Response to Public Comments

A Greenhouse Gas Emissions Reduction Measurement and Monitoring Methodology for Carbon Capture and Storage Projects in Oil and Gas Reservoirs has been developed by Blue Strategies and submitted to ACR for approval through the public consultation and scientific peer review process.

The methodology was posted for public comment from December 26, 2012 through January 31, 2013. Public comments and responses by the authors are documented below.

In addition ACR held a stakeholder consultation webinar on January 18, 2013. Questions and answers from the webinar are included below as well, organized by appropriate section of the methodology.

Following public consultation, the methodology will undergo a blind scientific peer review by experts in the fields of CCS, EOR, and GHG accounting. Peer review comments and responses are summarized in a separate document.

A. General

	Comment	Commenter	Response	Changes to Methodology

1.1	I find nothing seriously wrong with the document itself - in so far as it limits itself to "Measurement and Monitoring". But I find it very strange that ACR would do anything to encourage the further production of oil and gas from any form of existing fossil fuel reservoir. Should such sequestration come about, the production of such oil and gas should be viewed as a societal negative. The CO2 resulting from any enhanced oil and gas production should also be viewed as a negative. New anthropogenic CO2 should be subtracted from the CO2 captured and sequestered. If that is the ACR intent, it is not clear in anything I found at your web site. You should leave such promotion to others. I also have quickly reviewed the February 2012 C2ES background document, entitled "A Green house Gas Accounting Framework for Carbon Capture and Storage Projects" by Mike McCormick. I have exactly the same concerns. Apparently an authoritative approach - but totally silent on the question of how to handle the newly produced gases, which so many of us are trying to stop - not encourage. I can only imagine that carbon credits, no matter whether there is an off-setting subtraction, must serve as a financial benefit to the oil and gas industry. This should be the last objective of ACR or any similar group. I would certainly not want to buy carbon credits for such a flawed	Ronal W. Larson, PhD, Past Chair and Fellow of the American Solar Energy Society (ASES)	The most recent Energy Information Agency (EIA) data indicates that in 2011, the US produced 5.65 million barrels per day (MMbbld) of crude oil while importing 8.94 MMbbld during the same period. So any incremental increase in domestic oil production through EOR would offset an equivalent quantity of imported oil that is produced by primary production processes which do not involve CO2 sequestration. The production of gas in the US and abroad also does not involve the simultaneous sequestration of CO2. In addition, the carbon footprint of the imported oil is also larger when you consider the CO2 emissions during transport of the produced crude to the US; often in large tankers over sea to US ports. Increasing domestic oil production also improves energy security by reducing our reliance on imports. Therefore the production of oil or gas by EOR should not be viewed as a societal negative. Since the oil and gas produced domestically by EOR displaces an equivalent quantity of current production (imported or domestic primary production), there are no incremental emissions of CO2 or other gases resulting from the combustion of the produced hydrocarbons. Additionally, the approach	

	product. I therefore strongly urge ACR to concentrate on sequestration sites that cannot produce new oil and gas. Also, the full long-term costs of deep underground sequestration should be compared with other sequestration approaches. Biochar will almost certainly cost less and be less risky. Analyzing CCS costs/risks for CCS makes no sense in the absence of discussion of the harm of the produced gases.		taken in this methodology is consistent with other GHG emission reduction methodologies, where emissions related to the use of the products are not included.	
1.2	It would be much helpful to define terms and abbreviations in the beginning of the protocol as well as employ a consistent glossary throughout the methodology.	Ambachew F. Admassie, Ethan Bio-Fuels PLC	Agree	Glossary added
1.3	I am very disappointed that ACR is supporting the coupling of CCS and EOR. Clearly the practice can only, repeat only, lead to more atmospheric carbon. I doubt very much that CCS is going to make sense even when the sequestered carbon is placed without intent for EOR - for a host of leakage reasons that I am sure you understand. An approach using CO2 from biomass (BECS/BECCS) might be worthy of your support, but I urge you to instead place ACR support behind biochar, where the sequestered carbon (char) can have exponentially growing soil benefits lasting for millenia.	Ronal W. Larson, PhD, Past Chair and Fellow of the American Solar Energy Society (ASES)	See response to 1.1	
1.4	Injecting CO2 to recover more fossil fuel, and claiming offsets while making more fossil fuel available for combustion seem to violate	Wolf Lichtenstein, Lightstone	The demonstration of additionality in the methodology is through meeting or exceeding a performance standard. Oil	

	additionality ... If anything a gift to the oil and gas industry. What am I missing?	Consulting, LLC (via webinar)	produced domestically through the use of CO2- EOR displaces imported oil that is produced by primary methods. Therefore there are no incremental emissions associated with the combustion of the produced oil. The methodology encourages the domestic production of oil with a lower carbon footprint due to the simultaneous injection and storage of anthropogenic CO2 that would otherwise be emitted to the atmosphere.	

B. Background and applicability

	Comment	Commenter	Response	Changes to Methodology
2.1	[Page 1, last paragraph] Specify that methodology is specific to oil and gas reservoirs (per title) as this is not otherwise clear from this introductory page, as it also refers to storage in saline aquifers.	Daniel Enderton, C12 Energy	Agree	Last para on Page 1 modified
2.2	[Page 2, 2nd paragraph] Change including to "including but not limited to" for list of potential sources.	Daniel Enderton, C12 Energy	Agree	Sentence modified
2.3	Would this CCS protocol be feasible in Asian territory, looking at the geomorphological/terrestrial features there? If yes, do we have any case studies implemented or in pipeline?	Keshav Jha, ICLEI-Local Government for Sustainability (via webinar)	The methodology was developed with a focus on CCS in North America. Since this methodology is currently seeking approval under the ACR, there are no case studies or projects either in the US or abroad that have been implemented	

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			using it.	
2.4	I am interested in how this methodology would apply to a scenario where CO_2 is produced with other hydro-carbon gases. An example would be La Barge (Exxon) facility and or Ft Nelson (Spectra - Canada, not in operation yet).	Chad Bown, BP (via webinar)	The methodology would apply to gas plants that produce other gases in addition to CO_2. Note that the methodology applies to the use of CO_2 in oil and gas reservoirs. The qualification of specific projects depends on each project's ability to meet the methodology's requirements (applicability, title, monitoring, etc.)	
2.5	Could this protocol be used to make CCS more economical for power plants looking to meet EPA's proposed new source performance standards for GHGs?	Ben Kaldunski, Argus Media (via webinar)	Yes, it could. If the quantity of CO_2 captured and stored exceeds the requirements imposed by the NSPS, then those excess reductions could qualify under the methodology (assuming other requirements are met). The monetary gains from the sale of their reductions could offset a portion of the costs of CCS implementation.	
2.6	What further plans might there be for CH_4 (methane) procedure development?	Christopher Philipp, The Climate Institute (via webinar)	Currently there are no plans for methane. While the injected CO_2 stream may contain some methane (e.g., CO_2 streams from gas plants), which is also simultaneously stored with CO_2, the methodology does not credit the methane reductions as a conservative measure.	

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2.7	Regarding to the N2O and CH4 potential (many times more potent than CO2), is there is a new technology to capture these GHG and storages, if there is a pilot project already exist, please say something about its techniques, location and the monitoring and evaluation of it?	Essam Hassan Mohamed Ahmed, EEAA (via webinar)	See 2.6 for comment on methane. The methodology is focused on CO2 as it is the predominant emission from the sources considered and its beneficial use in EOR. Emissions of N2O are not significant from these sources. There are technologies for N2O abatement from major N2O emitting sources (e.g., nitric acid production); however this is not within the scope of this methodology.	
2.8	Could we store CO2 in geological layers in steps, or is it only allowed to store in one injection? If multiple injections are permitted, what is the time limit between each two injections (time interval between each CO2 storage process).	Essam Hassan Mohamed Ahmed, EEAA (via webinar)	CO2 could be stored in different formations depending on each project's geologic setting and production plans. The methodology does not impose any restriction on the number of injections or the timing, as long as the project boundary is adequately defined to include all formations where CO2 is injected and is appropriately monitored.	
2.9	For the process to inject water with CO2, is it required to inject the fresh water or we could use brackish water?	Essam Hassan Mohamed Ahmed, EEAA (via webinar)	The methodology does not restrict the source of water used. Other regulations (state or federal) will determine whether fresh water can be used. In the US, produced water from the formation is usually re-injected during the process.	
2.10	Why isn't sequestration in saline formations included in this methodology?	Denise Farrell, Environmental Capital (via	Unlike EOR, there are no commercial-scale projects that involve CO2 injection and storage in saline aquifers. There is	

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		webinar)	one demonstration project in Illinois where CO2 is being injected at a rate of 1,000 metric tonnes per day which is far below commercial scale.	
2.11	Is this methodology designed primarily for EOR projects? Why is it not applicable to saline aquifers?	Joshua Horton (via webinar)	See response to 2.10	

C. Project boundaries

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3.1	The length of crediting period suggested in the draft seems arbitrary. It would be helpful if crediting period is tied with the length of return period on investment of CCS infrastructure.	Ambachew F. Admassie, Ethan Bio-Fuels PLC	The crediting period is limited to ten(10) years to ensure baseline validity while providing an adequate term for market participants to realize project benefits. The baseline does not have to be reevaluated until crediting period renewal. Allowing too long period of baseline validity in a sector like CCS where technologies, economics and especially the regulatory landscape are changing relatively quickly would not be conservative. If at year 10 a project can still meet all the baseline and additionality requirements, it can renew for another 10 years, and so on without limitation. This period also provides an adequate term during which market	

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			participants (project proponents, offset buyers, registries, etc.) have a level of assurance that offsets will be generated from the project as long as they are successfully verified in accordance with the project's approved project plan.	
3.2	[Page 4, 2nd paragraph] First sentence on physical boundary demarcating the sources and baseline emissions reads strangely as it is incomplete (as boundary includes transport, and injection and storage per Fig. 2-1). Suggest amending to include these other facets for completeness in an introductory sentence.	Daniel Enderton, C12 Energy	Agree	Sentence modified
3.3	Is the footprint of building new pipelines subtracted from the project?	Wolf Lichtenstein, Lightstone Consulting, LLC (via webinar)	No the footprint is not included. This is consistent with the approach in other GHG methodologies where the footprint of constructing the emission reduction technologies is not included.	

D. Baseline determination (and additionality assessment)

	Comment	Commenter	Response	Changes to Methodology
4.1	It seems that the methodology didn't delink the GHG source (the establishment that releases CO2) from the CCS infrastructure (the establishment that captures transports and	Ambachew F. Admassie, Ethan Bio-	Agree with this discussion for project-based baseline, where excess CO2 emissions could result from violations of permitted levels or not implementing	An additional term is included under baseline emissions that

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	stores). As it stands now, there is no safeguard against gaming in case where the GHG source is not being properly maintained or is even in the first place an old technology emitting large volumes of GHG. The Additionality section may or may not be sufficient to control such free riding. It may be much easier to consider the eligible project as the CCS infrastructure independently. The following alternative baseline cases, with CO2 source is kept out of the project boundary (i.e CO2 reduction through new installation or retrofit of existing CO2 source is treated with different methodology), could be helpful: <u>1. Case 1</u> Baseline Scenario: Existing CO2 source with existing CCS infrastructure Project Scenario: retrofit of existing CCS infrastructure Crediting: the improvement in sequestration performance (from average of recent years) of the existing CCS infrastructure (CCS retrofit) Safeguard required (1) : For the existing production capacity of the plant releasing CO2, CO2 injected in CCS from existing plant not to exceed (to be capped at) --	Fuels PLC	mandated technologies. As long as the operator builds and operates the primary process facility as permitted, there is no opportunity to game the system. New industrial sources are required to implement Best Available Control Technologies (BACT) and existing sources are often subject to reasonably available control technology (RACT) requirements. The source’s permit will include those requirements. As long as a source has a permit to operate and does so within those requirements, the safeguards will automatically apply. There is no need to adjust the qualifying CO2 levels by emerging regulations until the date the mandated regulation applies to the facility. At that point in time, the facility’s permit will be modified to reflect the effect of the new regulation. Regulations directly affecting CO2 emissions are covered by the Regulatory Surplus test discussed in Section 3.2. For the Standards-based baseline, the performance standard for that industrial sector will reflect the level of mandated technologies or other standards in effect at the time the standards were in effect.	reduces the eligible baseline by any excess CO2 emissions generated by permit violations.

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	a) the three most recent years historical average b) adjusted by any emerging regulation/ standard in the sector mandating a certain product CO2 benchmark. For example, a mandatory CO2 target or indirectly affecting CO2 release; Ex: a mandatory regulation for dust control in cement plants results in mandatorily reduced CO2 which should not be credited in case it is injected for CCS. <u>2. Case 2</u> Baseline Scenario: Existing CO2 source with no CCS infrastructure Project Scenario: installation of new CCS infrastructure Crediting: the CO2 captured in the new CCS infrastructure Safeguard: For the existing production capacity of the plant releasing CO2, CO2 injected in CCS from existing plant not to exceed -- a) the three most recent years historical average b) adjusted by any emerging regulation/ standard in the sector mandating a certain product CO2 benchmark. For example, a mandatory CO2 target or indirectly affecting		Even if standards change, a project validated against the previous standard should continue to be allowed to generate emission reductions against it until the end of the project crediting period. This is consistent with the requirements of other methodologies on the ACR and other carbon registries. There is no need to cap the eligible emission reductions over that calculated based on the performance standard. Furthermore, at the expiration of each 10-year crediting period (See Response to 3.1), the project shall be reassessed against all applicable regulations (including NSPS). If both baseline approaches apply to a project, then the more conservative (i.e. lower) baseline value should be used as indicated in Section 3.1.1.	

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	CO2 release; Ex: a mandatory regulation for dust control in cement plants results in mandatorily reduced CO2 which should not be credited in case it is injected for CCS. <u>3. Case 3</u> Baseline Scenario: No CO2 source but existing CCS infrastructure Project Scenario: connection to CCS infrastructure of one or several CO2 sources previously not connected with a CCS infrastructure or newly built Crediting: the CO2 captured in the connected CCS infrastructure Safeguard: For the existing production capacity of the plant (s) releasing CO2, CO2 injected in CCS from existing plant not to exceed -- a) the three most recent years historical average b) adjusted by any emerging regulation/ standard in the sector mandating a certain product CO2 benchmark. For example, a mandatory CO2 target or indirectly affecting CO2 release; Ex: a mandatory regulation for dust control in cement plants results in mandatorily reduced CO2 which should not be credited in case it is injected for CCS.			

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	4. Case 4 Baseline Scenario: New CO_2 source installed together with new CCS infrastructure Project Scenario: installation of new CCS infrastructure Crediting: the CO_2 captured in the new CCS infrastructure Safeguard: For the plant releasing CO_2, CO_2 injected in CCS from existing plant not to exceed -- a) The average three recent years average CO_2 emission factor of all the plants in the state multiplied by the production output of the plant from where the project CO_2 is sourced or the average CO_2 intensity of the product produced by the project plant multiplied by the annual production volume b) adjusted by any emerging regulation/ standard in the sector mandating a certain product CO_2 benchmark. For example, a mandatory CO_2 target or indirectly affecting CO_2 release; Ex: a mandatory regulation for dust control in cement plants results in mandatorily reduced CO_2 which should not be credited in case it is injected for CCS. However, if we wish to maintain the existing			

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	approach in the draft, we may need to address the following issue a) under the project based baseline: • a safeguard for not crediting GHG that should never have been emitted in the first place due to either a mandatory CO2 standard or other regulations affecting CO2 release from a production facility (which is the primary source of CO2 to be sequestered by CCS). Ex: negligent operation of a cement kiln dust releases more CO2 not even allowed by existing regulations mandating air pollution indirectly affecting CO2 levels or direct CO2 regulations that may emerge or may have already emerged in a state or nation. • a safeguard for not crediting GHG that should never have been emitted in the first place due to the natural technology penetration trend automatically outdating older technologies in production facilities (which is the primary source of CO2 to be sequestered by CCS). A transition from VSK kiln to rotary kiln may be mandated by regulations controlling minimum industrial efficiency levels there by affecting available choice of technology and indirectly affecting CO2 release. Such CO2, which should not have happened in first place, may be credited under			

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	the existing approach. b) under the standards based baseline: • The above bullets also apply here • the existing provisions need more elaboration and robustness check • cases not covered; when CCS infrastructure is owned by independent entity than the emission source or several emission sources			
4.2	[Section 3.2] The case that CO2 capture, transport and storage from power, ethanol, hydrogen, ammonia, and ethylene oxide plants is sufficiently rare to warrant automatic satisfaction of the performance standard is very strong given the low utilization levels and levels of CO2 managed (e.g. Table 3-2). The case for natural gas processing is not as strong given the long history (e.g. SACROC in 70s, Shute Creek in 80s) and larger volumes (15%-20% of all CO2 used for EOR), but probably still warranted.	Daniel Enderton, C12 Energy	The volumes of anthropogenic CO2 sourced from gas plants and used for EOR is greater than from other sources because of the proximity of gas plants to oil and gas fields. Yet there are only 8 out of a total of 493 gas plants that are currently supplying CO2 for use in EOR, which is indicative of low penetration rates in this industrial sector. Therefore it meets a practice-based performance standard.	
4.3	Will the geographical project boundary include the entire sequestration reservoir or will it be limited to an area surrounding the injection site?	Ana Maria Radu, Canadian Institute of Resources Law (via webinar)	The geographic project boundary will include the entire areal coverage of the reservoir(s) within the boundaries of the oil field lease where the CO2 will be injected. However, specific monitoring activities will be focused on an area surrounding the injection site and expanded across the reservoir as more	Added definitions of Reservoir (three-dimensional subsurface region) and Reservoir

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			patterns are brought under CO2 injection.	Boundary (two-dimensional "areal extent of the CO2 plume plus some buffer"

E. Quantification methodology

	Comment	Commenter	Response	Changes to Methodology
5.1	Safeguard on double crediting: A perceived threat of double counting arises when we consider the possibility of redirecting a CO2 that has escaped or came together with oil out of the storage site that has previously been credited. Particularly an equation that adds this source of emission to equations in project emission or leakage emission should be considered.	Ambachew F. Admassie, Ethan Bio-Fuels PLC	In the storage section, the methodology only includes project emission terms (Eq. 4-17 to 4-23); there is no opportunity to add back CO2 streams either redirected or produced with the oil. Any recycled CO2 that escapes from surface facilities will be accounted for by Eq. 4-19.	
5.2	Currently, the quantification of baseline emissions requires that the project developer meter the amount of CO2 from the emission source and deduct all vented and fugitive	Ian Kuwahara, The Prasino Group[1]	The methodology presents a generalized approach that applies to various sources, baseline conditions, and transportation infrastructure. The approach suggested is	

[1] Prasino Group notes: "The Prasino Group has been involved with the development of Quantification Protocol for the Capture of CO2 and Permanent Storage in Deep Saline Aquifers under the Alberta Offset System for Shell's Quest project. The Prasino Group has gained valuable experience from quantifying the GHG's from six sequestration projects as well as participated in multiple protocol technical review sessions. Our objective is to share our knowledge and provide feedback on the quantification methodology proposed in hope's to gain alignment around best practices for GHG quantification from CCS projects."

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	emissions during the capture, transport and injection phases of the project. We recommend the quantification of baseline emissions use (or at least provide the option for) a reservoir balance-based baseline as it is more accurate and less burdensome on the project developer. This means, instead of measuring captured CO2 and deducting vented and fugitive emissions during the capture and transport phases, baseline emissions can be established by only measuring the injected gas. All vented and fugitive emissions that occurred before the metering point at the injection wellhead would have occurred in the baseline anyways, and can be excluded from the quantification.		simplistic and could apply in the case of a project source connected to an injection site via dedicated pipeline and all CO2 injected constitutes the baseline. However, actual baseline could be less than injected value based on the applicable baseline scenario. Each project proponent can simplify the number of monitoring points based on project-specific conditions, if they can show all emission sources are being accounted for by their monitoring scheme.	
5.3	The methodology must account for gas that is produced with the oil & gas, compressed and re-injected. We suggest adding a Produced Gas Source/Sink in the project condition. This is typically always measured anyways by oil and gas producers and does not impose any more burden on the project developer.	Ian Kuwahara, The Prasino Group	The methodology treats the CO2 produced with the oil and gas, then separated at the surface, and reinjected (recycled) back into the subsurface, as being contained in a closed loop. If any produced CO2 is vented during these operations or is lost as fugitive emissions, then those emission are accounted for in Eq. 4-19 (vented) and 4.20 (fugitive). In its current form, the methodology already accounts for this produced gas stream and a separate term is not required.	

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5.4	Prasino Group has been involved in discussions with Alberta Environment and Sustainable Resource Development regarding how to account for produced CO2 after the injection program ceases. In real terms, there is a portion of injected CO2 that will be produced with the oil & gas after injection (and quantification) ceases that could either be re-injected, or if volumes do not justify compression and re-injection, this gas can be vented to atmosphere. For the sake of conservativeness in the GHG quantification, some approach to monitoring and reporting of these emissions should be included. The Prasino Group would be happy to participate in a discussion of how to resolve this issue by providing lessons learned from our past experience. For your reference, we have attached the draft Quantification Protocol for the Capture of CO2 and Permanent Storage in Deep Saline Aquifers under the Alberta Offset System. Please refer to Section 2.0 Baseline Condition (page 7) for a description of how this protocol establishes the baseline condition.	Ian Kuwahara, The Prasino Group	Following the completion of injection activities, any produced oil/gas/CO2 will be separated and the CO2 reinjected in the reservoir prior to the wells being plugged. If this CO2 is not reinjected but emitted to the atmosphere, then those volumes shall be measured and deducted from the annual totals for that year. Once injection stops, the reservoir pressure will equilibrate quickly within a few days. So while there will be some oil and gas coproduced after injection stops, this production ceases once equilibrium is reached. This occurs well within the minimum project term defined as five years post injection.	
5.5	In the context of reducing fossil carbon emissions to the atmosphere, the calculations offered in the draft fail to take into account ultimate CO2 emissions from the product	Greg H. Rau, Ph.D. University of California,	See response to 1.1 It seems unjust to redefine project boundaries for this project in an inconsistent manner. In its permit	

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	produced. In particular, conventional CO_2-EOR ultimately generates much more atmospheric CO_2 than is injected/stored. For every tonne of CO_2 injected roughly 3 -5 tonnes of CO_2 are ultimately released to the atmosphere from the combustion of the petroleum product produced (Jaramillo et al, 2009). This ratio is not likely to decrease in a CCS context given that the cost of CO_2 captured and concentrated from waste sources is typically much higher than that of the natural sources of CO_2 currently used (Jaramillo et al., 2009; Carter, 2011; Dooley et al., 2011). The economic motivation will then be to inject less rather than more CO_2, therefore further exacerbating net atmospheric release from such oil production. What is first required is an expansion of the physical boundaries defined on pgs. 4- to include the very intentional "leakage" (extraction of the otherwise well-sequestered petroleum carbon) for the primary purpose of producing fuel for combustion and ultimate CO_2 emissions to the atmosphere. At a minimum this represents about 3 tonnes of CO_2 emitted per tonne of crude oil (EPA, 2012), ignoring additional emissions in the refining and delivery of this crude, which can generate as much as 20% additional CO_2 emissions, especially with lower quality crudes typical of those extracted using	Santa Cruz and Lawrence Livermore National Laboratory	application Indiana Gasification argument about CO_2 indicated that "*refineries producing gasoline as a product are not responsible for the air emissions from automobile refueling or the combustion of the gasoline in automobiles. The Clean Air Act places compliance obligations on the emitter of air pollution, not the manufacturer of products that may later through their use result in air pollution*"	

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	EOR (Jaramillo et al., 2009; Abella and Bergerson, 2012). Considering the preceding, equation 4.24 (pg. 50) in the methodology calculating net GHG reduction must therefore be modified as follows: GHG $Reductions_y = BE_y – PE_y – CO2_{(oil)y}$ where BE_y = the captured CO2 quantity (tonnes/yr) PE_y = CO2 (or total GHG) loss associated with CO2 capture, transport, and local CO2-EOR activity $CO2_{(oil)y}$ = CO2 emissions from oil product (tonnes CO2/yr) = $Mass_{(oil)y}$ x 0.82 tonnes C/ tonne oil x 44 tonnes CO2/12 tonnes C, and where Mass(oil)y (tonnes/yr) is as defined on pgs 47, 77, 88. Note that net, lifetime GHG Reductions can only be positive when BE > PE + $CO2_{(oil)}$ as integrated over the lifetime of the project. Assuming PE is relatively small, the preceding means that the CO2 quantity captured and injected, represented by BE, must be larger than $CO2_{(oil)}$ in order for a credit to be given for GHG			

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	emissions reduction. Life cycle $CO2_{(oil)}$ is typically larger than BE by at least a factor of 3 (Jaramillo et al., 2009). Therefore, when CO2 concentrated from waste streams or air is used in CO2-EOR, such projects will remain a net source of GHG to the atmosphere unless and until the quantity of carbon injected exceeds that emitted in the extraction, processing, and use of the product oil. If CO2-EOR is to contribute to GHG reduction and receive credit for such, a total accounting of all CO2 in and out of the process including product use must be considered. CO2 loss to the atmosphere must be fully accounted for without employing arbitrary, subplanetary geographic and end-product boundaries as used in this draft.[2]			

[2] References for this comment are:

Abella, J.P., J.A. Bergerson. 2012. Model to Investigate Energy and Greenhouse Gas Emissions Implications of Refining Petroleum: Impacts of Crude Quality and Refinery Configuration. Environmental Science and Technology 46: 13037–13047.

Carter, L.D. 2011. Enhanced Oil Recovery & CCS. (United States Carbon Sequestration Council, Mars, PA). http://www.uscsc.org/Files/Admin/Educational_Papers/Enhanced%2520Oil%2520Recovery%2520and%2520CCS-Jan%25202011.pdf

Dooley, J.J., R.T. Dahowski, C.L. Davidson. 2011. CO2-driven Enhanced Oil Recovery as a Stepping Stone to What? Rprt. PNNL-19557 (Pacific Northwest National Laboratory, U.S. Dept. Energy, Richland, WA).

EPA. 2012. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2010 U.S. EPA #430-R-12-001 (U.S. Environmental Protection Agency, Washington, DC).

Jaramillo, P., W.M. Griffin, S.T. McCoy. 2009. Life cycle inventory of CO2 in an enhanced oil recovery system. Environmental Science and Technology 43: 8027–8032.

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5.6	[Section 4.2.5] Claiming that a CO2 storage site being in compliance with its permit should mean zero leakage to the atmosphere is generally okay, though may be a little misleading. For an EOR project, a developer is required to have an EPA UIC Program Class II injection well permit (typically administered by state office). The rules for Class II are designed to protect underwater sources of drinking water. The rules cover injection wells construction, and here, compliance with rules should result in zero leakage to the atmosphere through the injection bore hole. However, Class II permits only have an area of review of a fixed radius, typically set at a quarter mile, for which existing well bores (and natural leakage pathways?) are reviewed. Often there is no monitoring required outside the injection well bore. However, the additional requirement of considering the full spatial fate of the CO2 and analyzing and remediating potential leakage pathways therewithin address this issue.	Daniel Enderton, C12 Energy	A CO2 storage site that is operated in accordance with its permit requirements, including monitoring and well integrity testing requirements, is one step in the monitoring approach to ensure zero leakage. The MRV guidelines we have proposed include modeling of the areal extent of the plume and defining the "reservoir boundary" to include the expected ultimate extent of the CO2 plume. Appropriate monitoring techniques should be used to ensure the plume remains confined within the reservoir boundary. This boundary extends well beyond the fixed radius area of review around the well. As correctly pointed out by the reviewer, identifying potential leakage pathways and tailoring the monitoring to detect leakage through these pathways coupled with a remediation plan that can be readily implemented in case of leakage are additional components included in the monitoring plan guidelines.	
5.7	Is it assumed than no leakage will occur in transportation pipelines and storage sites?	Ambachew Admassie, Ethan Bio-Fuels PLC	There is no assumption of zero leakage in pipelines and storage sites. Vented and fugitive emissions during transportation are accounted for in Eq. 4-10. At storage sites, leakage is expected (but not	

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		(via webinar)	assumed) to be zero, if a robust site-specific MRV plan is implemented as outlined in Section 5.4.	

F. Data collection and monitoring

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6.1	[Section 5.4] Overall, I think that the content of this Monitoring, Reporting, and Verification (MRV) Plan section is good, but could benefit from some organizational clarity. The steps at the bottom of page 61 are a very appropriate general process for all developers to follow to consider the fate of the CO2 over the appropriate spatial and temporal scales in the subsurface. It is great to see this in the framework.	Daniel Enderton, C12 Energy	Agree	Appropriate changes made to methodology
6.2	The lists at the bottom of p. 60 and p. 61 could be harmonized by either combining into one list or cross referencing one another (e.g. the first three points on the list at the bottom of p. 60 are overlap with points in the list at the bottom of page 61).	Daniel Enderton, C12 Energy	Lists have been combined	Appropriate changes made to methodology
6.3	The paragraph on IOGCC conclusions is good, through it could be worth mentioning that monitoring programs should be tailored to	Daniel Enderton, C12 Energy	Agree-that point was included as the last sentence. Additional guidance from the USDOE on this	USDOE recommendations on site-specific monitoring has been

	Comment	Commenter	Response	Changes to Methodology
	specific sites should be included.		issue has been added	added
6.4	The MRV plan described starting on p. 62 is not a plan, per se, but rather an outline of steps that could be taken, and should be presented as such. Furthermore, whatever is presented here should also be consistent in format and scope with the approach described in the lists at the bottom of p. 60 and p. 61, which it is not.	Daniel Enderton, C12 Energy	The lists on pg. 60 and 61 have been combined	
6.5	The quantification approach taken requires a greater burden on proponents by requiring multiple metering points. This translates to more complicated data management, calculations and verifications which generally increases the risk of inaccuracy. Rather than meter every emission along the pipeline, the method could require the metering of injection at the point of injection. All fugitives upstream of this are equivalent and therefore irrelevant to the quantification.	Ian Kuwahara, The Prasino Group (via webinar)	See response to comment 5.2.	
6.6	Who will be responsible for monitoring? The project proponent or directly a public agency?	Laura Tagliabue (via webinar)	The project proponent is responsible for monitoring.	

G. Emissions ownership and quality

	Comment	Commenter	Response	Changes to Methodology
7.1	[Section 6.3] Liability within a project generally	Daniel	Agree	Appropriate text has

	Comment	Commenter	Response	Changes to Methodology
	follows title to the CO2. For example, if a CO2-EOR project has a CO2 leak which causes damage, the CO2-EOR operator will be liable in a criminal or civil setting. (And indeed, insurance can be purchased). Case law has built up around claims associated with subsurface injection and liabilities can be managed through the tort system. May be useful to say something along these lines (Note that the cited case dealt with trespass, not damages).	Enderton, C12 Energy		been added
7.2	[Section 6.3] Leakage well beyond the end of injection will always be an issue difficult to address in this type of methodology. Risks do decrease rapidly following the end of injection, though this may or may not coincide with the end of the credit claiming period. The most important steps for ensuring permanence is careful site selection and operation, though even then it is impossible to ever be 100% confident in the permanence, as is with virtually all classes of GHG offsets that don't actually destroy the GHG.	Daniel Enderton, C12 Energy	Agree	
7.3	[Section 6.3] Financial responsibility requirements for Class II permits (unlike Class VI) are minimal and often simply cover plugging and abandonment. The opening statement of page 80 paragraph 4, while true, is misleading when combined with the discussion before and	Daniel Enderton, C12 Energy	We do not believe the statement is misleading. Our intent is not to require anything more than is currently practiced commercially or required by regulation.	

	Comment	Commenter	Response	Changes to Methodology
	after pertaining to leakage.			
7.4	[Section 6.4] The issue of pore space could be discussed more clearly. Yes, historically, oil and gas leases can allow for use of CO_2 to boost recovery but typically have not explicitly contemplated rights to concurrently store CO_2 permanently, though this is a natural result. The second sentence of the second paragraph on p. 82 in some ways alludes to this by saying that one can store CO_2 during the operational phase but is silent on the period beyond operations. The reality is that EOR operators will claim concurrent storage benefits, and courts will have to decide if land owners will have grounds in court for objection (my suspicion is that it is doubtful they would have a claim given existing case law, but I am not a lawyer). The inclusion of the last paragraph on p. 82 is important. For claiming offsets, this is the most important practical consideration, and the inclusion of maintaining access for monitoring is welcome.	Daniel Enderton, C12 Energy	Agree	Sentence added to clarify post-operational phase operations
7.5	[Section 6.4] There is some obfuscation of the issue of pore space rights for EOR with those for saline storage. For example, the Wyoming, Montana, and ND rules references are for non-EOR storage and their discussion here is confusing.	Daniel Enderton, C12 Energy	The discussion is meant to point out that these issues are only now being addressed by States. A clarification on their applicability to non-EOR storage will be added.	Text has been modified to clarify that MT, WY and ND rules on pore space ownership apply to non-EOR storage.

	Comment	Commenter	Response	Changes to Methodology
7.6	Is liability insurance a requirement of projects? How much insurance coverage is required?	Wolf Lichtenstein, Lightstone Consulting, LLC (via webinar)	Liability insurance is required to cover the project proponents' obligations through compensation for reversals in GHG emission reductions. Other approaches can be used in lieu of insurance as those products are introduced in the marketplace. See last paragraph of Section 6.3.	
7.7	How is leakage and reversal risk dealt with? Can you please provide some information about reversal risk – how this is estimated and addressed.	Aditi Sen, Verified Carbon Standard Association (via webinar)	The project's MRV plan primarily provides assurance that leakage does not occur. This is explained in the monitoring section. If small releases occur, then the quantity of CO2 that leaks to the atmosphere is estimated using sound engineering practices and deducted from the project's total emission reductions. If the releases are large and exceed the net GHG reductions for that reporting period, then those releases must be deducted from the following year's total of qualified credits or be covered by liability insurance. Reversals are also estimated in a similar manner. If these occur during the post-injection phase then those liabilities are covered by insurance or other	

	Comment	Commenter	Response	Changes to Methodology
			similar products as indicated in response to 7.6. See last paragraph of Section 6.3.	
7.8	How is the long-term liability for leakage going to be dealt with?	Ana Maria Radu, Canadian Institute of Resources Law (via webinar)	See response to 7.7	

H. QA/QC

	Comment	Commenter	Response	Changes to Methodology
8.1				

I. Uncertainties

	Comment	Commenter	Response	Changes to Methodology
9.1				