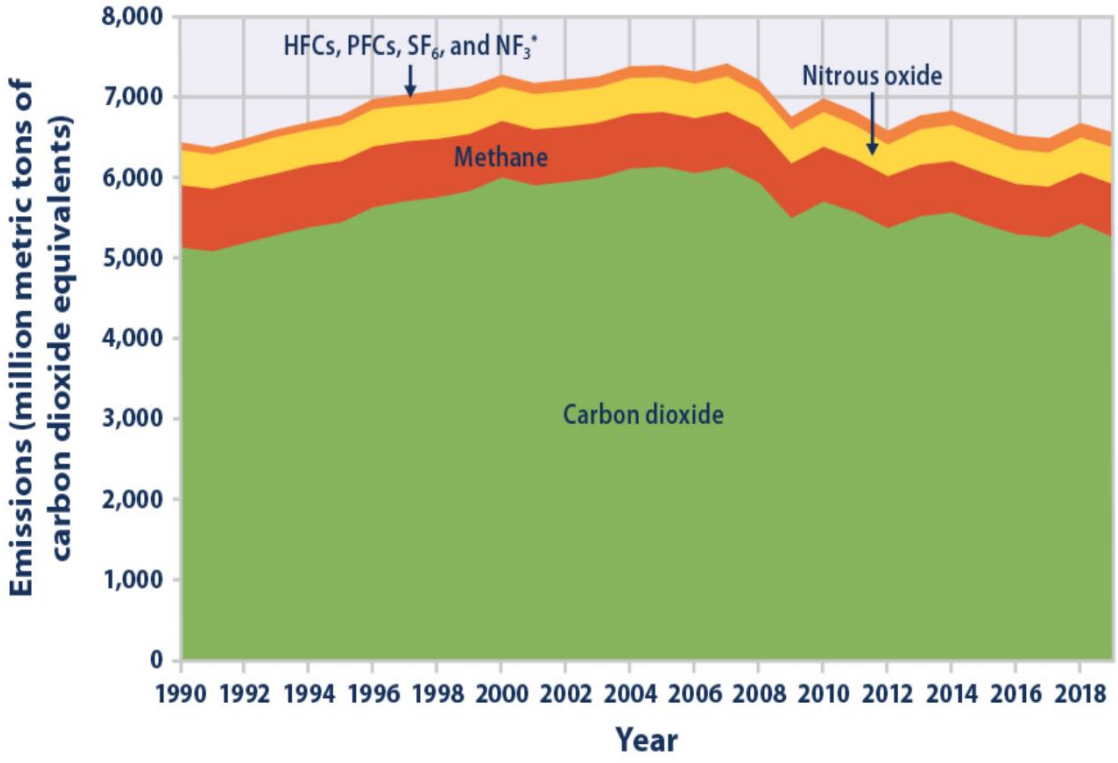
Figure 2. U.S. Greenhouse Gas Emissions and Sinks by Economic Sector, 1990–2019



Climate Change Indicators: U.S. Greenhouse Gas Emissions

This indicator describes emissions of greenhouse gases in the United States.

Figure 1. U.S. Greenhouse Gas Emissions by Gas, 1990–2019



Appendix C – The Coase Theorem

The **Coase Theorem** legal and economic framework offers key insights in clarifying a path to the efficient resolution of conflicting property rights, but the direct application to a problem as complex as climate change is conceptionally flawed, as the idealized theoretical construct to arrive at overall advantageous environmental bargains.

Coase Theorem Constraints [9]

1. Two parties to an externality
2. Perfect information regarding each agent's production or utility functions
3. Competitive markets
4. No transaction or monitoring costs
5. No court costs
6. Rationale actors seeking combined profit and utility-maximization
7. Absence of wealth effects

The **Coase Theorem** clarified that under ideal economic conditions, where there are conflicting property rights, the parties involved can negotiate terms that reflect the full costs and values of the property rights at issue, resulting in the most efficient outcome.

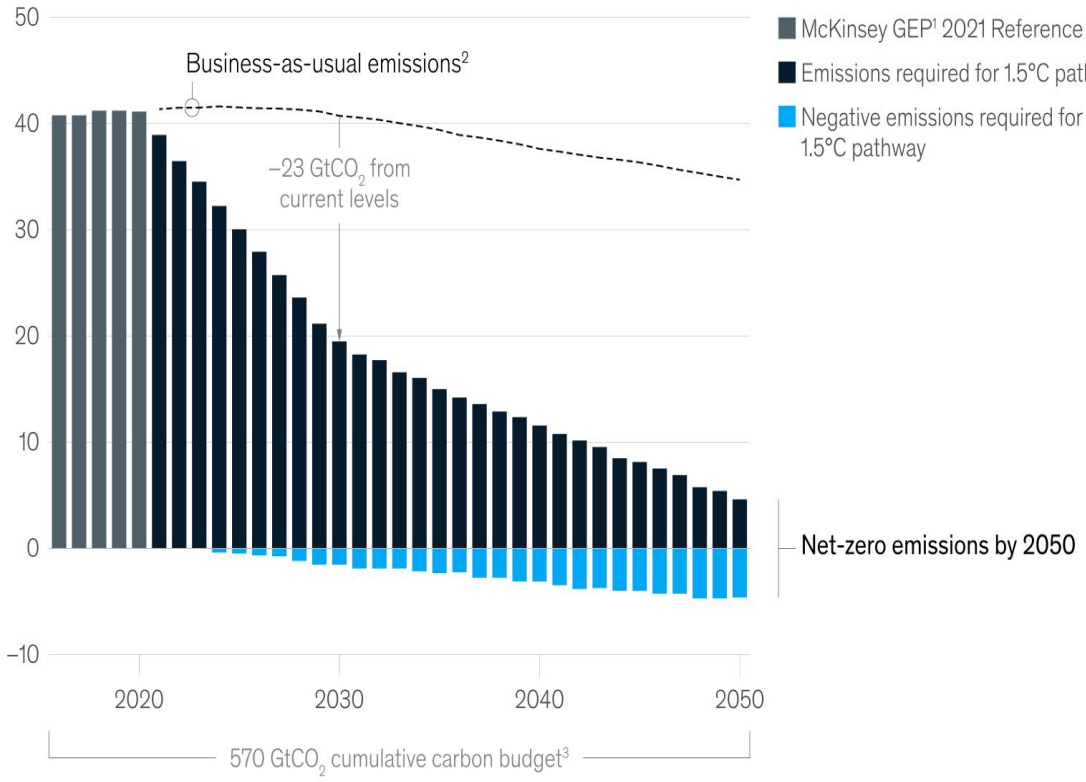
However, in the real world, clearly such idealized conditions do not exist, thus **Voluntary Carbon Markets** with **Global Sustainable Finance** ("**GSF**") have not succeeded in mitigating climate change in 25-years.

[9] Encyclopedia of Energy, Natural Resource, and Environmental Economics, Reference Work 2013, Jason F. Shogren

Voluntary Carbon Markets ("**VCM**") based on the **Coase Theorem** are conceptually flawed as they lack the pre-conditions for successful application to global markets and have empirically been proven not to work for decades. There is no sensible hope that **Voluntary Carbon Markets** and regional **Cap and Trade** markets can suddenly work with **Global Sustainable Finance** in a realistic timeframe to mitigate climate change. Wasting valuable time and resources on such an endeavor is truly planning to fail.

Reaching the 1.5-degree warming target could require a large quantity of negative emissions, including some generated using carbon credits.

Global carbon-dioxide emissions, gigatons ($GtCO_2$) per year



[1]Global Energy Perspective.
[2]While emissions fell by a quarter at the peak of COVID-19-related lockdowns, daily emissions have rebounded to be only 5% lower than 2019 levels. Scenarios to 2050 remain the same. Forster et al., "Current and future global climate impacts resulting from COVID-19," *Nature Climate Change*, August 7, 2020, nature.com.
[3]Budget of 570 $GtCO_2$ emissions from 2018 onward offers a 66% chance of limiting global warming to 1.5°C, when assessing historical temperature increases from a blend of air and sea-surface temperatures.
Source: Corinne Le Quéré et al., "Global Carbon Budget 2018," *Earth Systems Science Data*, 2018, Volume 10, Number 4, pp. 2141–94, doi.org; IPCC; *McKinsey Global Energy Perspective 2021*; McKinsey analysis

McKinsey & Company