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Office of the Chief Economist
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Procedures for Quantification, Reporting, and Verification of Greenhouse Gas Emissions Associated With the Production of Domestic Agricultural Commodities Used as Biofuel Feedstocks

Submitted by:
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Introduction

Charm Industrial (Charm) is one of the world's leaders in delivered tons of permanent carbon dioxide removal (CDR), utilizing carbon captured by plants in agricultural and forestry residues and permanently storing it in geologic formations. Therefore, while Charm doesn't turn agricultural biomass into biofuel, Charm is deeply invested in appropriately measuring the greenhouse gas emissions associated with agricultural practices.

Charm's comments include responses to the RFI questions, and center around these key priorities we request the agency consider in its review:

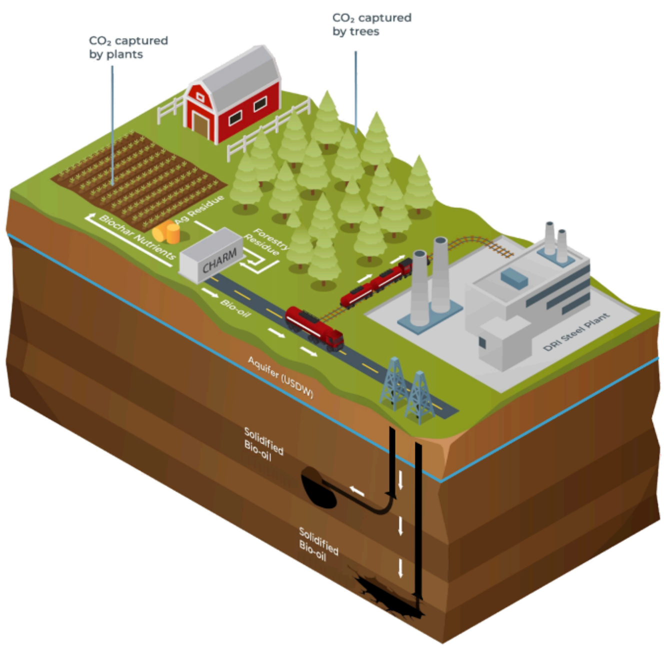
1. We encourage the agency to assess the impacts of residue removals and to quantify both the potential for climate benefit that residue removal can provide, such as in decreasing nitrous oxide (N_2O) emissions in some regions, as well as the sustainable limits of residue removal as a function of environmental and farm management factors.
2. We encourage the USDA to perform initial quantifications of climate smart farming practices at a regional, state or sub-regional scale, which will enable the industry to proceed with operational certainty.

Background on Charm

Charm Industrial removes carbon from the atmosphere by capturing carbon dioxide in plants, converting plant biomass into an injectable bio-oil and biochar, and permanently sequestering this bio-oil underground in geological storage. The agricultural biomass residues (e.g., corn stover, wheat straw) and forestry residues that Charm uses would otherwise decompose or burn, releasing the embodied carbon dioxide into the atmosphere. Charm uses fast pyrolysis to quickly heat the biomass to 500°C, breaking down the biomass into a carbon-rich bio-oil that can be easily transported, quantified, and injected for permanent sequestration or used to create a syngas to decarbonize industry. The produced biochar can then be used as an agricultural amendment or sequestered as carbon removal.

Charm's key technology is a custom-built, mobile pyrolyzer that moves to each farm or forest landing site to process non-edible, residual biomass into bio-oil. The produced bio-oil is transported to a network of existing EPA- and state-regulated injection wells, where the bio-oil is pumped underground for permanent storage. Bio-oil is denser than most subsurface fluids, including brine and hydrocarbons (and substantially denser than supercritical CO_2, which is more buoyant than those subsurface fluids), so it sinks within the reservoir. A chemical reaction called auto-polymerization solidifies the bio-oil, locking it in place for a certified period of at least 1,000 years. The net effect is permanent sequestration of the CO_2 captured from the atmosphere by the plants.

The image to the right is a concept drawing of Charm's bio-oil sequestration process. This new, patent-pending method effectively captures atmospheric CO_2 in biomass and sequesters it in formations that have stored oil and gas for hundreds of millions of years. Charm has delivered over 7,000 tonnes, accounting for a large portion of the permanent carbon removal to date.



Comments

Qualifying Practices

(1) Which domestic biofuel feedstocks should USDA consider including in its analysis to quantify the GHG emissions associated with climate smart farming practices? USDA is considering corn, soybeans, sorghum, and spring canola as these are the dominant biofuel feedstock crops in the United States. USDA is also considering winter oilseed crops (brassica carinata, camelina, pennycress, and winter canola). Are there other potential biofuel feedstocks, including crops, crop residues and biomaterials, that USDA should analyze?

> As noted in DOE's 2023 Billion Ton Report, agricultural residues and wastes make up over 15% of the potential available biomass in a mature market biomass potential scenario. Given the magnitude of the opportunity, USDA should analyze crop residues as a feedstock for biofuels, and other bio-based products, such as CDR. Specifically, USDA should provide analysis with respect to the baseline fate and GHG impact of residues

under current practices, and the extent to which residues can be harvested for other purposes, such as CDR, without negative GHG impacts resulting from increased fertilizer requirements or diminished soil carbon levels.

(2) Which farming practices should USDA consider including in its analysis to quantify the GHG emissions outcomes for biofuel feedstocks? Practices that can reduce the greenhouse gas emissions associated with specific feedstocks and/or increase soil carbon sequestration may include, but are not limited to: conservation tillage, no-till, planting of cover crops, incorporation of buffer strips, and nitrogen management (*e.g.,* applying fertilizer in the right source, rate, place and time, including using enhanced efficiency fertilizers, biological fertilizers or amendments, or manure). Should practices (and crops) that reduce water consumption be considered, taking into account the energy needed to transport water for irrigation? Should the farming practices under consideration vary by feedstock and/or by location? If so, how and why?

As grain yields, and specifically corn yields, have continued to increase in modern agriculture, so have the yields of corn residues, which now result in approximately 100 pounds/acre/year of dry matter. With these increased rates of residue production, researchers are now identifying many regions and farming systems in which residue removal can reduce field-scale greenhouse gas emissions meaningfully. This occurs because residue removal can improve soil nitrogen cycling and limit nitrogen losses to the environment, particularly in the form of nitrous oxide, a potent greenhouse gas. Given this emerging research, we believe that USDA should strongly consider residue removal practices when determining the greenhouse gas emissions associated with associated feedstocks.

Because the impacts of stover removal are dependent on local conditions, largely moisture, we suggest that USDA take a state or regional level approach in setting guidelines, and related emissions impact factors, associated with removal rates. This guidance should address removal rates for which a positive GHG impact can be achieved, as well as the removal rates which should not be exceeded in order to avoid detrimental GHG impacts.

Charm's model, as a provider of biomass-based permanent carbon dioxide removal, is to convert residue feedstocks that would otherwise decay or burn into a permanent store of carbon. To date, absent any formal guidance, we have been conservative in the rate of stover or residue removed from any given farm where we source material. By considering the GHG impact of stover removal explicitly, USDA can provide guidance that best supports maximizing the impact of stover-fed CDR and other beneficial uses of this residue.

(4) For practices identified in question 2, to what extent do variations in practice implementation affect the overall GHG benefits of the practice (*e.g.,* the date at which cover crops are harvested or terminated)? What implementation strategies maximize the GHG benefits of these climate-smart agriculture practices?

The proportion of crop residues harvested is a key parameter in assessing the GHG impacts resulting from harvest of crop residues as biofuel feedstocks. Maintaining a sustainable rate of residue retention can help to maintain nutrient and soil carbon stocks and protect against soil erosion.

Conversely, emerging research is increasing our knowledge about the emissions impacts from residues remaining on the field. In some conditions, large portions of retained residues (i.e.., 75% or 100% of residues retained on a field) may be creating release of nitrogen, in the form of nitrous oxide, into the environment. These relationships merit research and incorporation of that data in modeling.

The optimal levels of residue harvest and retention is a function of several factors, including crop rotations, tilling practices, and environmental conditions, including precipitation. As such, guidance and evaluation of residue harvest and retention must be provided as a function of these factors.

(6) Given the degree of geographic variability associated with each practice, on what geographic scale should USDA quantify the GHG net emissions of each practice (*e.g.,* farm-level, county-level, state, regional, national)? What are the pros and cons of each scale? How should differences in local and regional conditions be addressed?

Charm encourages USDA to provide a set of guidance general enough that it does not impose the tremendous MRV burden of having to measure on-the-ground conditions at a farm-by-farm level. That being said, we understand that the nitrous oxide impacts of stover removal are dependent on field conditions, primarily driven by moisture. Given that, state or regional granularity would be appropriate.

(15) What records, documentation, and data are necessary to provide sufficient evidence to verify practice adoption and maintenance? What records are typically maintained, why, and by whom? Where possible, please be specific to recommended practices (*e.g.,* refer to practices identified in question two).

Charm utilizes carbon accounting protocols maintained and certified by Isometric, which identify best-in-class standards for data, documentation, etc. necessary to verify practices, including residue removal. Information on MRV policies under the protocol are available online:

- Bio-Oil Geologic Storage Protocol: https://registry.isometric.com/protocol/bio-oil-geological-storage
- Biomass Feedstock Accounting: https://registry.isometric.com/module/biomass-feedstock-accounting

Verifier Qualifications/Accreditation Requirements

(21) How could USDA best utilize independent third-parties (*i.e.,* unrelated party certifiers) to bolster verification of practice adoption and maintenance and/or supply chain traceability? What

standards or processes should be in place to prevent conflicts of interest between verifiers and the entities they oversee?

> As discussed in question 15, Charm utilizes carbon accounting protocols maintained and certified by Isometric, a CDR registry that conforms with the Isometric Standard, a stringent set of criteria for assessing carbon removal activities. In order to qualify to operate as a Validation and Verification Body (VVB) that reviews credits for consideration under the Isometric Protocol, Isometric specifies that:
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>> "VVBs must be able to demonstrate accreditation from: an International Accreditation Forum member against ISO 14065 or other relevant ISO standard, including but not limited to ISO 14034, ISO 17020, ISO 17029; or a relevant governmental or intergovernmental regulatory body.
>>
>> Alternatively, on a case-by-case basis, if VVBs are able to demonstrate to Isometric that they satisfy all required Verification needs and competencies required for the relevant Protocol and follow the guidelines of ISO 19011 or other relevant standards, they may be approved."
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> More information on MRV policies under the protocol are available online:
> - Bio-Oil Geologic Storage Protocol: https://registry.isometric.com/protocol/bio-oil-geological-storage
> - Biomass Feedstock Accounting: https://registry.isometric.com/module/biomass-feedstock-accounting

Thank you for your consideration of these comments.