Corporations Jointly Financing Carbon Capture Systems: Decarbonizing Upstream Inputs While Generating Tax Credits & Carbon Offsets

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Introduction

About 21% (417) of the world's top 2000 public corporations— together representing nearly $14 trillion in annual sales— have net-zero commitments.[1] Some of these companies may be able to reduce their carbon emissions directly, but due to the difficulty of eliminating all emissions, many will have to use carbon offsets: Of these corporate commitments, only 33 companies explicitly rule out the use of offsets, while 87 set conditions for their use of offsets.[1]

For industry and power-generation plants, directly removing emissions is somewhat more straightforward: Conceptually, the plant's exhaust is pumped into chemical "scrubbers" that bind to CO_2 molecules, capturing about 90% of the carbon dioxide that would have otherwise been released into the atmosphere, where it can be processed and stored.[2] However, these systems are not cheap: Occidental Petroleum's Century plant (captures ~8.4 Mt/yr) costed ~$1.1B,[3a] the Petra Nova project (1.4 Mt/yr) costed about $1B,[3b] the Air Products steam methane reformer project (1 Mt/yr) costed around $431m,[3c] and the Illinois Industrial Carbon Capture and Storage plant (1 Mt/yr) costed ~$208m.[3d] Although the United States Department of Energy (DOE) provides significant financial support through grants for carbon capture systems— through CarbonSAFE funding, FEED study projects, and the Regional Initiative to Accelerate CCUS Deployment[4]— meeting the International Energy Agency's Sustainable Development Scenario requires 9% of the world's emissions to be reduced by carbon capture and storage (CCS), which translates to an estimated $655B - $1280B in total capital investment.[5] This scale of investment necessitates private investment into CCS.

Currently, the main incentive in the United States for deploying carbon capture and sequestration technology is the 45Q tax credit,[6] although state-level incentives can apply as well.[7] This paper explores the potential of corporations financing carbon capture systems of upstream suppliers.

Carbon Capture Insets Versus Credit Offsets

If a company purchases a carbon credit that counts for carbon removal outside of their supply chain, it is called an *offset;* if a company invests in reducing the emissions directly from their own supply chain, it is termed an *inset.*[8] Insets are intrinsically more valuable because the emitting entity is taking direct responsibility for eliminating that emission, rather than placing the burden upon a third party. Carbon capture and sequestration is one of the most affordable and attainable options of insetting for industries with fixed point source carbon emissions— such as for heat and power generators, and cement, chemical, steel, and other industrial manufacturers.[9]

To offset carbon emissions, there are a few different options a company can pursue.

Forestry and Conservation

Some of the most popular carbon offsets are in the form of reforestation,[10] in which trees are planted where forests were recently cleared; afforestation, in which trees are planted where there were none previously; and natural regeneration, where trees are not manually replanted but instead the ecosystem is allowed to naturally regrow.[11] Forests sequester carbon from the atmosphere into wood, plant matter, and soil, so they can reduce the rate at which CO_2 accumulates in the atmosphere, while also providing habitats for other species and cleaning water.[11] Undoubtedly, forests can play a significant role in both atmospheric carbon reduction and ecological health, but their use as carbon offsets is complicated:

(1) It is difficult to verify the amount of carbon sequestered by forests.[11] There are empirical methods of calculating these numbers, but the estimates often have large confidence intervals,[12] making it quite difficult to say, with certainty, the effects of these efforts. In fact, there are actually some concerns that amateurly planting trees may cause ecological changes that actually *releases* net carbon dioxide into the atmosphere, because it may disrupt the soil microbiomes that dictate the soil's organic carbon capacity.[13]

(2) This carbon is not necessarily sequestered on the geological timescale needed to meaningfully offset anthropogenic carbon emissions. For example, if reforested or afforested trees are ever, say, burned in a wildfire[14] or deforested for land development, much of the carbon that was captured can be rereleased into the atmosphere.

(3) Trees do not capture and sequester enough carbon for industrial-level emissions, meaning that, absent other strategies, they would use far too much land to be practical for mitigation. To meet nations' existing net-zero climate pledges solely by planting trees, "the total amount of land required for planned carbon removal could potentially be five times the size of India, or the equivalent of all the farmland on the planet."[15] This magnitude of competition in land-use could have devastating unintended consequences, especially in agriculture.

(4) Large-scale forestry projects may have other environmental consequences unrelated to carbon emissions. For instance, attempting to prevent desertification in the dry Northern part of China, planting trees that were not suitable for dry climates depleted water supplies and degraded soils; likewise, reforestation with one species of tree has led to the loss of biodiversity in Southern China.[11]

To be clear, forestry and conservation, if done well, has numerous environmental and societal benefits that can far outweigh its costs. However, since significant uncertainty exists in carbon accounting, the use of vast quantities of managed land as an offset to enormous quantities of otherwise unabated industrial emissions is overall risky.

Renewable Energy

Another common form of carbon offsets is funding renewable energy projects.[10] Although renewable energy is necessary for a net-zero carbon economy, there are a few considerations that should be made when using them as a form of carbon offsets:

(1) Renewable energy projects indirectly reduce emissions because they, ideally, will cause carbon-emitting power plants to produce less. This makes the exact carbon offset difficult to measure with certainty, as electricity has many different producers, each with different carbon intensities and outputs. For instance, "electricity trade among power grids leads to difficulties in measuring greenhouse gas (GHG) emission factors of purchased electricity," which "can underestimate or overestimate GHG emissions of purchased electricity in interconnected grid networks, potentially leading to incorrectly accounting for the effects of emission reduction policies involving purchased electricity."[16] Quantifying the indirect impacts that renewable energy projects have on emissions is, by nature, uncertain, which calls into question its verifiability of offsets derived by it.

(2) Securing local communities' consent to develop large renewable projects may prove to be more difficult than might be assumed. In nearly every state, some

> local governments have enacted policies to block or restrict renewable energy facilities, and local opposition has resulted in the delay or cancellation of particular projects: There have been at least 103 such local policies and 165 contested renewable energy facilities.[17] Of the "53 utility-scale wind, solar, and geothermal projects that were delayed or blocked between 2008 and 2021 in 28 U.S. states [...] 34% faced significant delays and difficulties securing permits, 49% were cancelled permanently, and 26% resumed after being stopped for several months or years."[18]

Renewable energy projects are essential for a decarbonized economy, and as such its deployment should be accelerated. However, for industries in specific need of carbon offsets, renewable energy purchases are not an ideal solution. Although renewable energy remains vital to a decarbonized grid, the merits of carbon offsets generated by their avoided emissions may be scrutinized due to their lack of verifiability and certainty. Likewise, it is quite possible that developing large tracts of land needed to generate a meaningful source of renewable offsets could surprisingly run into significant local opposition.

Carbon Capture

Unlike investing in tree-planting and renewable energy farms, carbon capture systems produce a measurable quantity of carbon emissions avoided. The pipe's flow rate of the pressurized captured carbon can be used to calculate and verify, with certainty, the amount of sequestered carbon dioxide— an advantage that is unique to only carbon capture.

The concentration of carbon dioxide in high-emitting facilities' waste makes it less energy intensive to capture than from the diluted concentration in the air.[19] With the industry standard of capturing about 90% of carbon dioxide,[2] carbon capture is an extremely effective way of significantly reducing greenhouse gas emissions that are guaranteed to have otherwise been released into the atmosphere.

Direct Air Carbon Capture and Bioenergy with Carbon Capture, as well as carbon capture on industrial processes, is often a cited strategy for achieving net-zero emissions from comprehensive mitigation reports, such as from the Intergovernmental Panel on Climate Change[20] and the Lawrence Livermore National Laboratory.[21] This will require an incredibly quick scaling up of the technology: The International Energy Agency's Net Zero Emissions by 2050 Scenario has Direct Air Capture being scaled from 0.01 Mt CO_2/year currently to 85 Mt CO_2/year in 2030 and ~980 Mt CO_2/year in 2050.[19]

Getting carbon capture projects operating as soon as possible will be essential for the world to meet its climate goals. Recognizing this, the United States federal government offers tax incentives— 45Q— which is described in detail below.

45Q Overview

Unlike other offset methods, 45Q is a federal tax credit that is given to firms for capturing and sequestering carbon oxides— mostly carbon dioxide.[6] It was originally created in 2008, but significantly revamped in 2018, treating carbon capture facilities constructed before and after the revamp slightly differently.[6] For the purposes of this paper, we will focus on equipment built after the 2018 bill.

The credit amount depends both on what happens to the captured carbon and when it is captured. Each year until 2026, the credit increases to a fixed price, up to $50 per metric ton for geological sequestration; after 2026, the credit is adjusted for inflation,[22a] as shown in table 1. For carbon oxides that are not geologically sequestered, a firm may sell it for enhanced oil recovery or utilize it some other way— providing a potential revenue stream— but at the expense of a lower applicable tax credit.[22b]

The claim period for this tax credit is 12 years after the carbon capture system is placed in service, meaning firms cannot claim credits after that period.[6] Additionally, only facilities that begin construction before 1/1/2026 qualify for the tax credits.[6] Depending on the type of facility, there are minimum annual capture requirements to be eligible for the tax credits: Power plants must capture at least 500,000 metric tons of carbon per year, facilities that emit less than 500,000 metric tons of carbon per year must capture at least 25,000 metric tons, and Direct Air Capture and other capture facilities must capture at least 100,000 metric tons.[6]

Two other important aspects of 45Q is that joint owners of carbon capture systems can allocate tax credits among themselves via a partnership, and the owner of the carbon capture system does not necessarily have to be the owner of the emitting facility.[9c] Likewise, the capturer of CO2 can, in certain situations, allow other contracted companies to receive the tax credit.[22d, 22e] Therefore, it seems that a single firm does not have to fund, own, and operate the carbon capture system, transportation, and injection sites to receive the credit, providing a potential avenue for creative financing.

Although there have been some calls to make 45Q "direct pay",[23] tax credits from 45Q are currently not refundable, meaning a firm's benefit from the 45Q tax credits generated is limited by their annual tax liability. For example, if some firm had to pay $100m in federal taxes, but had $120m in non-refundable federal tax credits (such as from 45Q), the firm's tax liability would go to $0 for the year, but they would *not* be able to receive a $20m refund.

It is also important to recognize that federal incentives can supplement state and local incentives: For instance, a firm may claim federal 45Q tax credit in addition to, let's say, California Low Carbon Fuel Standard's incentives.[7] For the purposes of this report, we will for now neglect state and local incentives, only considering the federal 45Q tax credit. Considering the fact that quite a large portion of U.S. states have at least one incentive for implementing CCS[24] — and some of these incentives are substantial— it is important to keep this in mind as we consider federal incentives.

Year	**Applicable Dollar Amount (Geological Storage)**	**Applicable Dollar Amount (EOR or Utilization)**
2017	$22.66	$12.83
2018	$25.70	$15.29
2019	$28.74	$17.76
2020	$31.77	$20.22
2021	$34.81	$22.68
2022	$37.85	$25.15
2023	$40.89	$27.61
2024	$43.92	$30.07
2025	$46.96	$32.54
2026	$50.00	$35.00

Table 1. Tax Credits per Metric Ton of Captured Carbon Oxide Based on Year and Sequestration Method.

Candidates For Carbon Capture and Sequestration

There are two obvious kinds of high-emitting facilities that can potentially be fixed with carbon capture systems.

Coal-Fired, Natural Gas, and Oil Power Plants

Many states have enacted clean energy standards,[25] requiring electricity production to be net-neutral carbon emissions by a certain timeframe (typically between 2040 and 2050). Unless these regulations are lifted sometime between now and then, coal-fired, oil, and natural gas power plants will have no choice but to either use carbon capture systems, or cease operations.

If a carbon-emitting power plant owner plans on operating for the next few decades, they will eventually need to consider carbon capture systems to meet the regulations. This may partially explain why there are currently quite a few carbon capture projects planned in the United States.

It is also possible that many coal- and natural gas-fired power plants are owned by companies that have relatively modest tax liabilities compared to the carbon credits they could potentially generate, disincentivizing them from investing in the systems. Duke Energy, for instance, owns 11 coal-fired power plants in the United States[26] and has had a negative tax liability for the last 5 years.[27a]

Industrial Plants

Cement, iron and steel, and chemical manufacturing are considered *hard-to-abade* industries because efficiency improvements can have only a limited impact on emission reductions and shifting to low-carbon inputs cannot reduce process emissions.[28] Thus, carbon capture systems could have a role in emission reductions for these kinds of industries. In particular, "cement production is a good candidate" for considering industrial carbon capture because they are "quite homogenous, with non-combustion and combustion emissions combined in the flue stream," and "the percent of CO2 in the flue stream of a cement plant is greater than the CO2 concentration of the flue gas of a coal-fired power plant."[28] For these reasons, carbon capture systems are reasonable candidates for reducing industrial emissions.

The demand for "green"— low-carbon emissions— materials has been growing. For instance, the global market size of "green" cement was around $609m in 2019, forecasting to grow to $678m in 2026.[29] If these types of markets continue to grow, there could be an business incentive for investing in carbon capture systems; likewise, different levels of government could foreseeably play a role in growing the supply and demand of these low-carbon industrial goods.

Although many governments have been proactive in regulating the electricity sector's emissions, industry has, to a far greater degree, remained unbothered by carbon standards. Implementing taxes to specifically try reducing industry emissions is rare, and although many countries levy carbon or energy taxes, sub-sectors of industry are sometimes exempt or pay a discounted tax out of concern about competitiveness in international markets; despite this, "emissions from the industry sector are expected to draw increasing attention by policy-makers as they look for means to reduce domestic greenhouse gas (GHG) emissions."[30] Thus, as the pressure to decarbonize industry grows, carbon capture systems may begin to look increasingly attractive for these kinds of high-emitting facilities.

Overall, though, absent additional governmental policy that targets emission reductions more broadly instead of just from the electricity sector, it might be a bit more difficult to convince industrial plants than power plants to install carbon capture systems.

Proposal To Finance Carbon Capture Projects

Background

Some plants may want to be "early adopters" of carbon capture, perhaps to gain early access to Department of Energy financing or to meet rapidly approaching regulatory deadlines. Given the size of most carbon capture projects, there are a number of examples where difficulty obtaining adequate financing or unfavorable economic conditions at least partially led to the failure of deployment: The Petra Nova project, the only commercial power plant in the U.S. equipped with carbon capture, ceased operations in May 2020 due to low oil prices; Basin Electric withdrew plans as it was unable to develop a "workable business plan, even with $100 million of potential DOE funding;" Southern Company Services withdrew after the DOE's "accelerated negotiation schedule" did not allow enough time to commit to "a nearly $700 million investment;" American Electric Power withdrew, citing, among other reasons, "limited support from other outside partners to help fund the cost" and that it was not economically viable to invest in CCS without "legislation to [...] provide federal support for early CCS projects;" the DOE terminated its agreement with FutureGen 2.0 projects because, among other reasons, "the project did not proceed to construction because it had not [...] secured commercial financing"; the DOE terminated its agreement with Summit Texas Clean Energy after it could not "obtain additional private financing."[31] Projects with large estimated budgets were especially challenging because they "had difficulty obtaining financing."[31] **Clearly, financing carbon capture systems had been, and remains, one of the largest barriers to the technology's deployment.**

Some of the companies who own high-emission facilities might not have enough of a domestic tax bill to take advantage of 45Q, so they may lack financial incentive to build carbon capture systems on their own. However, with possible regulatory pressures coming and market-wide demands for more environmentally-friendly business practices becoming stronger, high-emitters may become more open to carbon capture systems.

On the other hand, there are an array of corporations pledging their businesses will be net-zero carbon emissions relatively soon. To meet these goals, it will be essential for these companies to support the decarbonization of as many of their inputs as possible: A company, for instance, cannot claim "zero emissions" if the electricity they use comes from unabated coal. Rather than buying offsets and otherwise maintaining the business's status quo, it is more responsible for a company to take direct responsibility for their emissions by using low-carbon inputs where possible. Otherwise, accusations of greenwashing — "conveying a false impression or providing misleading information about how a company's products are more environmentally sound"[32] — will likely be unavoidable.

A company's emissions that cannot reasonably be decarbonized must then be compensated by carbon offsets, to meet their "net-zero emissions" goals. Instead of purchasing offsets with dubious verifiability, a company (or collection of companies that share the same inputs) can take direct responsibility for emissions released throughout their supply chain by funding the installation of CCS systems on its suppliers with high direct emissions. Whether on a power plant for supplied electricity or an ethylene cracker for plastic feedstock production, financing capturing carbon for upstream suppliers' facilities could significantly reduce a company's own emission footprint, while allowing them to claim the offsets and yield the 45Q tax credits.

Unlike some of the owners of coal-fired power plants, many of these corporations that have pledged net-zero emissions pay large amounts of federal taxes consistently: Between 2017 - 2021, IBM's domestic tax bill has been up to $2.443 billion,[27b] DOW Inc. up to $337 million,[27c] and Verizon over $4.3B[27d] (Appendix I). Since carbon capture generates federal tax credits, these companies can meet carbon neutrality goals while fully realizing the value of the 45Q credits because their tax liabilities are large enough.

Proposal

Corporations could, as a partnership, jointly finance the carbon capture and sequestration systems for high-emitting suppliers (e.g. power plants, cement producers, chemical feedstock providers), especially if those facilities are at risk of prematurely ceasing operations due regulatory pressure. Many carbon capture systems are already joint ventures[33] (Appendix II), so this concept is not novel.

In concept, a group of corporations who have pledged carbon-neutrality, but are not themselves high direct emitters, could form a partnership. Ideally, these would be companies who consistently pay substantial federal income taxes, and who use the same suppliers (e.g. occupy the same electric grid, purchase from the same chemical facility, use the same cement or steel suppliers, etc.)— so they can reduce their scope 2 and 3 emissions for discounted rates.

A simple example is given below to illustrate the idea in more detail:

Assume three of the MCSC partners— Verizon, DOW, and IBM— agree to such a partnership. For whatever reasons, assume Pennsylvania's Seward power plant, with its 525 MW capacity and 2.72 Mt of CO_2/year[34] is considering a carbon capture system. Verizon, DOW, IBM, and the Seward plant each pay for ¼ the cost of building the carbon capture system, and they agree to split the tax credits proportional to ownership (i.e. they all get ¼ of the tax credits generated). They contract other companies to transport and inject the captured CO_2 but do not allow them to claim any of the 45Q credits.

If we assume that this plant (1) receives $50 in tax credits per metric ton (i.e. the carbon dioxide is geologically stored instead of utilized, and sequestration begins after 2026), and (2) is fitted with a carbon capture system that captures the industry standard of about 90% of carbon emissions, the plant would generate about $122,400,000 in tax credits per year, or $30,600,000 for each owner.

However, the average projected cost of capture, transport, and storage per metric ton of CO2 for coal in Pennsylvania is around $60 in 2018 dollars.[35] Using this number, the plant would have to pay $146,880,000 in costs per year, or $36,720,000 for each owner. Assuming the full value of the tax credits are realized each year, this suggests that each owner would have to actually pay a total of $6,120,000 to avoid 612,000 tons of CO_2, **or $10 per ton of CO_2.** Furthermore, this shows that a *negative* cost of avoiding carbon may actually be within striking distance.

Limitations and Conclusion

This scenario, of course, makes some simplifying assumptions and has some limitations:

The above example assumes that Verizon, DOW, and IBM are willing and capable of being joint owners of a massive project that is outside of their specialties: Currently, most, if not all, of the owners of the joint-venture CCS projects are in the energy industry[33] (Appendix II)— not telecommunications, chemical manufacturing, or technology companies. If the partnership structure could somehow limit the investing companies' exposure to the carbon capture plant's operations, while still yielding the tax benefits and offsets, that would be ideal.

At the same time, the effect of carbon capture on a firm's individual inputs could be diluted in decentralized markets: The effect of, for instance, putting the carbon capture system on a power plant could be impossible to measure as the electricity market has many different generators, each with different carbon-intensities. Thus, the benefit of "decarbonizing the inputs" could be diluted to obscurity, blunting the investor firms' realized scope 2 emission reductions.

Furthermore, the $10 per ton of CO_2 abated assumed that each of the investing companies was able to fully realize the value of the 45Q tax credits— that is, their tax liability was consistently higher than the tax credits generated. Should this assumption be broken— whether the federal corporate tax rate decreases, a recession plummets the corporation's taxable income, or if the high-emitting facility's production fluctuates— the abatement cost of CO_2 may have to rise.

Convincing direct-emitters to install carbon capture systems might also be nontrivial. As alluded to before, industrial and power plants have little incentive to reduce emissions— especially since CCS installation will at least temporarily disrupt operations during construction, and potentially complicate future operations. Considering that the claim period for 45Q is only 12 years after it is placed in service,[6] what happens after could be of concern for all parties involved in the project. Absent incentives to capture CO_2 — in the form of carbon taxes or cap-and-trade systems, a significant market demand for it, or direct regulation— emitters might be opposed to the proposal.

In a similar vein, the projection of $60 / Mt CO_2 could provide some preliminary insight, but there is still significant uncertainty in the true costs of capturing carbon and storing it, complicating firms' ability to build workable business plans. For example, this number was an average of a single state for just coal: There is significant variation in the individual projections depending on state, CO_2 source (e.g. coal or natural gas), and the type of storage site (e.g. onshore or offshore; oil and gas fields or saline),[35] which is somewhat hidden by just looking at the average (Appendix III). On the other hand, this paper's discussion only considers the 45Q tax incentive, so it is possible that considering state-level incentives in conjunction could make this kind of proposal more attractive.

Despite its limitations, if the cost to avoid one metric ton of carbon is, in practice, truly around $10, it becomes competitive with any other carbon offset method, as nature-based offsets are typically between $4 and $50.[36] Given carbon capture's advantages over reforestry and renewable energy projects, and the mutually beneficial nature of the partnership among corporations and their upstream suppliers, this proposal should be considered as an innovative way to meet any corporation's net-neutral pledges.

Appendix

I. Sample Companies' Income Tax - Current Domestic per Year (in millions USD)

	2021	**2020**	**2019**	**2018**	**2017**
Duke Energy[27a]	-	-290	-289	-658	-243
IBM[27b]	535	657	246	-215	2443
DOW[27c]	2	-172	-262	337	-
Verizon[27d]	2,290	3,907	1,492	2,928	4,307

II. Examples of Joint Venture Carbon Capture Projects:

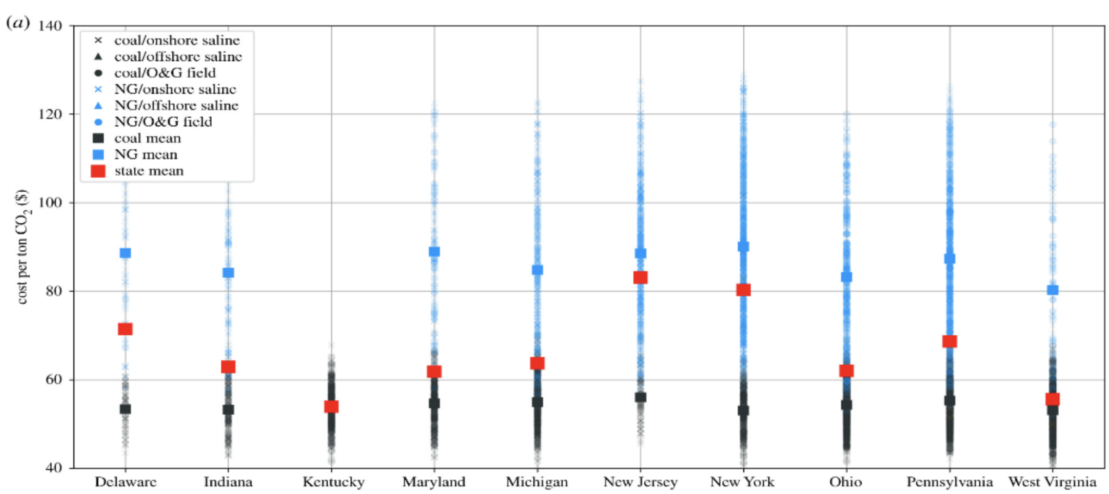
Petra Nova - NRG Energy (50%) & JX Nippon Oil & Gas Exploration (50%)[33a]

Bayou Bend Offshore CCS - Chevron (50%), Talos Energy (25%), Carbonvert (25%)[33b]

Quest CCS - Shell (60%), Chevron (20%), Marathon Oil (20%)[33c]

Gorgon Project - Chevron (47.3%), ExxonMobil (25%), Shell (25%), Osaka Gas (1.25%), Tokyo Gas (1%), JERA (0.417%)[33d]

III. Cost of capture, transport and storage of CO emissions organized by state, with the total cost spatially assigned to the location of the CO_2 emissions source[35]



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