Potential greenhouse gas emissions associated with the deepening of the Matagorda Ship Channel

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Background

In 2019, the US Army Corps of Engineers completed an Environmental Impact Statement (EIS) for increasing the channel dimensions of the Matagorda Ship Channel, which serves the Port of Calhoun near the city of Port Lavaca, Texas[1].

The EIS stated that the proposed deepening of the Channel would help enable a new activity at the Port of Calhoun (the Port): exporting crude oil and condensates (which are another form of oil).

As found by the EIS, crude oil exports from the Port were foreseen to reach as high as 3.6 million metric tons of oil per year, equivalent to about 26 million barrels annually, or an average of 71,000 barrels per day. (A metric ton of oil is about 7.24 barrels[2].)

However, since the EIS was published in 2019, the existing infrastructure (pipeline and terminal) at the Port of Calhoun has been purchased by a new owner, Max Midstream. The company has dramatically expanded the scope of the proposed project, calling for exporting as much as 650,000 barrels per day of crude by 2023, or nearly ten times the size envisioned by the US Army Corps in the 2019 EIS[3].

An increase in crude oil exports of that scale, relative to what was envisioned in the 2019 EIS, would have a significant effect on global climate change. Namely, by expanding the flow of oil from the U.S. to the global market, global oil production and consumption would rise, which would increase global greenhouse gas emissions. These new potential impacts should be disclosed.

To demonstrate the significance of the greenhouse gas emissions associated with the proposed project, this memo estimates how the deepening of the Matagorda Ship Channel could affect US oil production, global oil consumption, and the global greenhouse gas emissions from burning oil.

Estimating the incremental greenhouse gas emissions of an energy infrastructure project

Infrastructure projects that affect supply or demand of oil affect the price of oil and, in turn, oil consumption and greenhouse gas emissions from producing and burning oil[4–6]. Estimating the incremental, or “net” effect of such a project involves evaluating how the project will change energy markets compared to if it were not built[7].

In the case of an oil export terminal like the proposed expansion at the Port of Calhoun, the availability of greater, and lower-cost crude oil export capacity from the US Gulf Coast region enables an increased supply of low-cost oil to the global market.

The more oil is available (and at lower cost), the lower the global price of oil, and the more oil is consumed. The more oil is consumed, the higher are greenhouse gas (GHG) emissions from producing and burning oil[5,8,9].

Estimating this incremental effect on GHG emissions involves assessing each step in the chain of causation[7], from the project being built, to how that would affect energy markets, to how that would change global emissions. These steps are, as applied to the channel deepening project at the Port of Calhoun :

1. How much oil is foreseen to be handled by the Port of Calhoun with the proposed project, compared to if the project did not proceed.
2. How new oil exports would affect the economics of oil production in Texas and neighboring states.
3. How the economics of oil production in this region affect global oil prices and consumption levels.
4. Lastly, how the change in oil consumption would affect global greenhouse gas emissions.

The discussion below addresses each of these steps in order.

The planned expansion at the Port of Calhoun.

Max Midstream's new plans, announced in media articles and company statements in late 2020 and early 2021[3,10–12], are to rapidly build out capacity at their Seahawk Terminal: new oil storage, pipeline connections, ship-loading births, and a dozen loading arms to fill vessels with crude oil.

These plans by Max Midstream would allow for substantially more crude oil to be export through the Port than had been envisioned in the 2019 EIS.

One reason the new plans would enable more oil is that the project would now allow for much bigger ships, and more of them. According to a company press release[12], once the channel is expanded and dredged, the Port would be able to load "Suezmax" vessels. Suezmax tankers can each load about 1 million barrels of oil[13], and which are therefore about 67% bigger than the "Aframax" vessels envisioned in the 2019 EIS[13]. Suezmax vessels have about double the capacity of the largest ships, called Panamax, that can currently access the Port[1,10].

In a news article posted on Max Midstream's website on April 12, 2021 (and which duplicates an article in trade publication *S&P Global: Platts* on April 6, 2021), the scale of the expansion was described:

> "The plan essentially is to grow crude export capacity from just more than 100,000 b/d now to about 325,000 b/d next year when new pipelines and Permian Basin connections are completed, and then to 650,000 b/d in 2023 when the dredging project is finished."[3,10]

These plans would allow for substantially more crude oil to be export than had been envisioned in the 2019 EIS, which instead foresaw maximum crude oil exports of only about 71,000 barrels per day (b/d) (Figure 1).

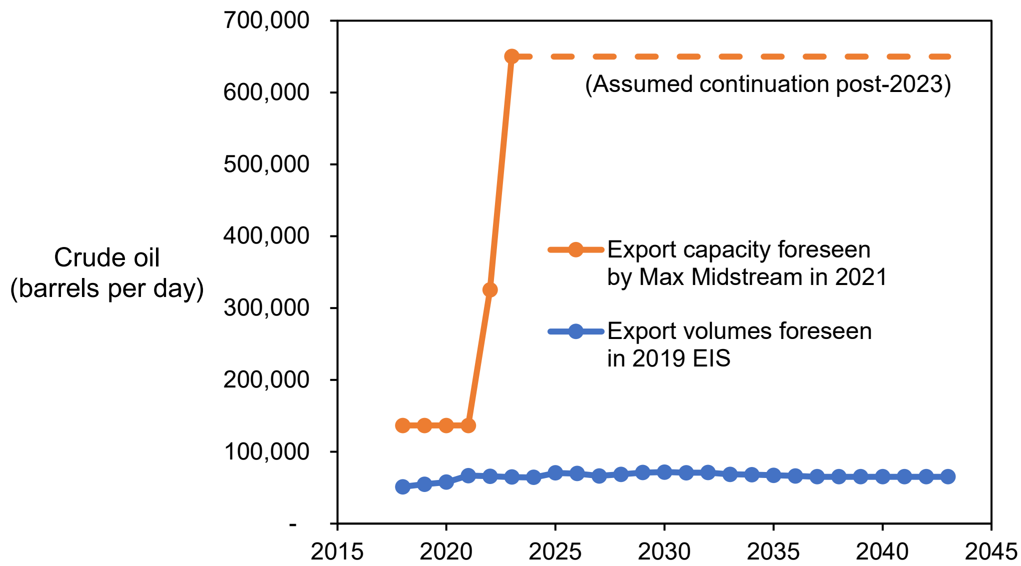

Figure 1. Port of Calhoun export capacity as envisioned in 2021 by Max Midstream compared to export volumes foreseen in the 2019 EIS

As shown in the chart, Max Midstream is envisioning the capacity for crude oil exports to be about 590,000 b/d *higher* in 2023 than the export volumes envisioned in the 2019 EIS.

Effect of the planned Port of Calhoun expansion on US oil production

Expanding crude oil exports by 590,000 b/d through the Port of Calhoun would change the economics of oil production in the greater US Gulf Coast region, especially Texas.

Public statements by Max Midstream provide one view on this:

> "The key to exporting Texas oil is transporting the commodity at an economic price from the sources to the ports, either through Houston or Corpus Christi ports, which are typically at or near full capacity with congestion. This project represents a game-changer, as it will open a third option—the Port [of Calhoun]."[12]

In other words, Max Midstream believes is that the expansion of the Port of Calhoun will allow for more Texas oil to be exported to the global market, and at lower cost, than otherwise would be the case.

This belief is in line with historical precedent. The availability of crude export capacity has enabled rapidly expanding volumes of Texas oil production and exports in recent years[14]. As shown in Figure 2, crude oil exports from the Gulf Coast region (called U.S. PADD 3) have expanded over the last five years, as has Texas oil production. The relationship is nearly one-to-one. (The best-fit line shows each increase in exports is associated with an increase in production of about 95% as much.)

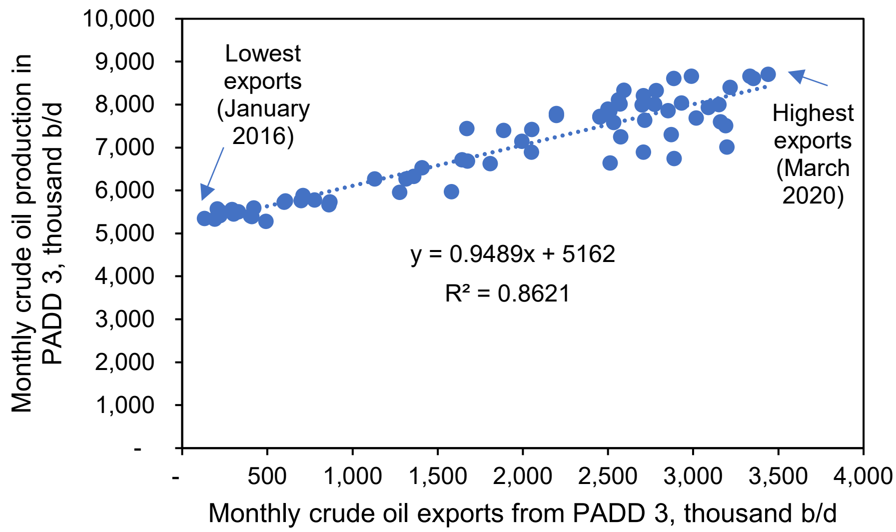

Figure 2. Monthly crude oil exports and production in PADD 3, December 2015 through August 2021 (Source: EIA 2021, https://www.eia.gov/dnav/pet/pet_sum_snd_d_r30_mbblpd_m_cur.htm)

This trend implies that, should the expansion in Port of Calhoun capacity be fully realized and crude exports to expand by 590,000 barrels per day, then Gulf Coast oil production would increase by about 95% as much, or 560,000 barrels per day. Another way to look at Figure 2 is that the growth of U.S. Gulf Coast oil production depends on increasing exports. This is because US oil consumption has been flat in recent years (and is expected to continue to either hold flat[15] or decline if the US follows through on its emission-reduction pledges[16]), and so, to find new buyers, any expansion in oil production must be exported.

Alternative view on Port of Calhoun expansion on US oil production

The near one-to-one relationship between crude oil exports and production is consistent with the view, as expressed by both Max Midstream and the 2019 EIS, that overall export capacity from the Gulf Coast is limited. In that view, new exports from the Port of Calhoun would lead to increased oil production and not reduce crude oil exports from other export terminals.

Still, it is possible that, if other ports (e.g., to the southwest, near Corpus Christi, or to the northeast, near Houston) are instead *near* (but not *at*) full capacity, then the situation could be more complicated. In such a case, new export capacity may not lead to as much new oil production, since producers have more choice about where to ship their oil, and therefore face less competition.

Past trends in how infrastructure bottlenecks affect oil prices can provide some insight into this question.

In Texas, oil is either priced at the local price of oil, so-called West Texas Intermediate (WTI), or at the world price, called Brent. The difference between these two prices reflects, in large part, to what degree the flow of oil from US to the world (or vice versa) is constrained, such as by transport or export bottlenecks. This is because, as described in more detail below, if and when bottlenecks constrain the flow of oil, US producers that can't access the broader (e.g. global) market must more aggressively compete with each other to sell oil, and that competition drives down the price.

To see this effect in more detail, it is helpful to look at past trends in WTI and Brent prices. In theory, if there were no barriers or disincentives to trade, then the local (WTI) and global (Brent) prices would be nearly identical, perhaps with just relatively small differences representing shipping costs to end destinations[17,18].

And, for most of the last few decades, this theory has largely been borne out: WTI and Brent prices have been nearly identical from 1987 through 2011 (Figure 3). During this time, there has been a ready domestic demand for oil (US oil consumption was much higher than domestic production), and there were few constraints on oil imports.

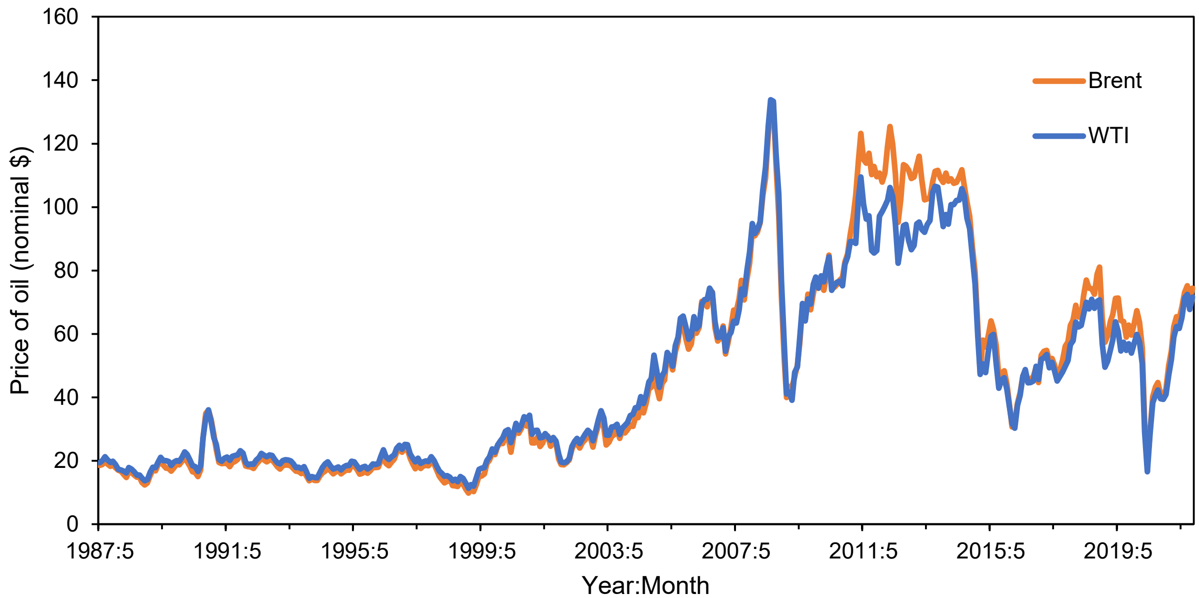

Figure 3. Monthly spot oil prices (nominal) from 1987 to the present

But then the situation started to change, when bottlenecks stated occurring in the early 2010s. At that time, US oil production was skyrocketing (due largely to developments in hydraulic fracturing technology and policy). Crude oil exports were banned, however (as they had been since the 1970s), and there were also bottlenecks that constrained oil flow within the U.S[19]. Together, these factors led to an over-supply of domestic oil, and which meant that producers had to compete aggressively with each other to sell oil, driving the local WTI price down below the international, Brent price[18]. For example, from January 2011 to December 2015, WTI oil sold for about $11 per barrel less than Brent; for a brief moment, the discount was as high as $27 per barrel (Figure 3).

But when the constraints were removed -- the crude export ban was lifted in 2015 -- the difference ("spread") between WTI and Brent in 2016 declined, averaging instead just $0.40 per barrel.

Since 2016, the WTI-Brent spread has crept up again, averaging over $6 per barrel in 2018 and 2019. This may reflect the presence of new bottlenecks. Namely, according to some observers, including at the

US Department of Energy, the WTI-Brent spread in 2018 and 2019 reflected a new constraint on exports. Even as crude oil exports were no longer *legally* limited, *physical* constraints in port capacity were putting a wedge between Brent and WTI prices[20].

In summary, the existence of a spread between WTI and Brent oil prices indicates how, when crude oil transport and export capacity is limited, that local oil producers may receive less per barrel less than they otherwise would. Recently (post the onset of Covid-19 in early 2020), the WTI-Brent differential has been about $2.30 per barrel.

This observation allows for an alternate method to analyze the question of how the project to expand crude oil export capacity at the Port of Calhoun could affect the economics of oil production in the Gulf region.

Namely, if Max Midstream's new plans to increase exports through the Port of Calhoun were to erase the current, $2.30 per barrel discount on WTI oil, new Gulf Coast oil wells and fields would be that much more profitable, allowing more of them to be approved for development, leading to higher future oil production.

Figure 4 shows how this would play out. Gulf Coast oil producers would now receive an added $2.30 per barrel -- the full, $50 per barrel Brent oil price foreseen by Rystad Energy – and not the lower WTI price. In that case, the dark blue oil fields would become economic and be developed, whereas without the added export capacity, they would not. US Gulf Coast oil production would increase by about 330,000 barrels per day, from just under 10 million barrels per day to about 10.3 million barrels per day.

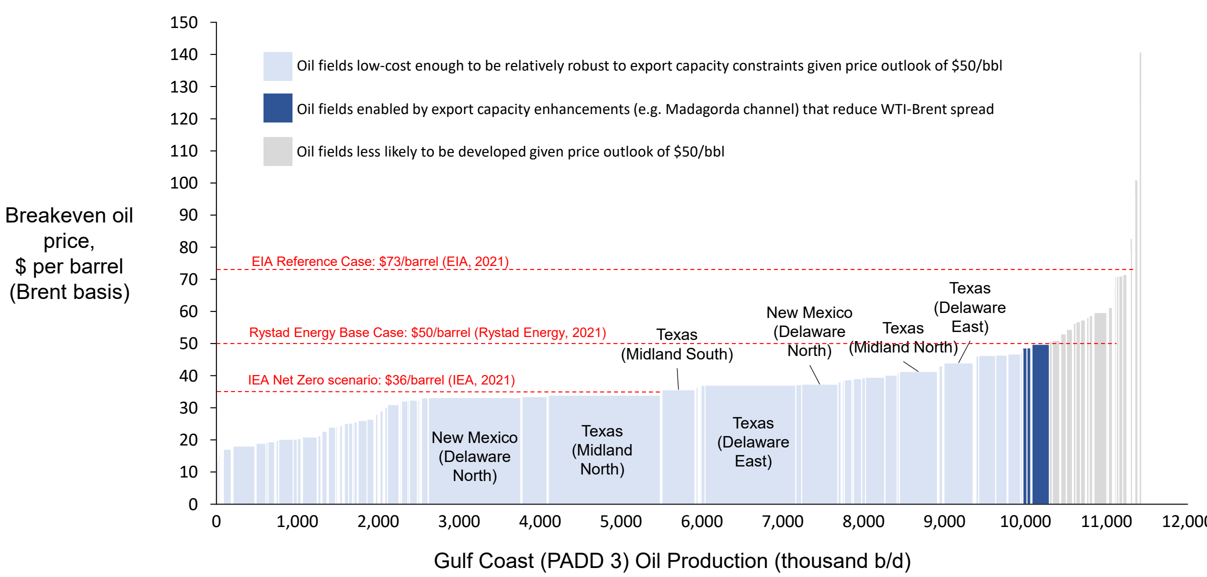

Figure 4. Cost curve of Gulf Coast oil production in 2030 from Rystad Energy[21], showing new oil (dark blue) that could be enabled by Matagorda expansion and which amounts to about 330 thousand b/d

This more nuanced look at WTI-Brent price spreads suggests that, instead of the Port of Calhoun expansion (relative to the situation foreseen in the 2019 EIS) leading to a near one-for-one (95%) increase in Gulf Coast oil production (as suggested by historical relationships between export and production increases), that it could instead lead to somewhat less. More specifically, in this scenario, 330,000 barrels per day of expanded oil production would represent just over half of the planned increase in exports.

Given the uncertainties in future oil prices (as well as in the development of other Gulf Coast oil export terminals), both of these possibilities are plausible. As a result, in the calculations that follow in the next sections, I will examine the case in which Max Midstream's planned expansion of the Port of Calhoun leads to either a 560,000 or 330,000 barrel per day increase in Gulf Coast oil production in the years ahead. Of course, while the precise outcome is uncertain, these possibilities help illustrate a range of potential outcomes.

Effect of expanded Gulf Coast oil production on global oil price and consumption

When oil supply increases, oil prices decline, because oil producers face more competition. And, when oil prices decline, oil consumption increases[4,8,22], because consumers drive and fly more, purchase less efficient vehicles, and use their less-efficient vehicles more often.

The effects of shifts in oil supply can be quantified using well-established economic principles and models, including straight-forward, elasticity-based models from economics textbooks[23], scientific studies[4], and U.S. government agencies[9,24–26].

Here I estimate global oil price and oil consumption using a simple oil market model, parameterized by elasticities. Elasticities describe how a change in price effects either oil demand or supply (and vice versa). By using both elasticities of supply and demand, an analyst can estimate how an increase in local production translates to a change in global oil price and production. Namely, an increase in global oil production is translated – and assuming this change is relatively small on a global scale – to a change in consumption by multiplying by the ratio of the elasticity of demand to the difference between the elasticity of demand and the elasticity of supply[4].

Using an elasticity of supply of 0.6 (meaning a 1% increase in price translates into a 0.6% increase in supply) and an elasticity of demand of -0.3 (meaning a 1% increase in price translates into a -0.3% change in demand), an increase in oil production in the Gulf Coast would therefore yield an increase in global oil consumption of 0.33 (33%) as much. Table 1, below, shows the effect on global oil price and consumption from each of the two expanded oil export and Gulf Coast production scenarios described in the previous section.

Expanded Gulf Coast oil production	**Resulting decrease in global oil price**	**Resulting increase in global oil consumption**
330,000 b/d	$0.22 / b	110,000 b/d
560,000 b/d	$0.37 / b	190,000 b/d

Table 1. Effect of expanded Gulf Coast oil production on global oil price and consumption

In this calculation, my source for the elasticity of supply value is a global oil supply curve produced by Rystad Energy, and is the same value used in my recent peer-reviewed scientific work[27,28]. The source of the elasticity of demand value of -0.3 is the high-end of the range of -0.2 to -0.3 reported by Hamilton[29]; a value at the higher end of this range is commonly believed to be more consistent with the greater current availability of electric vehicles, and is still lower than an alternative, commonly used higher-end value of -0.5 as reported by Raimi[5]. In my expert opinion, these represent reasonable values, given current oil price outlooks and the expanding alternatives to oil in the transport sector, which is by far the largest sector using oil. These values are also within the ranges used in other studies, and therefore should yield reasonable results for decision-makers, even as other values could also be used to explore a wider potential array of outcomes.

Effect of increased global oil consumption on greenhouse gas emissions

According to the United States Environmental Protection Agency, a barrel of crude oil (or its derivatives) releases an average of 432 kg CO_2 once combusted[2]. When taking into account other sources and types of greenhouse gas emissions associated with a barrel of oil, such as the highly potent gas methane (CH_4) released at oil extraction sites, the full GHG emissions associated with a barrel of crude oil is at least 10% higher than this figure, or about 480 kg CO_2-equivalent (CO_2e) for a barrel of oil from the Gulf Coast[30]. (CO_2 *equivalent* is a standardized metric that aggregates the weights of gases with different potencies according to their relative "global warming potentials").

This total estimate of 480 kg CO_2e per barrel of oil allows for a straight-forward estimate of how the increase in global oil consumption from Table 1 translates into global greenhouse gas emissions, as shown below in Table 2.

Expanded Gulf Coast oil production	**Resulting increase in global oil consumption**	**Resulting increase in global greenhouse gas emissions from producing and burning oil**
330,000 b/d	110,000 b/d	19 million metric tons CO_2 per year
560,000 b/d	190,000 b/d	33 million metric tons CO_2 per year

Table 2. Effect of expanded Gulf Coast oil production on global oil consumption and greenhouse gas emissions from burning oil

As shown, I estimate that the proposed project at the Port of Calhoun, as envisioned by Max Midstream, will result in a global increase of 19 to 33 million metric tons of CO_2e annually from producing and burning oil compared to the situation envisioned in the 2019 EIS. This is equivalent to the annual GHG emissions from about 4 million to 7 million passenger vehicles[31].

This estimate is subject to uncertainties, as is any estimate of GHG emissions associated with an infrastructure project that changes energy markets in ways that may not be perfectly foreseen. For example, as discussed above, it is possible that the expansion of crude oil exports at the Port could lead to an increase in Gulf Coast oil production higher or lower than the values calculated and used here.

Further, another source of uncertainty relates to how many emissions would be released associated with each barrel of added production. For example, if, in response to slightly lower oil prices caused by the project (Table 1), consumers could increase their oil consumption at the expense of other fossil fuel-based sources of energy, such as coal or gas-fired electricity. In that case, my incremental estimate of 19 million to 33 million metric tons CO_2 could be somewhat lower. However, as the global energy transition accelerates, the marginal source of the main substitute for oil – electricity – is no longer mainly fossil fuels, but instead primarily very low-carbon renewable power[32]. This strong trend towards renewable power suggests that any shift away from electricity would have relatively minor effects on my incremental GHG emissions estimate.

Another source of uncertainty relates to what other sources of oil production would be partially displaced by the new oil from the US Gulf Coast[4]. (Since I estimate each added barrel of Gulf Coast oil would increase global consumption by 0.33 as much, that implies the remainder, 0.67 as much, would displace other production.) If those other sources were more GHG-intensive than Gulf Coast oil, such as oil from Canadian oil sands, then my incremental estimate would also be somewhat lower. Or, if other sources were less GHG-intensive than Gulf Coast oil (such as oil from Norway or Saudi Arabia)[33], my incremental estimate would be somewhat higher. There are a variety of perspectives on what sources of oil are mostly likely to compete with US oil in the long-term[27,34,35], so, for simplicity, here I assume that competing oils or no more or less GHG-intensive than Gulf Coast oil.

Damages associated with this increase in global greenhouse gas emissions

Lastly, one way to evaluate the increase in global GHG emissions associated with the increased oil exports from the Port is to quantify the economic damages that would result from those emissions. This approach, called the Social Cost of Greenhouse Gases (or, sometimes, Social Cost of Carbon), tallies the costs of greenhouse gas emissions that arise from expected harms, such as human health effects from extreme temperatures and deteriorated air quality, agricultural productivity losses, property damages, biodiversity losses, and many other damages[36]. The U.S. Government's Interagency Working Group (IWG) on Social Cost of Greenhouse Gases publishes values, in terms of monetized damages per ton of GHG emissions, to use for this purpose[36]. To indicate the scale of damages expected from 19 million to 33 million metric tons CO_2e per year, the table below shows expected average annual global damages using two of the several alternative values presented by the IWG. The IWG's central case is the 3% discount rate case, for which the cost is about \$51 per metric ton CO_2 in 2020, rising to about \$62 per metric ton CO_2 in 2030, and higher thereafter. IWG also explore a lower, 2.5% discount rate case, for which the cost is about \$76 per metric ton CO_2 in 2020, rising to \$89 per metric ton CO_2 in 2030, and higher from there. (A discount rate is a measure of how much one discounts, or reduces in value, each successive future year, and is intended in this context to represent how much weight to put on future generations.)

As shown in the table, using these estimates of the social cost of greenhouse gases yields expected global damages resulting from expanded oil exports at the Port of Calhoun in the range of about \$1 billion (for the lower of my emissions estimates and the 3% discount rate case) to about \$3 billion (in the higher of my emissions estimates and the 2.5% discount rate case).

Expanded Gulf Coast oil production	Resulting increase in global greenhouse gas emissions from producing and burning oil	Annual damages – assuming 3% discount rate	Annual damages – assuming 2.5% discount rate
330,000 b/d	19 million metric tons CO_2 per year	\$1.2 billion	\$1.7 billion
560,000 b/d	33 million metric tons CO_2 per year	\$2.0 billion	\$2.9 billion

Table 3. Estimated annual climate costs resulting from the Port of Calhoun expansion.
Note: estimates here are for the year 2030 and presented in real, 2020 dollars. Since the social cost of greenhouse gases is expected to rise faster than the rate of inflation (1%-2% annually in real terms)[36], damages in years before 2030 would be somewhat less, whereas damages in later years would be higher. The year 2030 is chosen to represent a period long enough away that the expansion of the Port of Calhoun would be complete and the resulting increase in Gulf Coast oil production experienced, while still being close enough that the economic modeling approach used here to estimate the emissions increase is reasonably reliable

These estimates of climate costs are very conservative, however. As both the U.S. Government's IWG and outside experts have noted, recent economic conditions suggest a 2% discount case would be more appropriate, and which would lead to social costs of greenhouse gases of more than twice the 3% discount rate values[36,37]. Furthermore, many types of damages are not included in the IWG's estimates, or are insufficiently included due to data limitations[38]. True damages are likely to be higher.

Summary

Max Midstream is proposing to expand crude oil exports at the Port of Calhoun. The level of exports envisioned, up to 650,000 barrels per day by 2023, is nearly 10 times higher than the Army Corps of Engineers envisioned in their 2019 EIS for the project, then under different ownership. As the analysis above demonstrates, this expanded scope of the project could lead to a rise in Gulf Coast oil production, with global implications.

Namely, a previously unforeseen expansion in oil production would put downward pressure on global oil prices, leading to increased global greenhouse gas emissions from producing and burning oil of around 19 million to 33 million metric tons CO_2e. Emissions of this scale would lead to billions of dollars in global economic damages each year.

As with any estimate of how global energy markets may respond to a major new infrastructure project, there is uncertainty in these estimates. Nonetheless, straight-forward methods are available to do the calculations, and a potential increase in global GHG emissions of this scale should be disclosed.

About the author

Peter Erickson is a senior scientist and the climate policy program director at the U.S. Center of the Stockholm Environment Institute. He has worked in environmental research and consulting for over 20 years. For the last thirteen years, his professional focus has been on greenhouse gas (GHG) emissions accounting and the role of policy mechanisms in reducing GHG emissions. He has conducted and led research projects on these topics on behalf of numerous partners and clients, including international institutions (e.g., the United Nations Framework Convention on Climate Change, the World Bank), the U.S. government (U.S. Environmental Protection Agency), state governments (e.g., State of Washington, State of Oregon), and local governments (e.g., City of Seattle). His peer-reviewed studies on how policies, actions, or infrastructure projects increase or decrease greenhouse gas emissions have been published in major scientific journals, including *Nature, Nature Climate Change, Environmental Research Letters,* and *Climatic Change.* His work on how increasing oil supply affects oil markets and greenhouse gas emissions has been cited by the U.S. State Department[35], the United States Court of Appeals for the Ninth Circuit[26], and the District Court of the Hague (Netherlands)[39], among others. He works out of the SEI office in Seattle, at 1402 Third Avenue, Suite 925, Seattle, Washington, 98101.

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