

Report on Futurepast's Validation Engagement with Isometric

Relative to Its

Charm Industrial Great Plains Bio-Oil Sequestration Project

Report Date: 2024-06-25

Key Project Data

Project Title	Charm Industrial Great Plains Bio-Oil Sequestration Project
Project ID	7BDE
PDD File Name	V 1.5 Charm Industrial G.P. Bio Oil Sequestration PDD.docx
PDD Version	1.5
PDD Issue Date	2024-05-30
Project Location	Port Cartier, QC; El Dorado, KS; Hutchison, KS
Project Proponent	Charm Industrial, Inc.
Other Parties	AE Cote Nord Canada Bioenergy Inc. (bio-oil supplier) Vaulted Deep (Injection well owner/operator)
Legal ownership of the CDRs	Charm Industrial, Inc.
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Addressee

This report is addressed to the management of Isometric HQ Limited, 27 New Dover Road, Canterbury, Kent, United Kingdom, CT1 3DN.

Executive Summary

The Charm Industrial Great Plains Bio-Oil Sequestration project will earn Carbon Dioxide Removal credits (CDRs) issued by Isometric for the sequestration of carbon-rich bio-oil produced in Quebec, Canada, from woody biomass. The biomass consists primarily of sawdust and wood shaving residues accumulated by a lumber mill that adjoins a pyrolysis oil production facility. The project activity is to purchase bio-oil and sequester it in salt caverns located in Kansas, USA.

Responsibilities

It was the responsibility of the project proponent, Charm Industrial, to prepare its Project Design Document and supporting documents in accordance with Isometric criteria. This responsibility includes designing, implementing and maintaining a data management system adequate for the preparation and fair presentation of the statements. Charm Industrial was responsible for the fair presentation of its data and information and ensuring that these are free from material misstatements.

With respect to our validation, it was the responsibility of Futurepast to express an opinion as to whether any evidence was found that the assumptions, limitations and methods described in the project design document that supported forecast CDRs as stated by Charm Industrial did not provide a reasonable basis for the projections. In addition, Futurepast was responsible for assessing whether statements related to the design of the project conformed to the requirements of the agreed criteria.

Criteria

Isometric and Futurepast agreed that the criteria against which Carbon Dioxide Removal statements would be validated were the following:

- Isometric Standard v 1.2
- Isometric Bio-Oil Geological Storage v. 1.0.1
- Biomass Feedstock Accounting v. 1.1
- Biomass or Bio-oil Storage in Salt Caverns v. 1.0.2
- Embodied Emissions Accounting v. 1.0.2
- Transportation Emissions Accounting v. 1.0
- Energy Use Accounting v. 1.1.1

In addition to these specified criteria, the Isometric Standard considered its requirements to be “consistent with” ISO 14064-2:2019.

Futurepast assessed the criteria and found them suitable, considering:

- a) the engagement’s scope and boundaries
- b) the greenhouse gases and sources, sinks and reservoirs associated with Charm Industrial’s facilities, physical infrastructure, activities, technologies, and processes
- c) the quantification methods employed; and
- d) requirements for disclosures

In Futurepast’s opinion, the agreed criteria were relevant, complete, reliable and understandable.

Type of Engagement

This engagement included the following types of activities:

- Verification
- Validation
- Agreed-upon procedures

Objectives of the Validation

The objective of the validation was to determine whether Charm Industrial’s project design document (PDD) provided an adequate basis for the quantification and reporting of carbon dioxide removals from the atmosphere.

Scope of the Validation

Facilities, physical infrastructure, activities, technologies, and processes	Activities included the generation of woody biomass residues produced from sustainably managed forests in Quebec; the production of bio-oil through pyrolysis at a production site in Port Cartier, QC; pre-processing the bio-oil in El Dorado, KS, to make it ready for injection in salt caverns; injecting bio-oil in salt caverns located near Hutchison, KS; and the transportation of the bio-oil from Quebec to Kansas and to the final injection site.
Greenhouse gas sources, sinks, and reservoirs	Sources of greenhouse gas emissions (CO ₂ , CH ₄ and N ₂ O) were propane to start the exothermic reaction in the pyrolizer; transportation emissions; and electricity consumed at the pyrolysis facility, pre-processing facility, and salt cavern. Greenhouse gas sources were analyzed using consequential life cycle assessment techniques.
Types of greenhouse gases	Carbon dioxide (CO ₂), methane (CH ₄) and nitrous oxide (N ₂ O)

Time period	Not applicable for validation of the PDD.
Any material secondary effects	None identified.
Baseline scenarios (validation)	Two baseline scenarios were considered: <ul style="list-style-type: none"> 1. The continued accumulation of sawdust and mill shavings at the lumber mill adjacent to the pyrolysis facility; and 2. Processing sawdust and mill shavings into bio-oil at the pyrolysis facility.

Level of Assurance and Threshold of Materiality

This validation was performed at the limited level of assurance on the assumptions, limitations and methods that the Project Design Document (PDD) provided to forecast carbon dioxide removals over a five-year period. Futurepast also provided a reasonable level of assurance on the conformity of the PDD to the requirements of the Isometric Standard and the associated Protocol and Modules. The threshold of materiality for this engagement was five (5) percent for quantitative information. Qualitative information materiality was assessed using the professional judgment of the validator.

Validation Team Members and Reviewer

This validation was carried out by John Shideler, PhD, lead validator for Futurepast. Mr. Shideler has worked as a greenhouse gas verifier since 2007 and as a validator since 2010. Chad Milligan of Strata served as technical expert. Mr. Milligan is a registered geologist in Kansas and an expert on injection wells. This validation was independently reviewed by Tina Sentner, a greenhouse gas lead validator and verifier.

Summary of GHG-Related Activity

Carbon stored in woody biomass residues was converted to bio-oil at the AE Cote Nord Canada Bioenergy Inc. (AECN) pyrolysis facility in Port Cartier, QC. The facility used technology sourced from Honeywell UOP. After transport to El Dorado, a Charm Industrial facility sparged the bio-oil and volatile organic compounds were treated in a catalytic oxidizer. The bio-oil was transferred to a blending tank where its salinity was raised to match the salinity of brine removed during injection from the salt cavern. Samples drawn in El Dorado were tested for carbon content prior to transporting the bio-oil to Hutchison, KS. At the Vaulted Deep salt cavern site in Hutchison, operators injected the bio-oil into a salt cavern via a US EPA Class V injection well permitted by the Kansas Department of Health and Environment (KDHE). Truck scales at the Vaulted Deep facility measured the mass of bio-oil injected. This mass was multiplied by the analyzed carbon content of the liquid to determine the amount of carbon sequestered in the cavern.

Validation of the project was performed by a Futurepast validation team which observed the technology used to produce, pre-treat, and store the bio-oil in accordance with the Isometric Standard, the Bio-oil Geologic Storage protocol, and relevant Isometric modules.

Charm Industrial has prepared a Project Design Document to describe how its project is designed to remove carbon dioxide from the atmosphere by procuring bio-oil made from woody biomass residues and sequestering the carbon-rich bio-oil in a US EPA – permitted Class V injection well in Kansas, USA. Carbon dioxide removals (CDRs) were calculated by quantifying the amount of carbon contained in the bio-oil that was stored after subtracting project emissions.

Document Review, Findings, and Site Visits

Futurepast performed a desk review of documents provided by Charm Industrial. It then planned its validation and executed it with site visits to the pyrolysis facility in Port Cartier, QC, Canada, to Charm Industrial’s pre-processing plant in El Dorado, KS, USA, and to Vaulted Deep’s salt cavern operations in Hutchison, KS, USA. Throughout Futurepast’s validation process it employed such techniques as observation, inquiry of documents and persons, estimate testing, control testing, cross-checking, and confirmation. As a result of validation activities Futurepast issued 54 findings, most of which were clarification requests. Futurepast issued four nonconformities, all of which were resolved satisfactorily. Futurepast also issued nine forward action requests which are findings directed to persons verifying carbon dioxide removals during future reporting periods. A complete list of findings is found in Annex C of this report.

Standard, Protocol and Modules. Charm Industrial designed its project activities in accordance with requirements of the Isometric Standard (v. 1.2.0, 2024-02-15) and the following protocol and modules:

Applicable Protocols and Modules	Date	Version
Isometric Bio-Oil Geological Storage	2024-03-06	1.0.2
Biomass Feedstock Accounting	2024-05-21	1.2
Biomass or Bio-oil Storage in Salt Caverns	2024-03-06	1.0.2
Transportation Emissions Accounting	2023-12-22	1.0
Energy Use Accounting	2024-02-20	1.1.1
Embodied Emissions Accounting	2024-03-06	1.0.2

Table 1: Applicable protocols and modules

Futurepast’s validation team reviewed documents as part of its validation planning process. Key documents reviewed included those in the following table.

Documents Reviewed	Date	Version
V 1.0 AECN_Vaulted PDD	2024-03-07	1.0
V 1.1 AECN_Vaulted PDD	2024-04-10	1.1

V 1.2AECN_Vaulted PDD.docx	2024-04-19	1.2
V 1.3 AECN_Vaulted PDD.docx	2024-05-18	1.3
V 1.4 AECN_Vaulted PDD.docx	2024-05-26	1.4
V 1.5 Charm Industrial G.P. Bio Oil Sequestration PDD.docx	2024-05-30	1.5
Original AECN_Charm Purchase Agreement	2022-12-23	
2023_4 Purchase Agreement Amendment	2023-12-14	
Second Amendment to Bio-Oil Purchase Agreement Executed by AECN March 1 2024	2024-03-01	
EU-ISCC-Cert-DE100-15517123	2023-09-23	
BNI SFI Certificate for Rebec Inc.	2021-03-12	
Forest Management Plan Tactical Integrated 2023-2028, North Shore Region, 0941, Ministry of Natural Resources and Forests	2023-04-01	
Analysis of Bio Oil Methanogenesis		
Leila Negahdar et alia, Characterization and Comparison of Fast Pyrolysis Bio-oils from Pinewood, Rapeseed Cake, and Wheat Straw Using ¹³ C NMR and Comprehensive GC × GC, pubs.acs.org/journal/ascecg © 2016 American Chemical Society 4974 DOI: 10.1021/acssuschemeng.6b01329, ACS Sustainable Chem. Eng. 2016, 4, 4974–4		
Vaulted Deep Sequestration as a Service Agreement	2023-09-19	
First Amendment to Vaulted Deep Sequestration as a Service Agreement	2024-03-24	
Kansas Underground Injection Control Permit, Class V Fluid Emplacement Permit	2022-05-22	
Bio-Oil Emplacement Authorizatio, Kansas Department of Health and Environment	2023-10-27	

Table 2. Key documents consulted.

Futurepast’s validation team performed site visits at the bio-oil production facility in Port Cartier, at Charm Industrial’s pre-injection processing facility in El Dorado, KS, and at the Vaulted Deep injection facility in Hutchison, KS. Persons interviewed during the site visits are listed below in Table3:

NAME	TITLE	AFFILIATION	LOCATION	DATE
Mr. Tony Chabot	VP	AECN	Port Cartier, QC	2024-04-08
Ms. Manon Bouchard	Process Engineer	AECN	Port Cartier, QC	2024-04-08
Mr. Jean-Christophe Amado	Consultant	AECN	Port Cartier, QC	2024-04-08
Mr. Jeremy Fortin	Forest Operations	AECN	Port Cartier, QC	2024-04-09
Mr. Caleb Osborn	Field Operations Mgr.	Charm Industrial	El Dorado, KS	2024-04-10

Ms. Adriana Ovella	Chief Engineer	Vaulted Deep	Houston, TX	2024-04-10
Mr. Steve Pangburn	Operations Manager	Vaulted Deep	Hutchison, KS	2024-04-10
Ms. Vicky Spell	Office Manager	Vaulted Deep	Hutchison, KS	2024-04-10
Ms. Katie Holligan	Head of Operations	Charm Industrial	San Francisco, CA	2024-04-10
Mr. Max Lavine	Operations Measurement, Reporting, Verification	Charm Industrial	San Francisco, CA	2024-04-10

Table 3: Personnel interviewed.

Assessment of GHG-Related Activity Characteristics

Charm Industrial documented the project characteristics in a Project Design Document meeting the requirements of the Isometric Standard (3.2) and the Bio-oil Geological Storage protocol (6.1). Futurepast’s validation applied to version 1.5 (30 May 2024) of Charm Industrial’s PDD issued with the file name V 1.5 Charm Industrial G.P. Bio Oil Sequestration PDD.docx. This document described how Charm Industrial considered processes unique to bio-oil such as:

- location information for biomass production, biomass conversion, bio-oil injection, and geologic storage formation
- conditions of biomass use prior to project initiation, and
- details on technologies, products, and services relevant to biomass conversion processes, including production rates and volumes.

In subsequent sections of this report, Futurepast provided details how the validation team assessed the project activity in conformity with the selected protocol and applicable modules. We also assessed the project activity against the 13 characteristics defined in clause 7, Validation, of ISO 14064-3:2019.

Applicability. Isometric’s Bio-oil Geological Storage protocol included applicability criteria for projects. The following table lists applicability criteria from that document and describes how the project addressed them.

Item	Applicability criterion	How applicability criterion was met
1	Utilize agricultural or forestry residues as eligible feedstocks in accordance with the framework set out in the Biomass Feedstock Accounting Module	The project utilized forestry residues meeting the criterion EC5 of the Biomass Feedstock Accounting Module.

2	Convert the biomass to bio-oil via pyrolysis or similar processes or utilize bio-oil produced by a third-party supplier	The project purchased bio-oil from AECN Bioenergy Canada that was produced by converting biomass to bio-oil via pyrolysis.
3	Inject the bio-oil into natural or engineered geologic formations for long duration storage purposes via an underground injection well	The project injected bio-oil into natural salt caverns, displacing brine, for long duration storage purposes via an underground injection well.
4	The project provides a net-negative CO ₂ e impact (net CO ₂ e removal) as calculated in the GHG Statement, in compliance with Section 7	The project's injectate was demonstrated to meet the net-negative CO ₂ -e removal criterion in compliance with section 7 of the BiCRS protocol.
5	The biomass feedstock utilized is sustainably sourced	The feedstock utilized by the bio-oil producer was demonstrated to be sourced from lumber mill residues produced from timber that was sustainably harvested in Quebec, Canada.
6	The project does no net harm to the environment and society	The project proponent prepared an analysis that asserted that the project did no net harm to the environment or to society.
7	The project is considered additional, in accordance with the requirements of Section 6.5	The project demonstrated additionality in accordance with the requirements of section 6.5 of the BiCRS protocol.
8	The project provides long duration storage (>1000 yr estimated) of carbon in geologic formations	The project provided long-duration storage capability of a minimum duration of more than 1000 years.
9	The geologic storage site is located in the US	The project was located in the state of Kansas, USA
10	The geologic storage site is properly permitted and has a current relevant UIC well permit	The project's selected geologic storage site was permitted with an Underground Injection Control permit for Class V wells by the state of Kansas, USA
11	The site must be operated in compliance with current permits including those issued by the US EPA or U.S. States for underground injection control wells and specifically identify bio-oil or an	The injection well operator, Vaulted Deep, demonstrated a system for maintaining its operations in compliance with its UIC well permit and the injection of bio-oil was

	equivalent type of injectant, as acceptable injectants under the permit	specifically authorized by the Kansas Department of Health and Environment.
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Table 4: Applicability criteria.

Project Boundary. The Isometric Standard (2.5.1) required projects to have a defined temporal and geographical boundary that included GHG sources, sinks and reservoirs (SSRs) from:

- the construction or manufacturing of each physical site and associated equipment,
- the closure and disposal of each site and associated equipment, and
- the operation of each process.

Assessment and quantification of emissions was cradle-to-grave.

Futurepast confirmed Charm Industrial has defined a project boundary that encompasses the sourcing of sustainably harvested woody biomass residue from a lumber mill adjacent to the pyrolysis facility, the pyrolysis facility itself, transportation of bio-oil to Kansas, and pre-treatment and injection of the bio-oil in salt caverns. While the boundary included determination that the harvested wood is sustainably sourced, it did not include any upstream emissions associated with harvesting. Instead, GHG quantification began with the movement of woody biomass residues into the pyrolysis facility through to the production of bio-oil, its transportation, pre-treatment and injection into the salt cavern.¹ The validation confirmed with Isometric that woody biomass residues are effectively zero-emission biomass sources in accordance with the requirements of the Biomass Feedstock Accounting module.

Baseline Scenario Selection. The project baseline was selected from two alternative scenarios. The business-as-usual baseline scenario was continuation of the present practice of stockpiling woody biomass (sawdust and shavings from the adjacent Arbec lumber mill). The project scenario was processing the available woody biomass into bio-oil through pyrolysis at the AECN facility.

The Isometric Standard (2.5.2) requires that projects be assessed against a baseline of their activities not having taken place. In the project proposed by Charm Industrial, the hypothetical reference case was the continued accumulation of sawdust and shavings at the lumber mill site. Additionally, ISO 14064-3 requires that GHG-related activities that assert emission reductions or removal enhancements select “the most appropriate, plausible and complete hypothetical scenario” (7.1.4.5). Although Arbec, the owner of the lumber mill, and Groupe Rémabec, the wood harvester, had decided in 2016 to construct the pyrolysis facility to address the problem of accumulating sawdust and shavings from the lumber mill, the pyrolysis facility was operating far below capacity

¹ Assessment of the “GHG boundary” of GHG-related activities is a requirement of ISO 14064-3:2019, 7.1.4.4

and sawdust and shavings had continued to accumulate. For this reason it was appropriate for Charm Industrial to consider that the continued accumulation and storage of woody biomass represented an appropriate baseline scenario. Charm Industrial did not need to take into account the decision to build the pyrolysis facility in 2016 as this decision was made far in advance of Charm’s arrival as a potential off-taker of bio-oil. Nor did Charm Industrial’s interest in procuring bio-oil displace any other current users of the pyrolysis facility’s bio-oil product. From these facts the validation assessment team concluded that the project’s choice of baseline scenario was conservative and appropriate.²

Additionality. The Isometric Standard outlines three tests for determining additionality: financial, environmental, and regulatory. Based on the information provided and the evaluation conducted, Futurepast has determined that the project meets all three tests for additionality. The findings are summarized as follows:

- The project can be deemed financially additional as the primary purpose of the project is the removal of greenhouse gases, which constitutes the main objective and sole source of revenue for the project. This demonstrates that the project’s financial viability is contingent upon the revenue generated from GHG removals.
- The project can be deemed environmentally additional since the overall climate impact of the project is net negative. The GHG removals facilitated by the project result in a reduction of atmospheric GHG concentrations, thereby contributing positively to the environment by achieving a net decrease in GHG emissions.
- The project can be deemed to achieve regulatory additionality as it is not mandated by any existing regulatory, policy, or other legal requirements. This confirms that the project’s implementation goes beyond what is required by law and is undertaken voluntarily to achieve additional GHG reductions.

The validation team concluded that the project proponent has successfully justified the additionality of the project by meeting the financial, environmental, and regulatory criteria as specified in the Isometric Standard (v. 1.2) and the Bio-oil Geological Storage protocol (v. 1.0.2). Therefore, the project is considered additional under these standards, supporting its qualification for Carbon Dioxide Removal credits.

Durability. The Isometric Standard requires that project proponents demonstrate a durability of at least 1,000 years to ensure meaningful long-term climate action. Based on the information provided and the evaluation conducted, the validation team determined that the salt caverns in Hutchison, KS, will meet or exceed this standard. In interviews with operational personnel at Vaulted Deep, the following factors were presented that justify an estimate of durability as much as ten times greater than the minimum required by the Isometric Standard:

² Assessment of the “Baseline selection scenario” of GHG-related activities is a requirement of ISO 14064-3:2019, 7.1.4.5.

- After sealing a cavern, no change in pressure within the cavern is expected
- The deposition of bio-oil whose salinity has been adjusted to that of the brine that was extracted from the cavern should reduce the risk of chemical changes within the cavern
- Testing of the cavern for mechanical integrity as required by the operator's permit from the Kansas Department of Health and Environment (KDHE) reduces the risk of loss of cavern integrity
- Seismic and subsidence risks in the geological environment of Kansas were minimal in historic time

Charm Industrial confirmed that the geological conditions attributed to the Hutchison, KS, field of salt caverns have been confirmed in numerous literature studies cited in its Project Design Document (p. 18, "Durability Assessment").

Environmental Impact Assessment. Charm Industrial has analyzed relevant environmental risks in its PDD. These included the following:

- The risk that lumber mill woody biomass residuals would not be sourced from sustainably harvested timber.
 - This risk is managed by the lumber mill's acceptance of timber from sustainably harvested forests in accordance with the Quebec Provincial Management Plan and by the adherence of Rémabec, the owner of the lumber mill in Port Cartier, to sustainable harvesting of timber in accordance with the Sustainable Forestry Initiative, as evidenced by a certificate issued by the Bureau de Normalisation du Québec.
- The risk that the pyrolysis facility would not be operated in a sustainable manner.
 - This risk is managed by the voluntary adherence of the pyrolysis facility to the requirements of the International Sustainability and Carbon Certification standard and the requirements of the EU Renewable Energy Directive (RED) II, as evidenced by a certificate issued by SGS Germany.
- The risk of environmental damage from the injection of bio-oil into salt caverns in Kansas operated by Vaulted Deep.

The operator of the injection wells at Hutchison, KS, Vaulted Deep, have fully permitted facilities operated in accordance with the requirements of KDHE, which includes regular monitoring activities and biennial site elevation surveys.

- KDHE permitting requirements conform to the requirements of US EPA Underground Injection Control regulations.

In addition to these risks, the project proponent demonstrated conformity with specific environmental and social safeguard requirements identified in the BiCRS protocol, section 5.

Environmental permits. The project proponent ensured that the underground injection well operator, Vaulted Deep, had obtained the necessary Underground Injection Control permits from Kansas and had a system in place to ensure continuing compliance. Charm Industrial operated a pre-injection processing facility whose operations did not require clean air permitting at the time of validation. Futurepast has issued a Forward Action Request to ensure that verifiers inquire about the level of activity of the El Dorado, KS, facility's catalytic oxidizer to ensure that, should that emission source attain or exceed the threshold for air permitting, the source would have obtained or submitted an application for a required air emissions permit. Likewise, a Forward Action Request asks that subsequent verifiers follow up with AECN Bioenergy Canada's Port Cartier, QC, pyrolysis facility to ensure that an air emissions stack test required under that company's operating permit be completed as planned prior to the end of 2024.

Drilling permits. Permits for drilling new wells at Vaulted Deep's facility were managed by the site operator in accordance with the requirements of Vaulted Deep's UIC permit issued by the Kansas Department of Health and Environment.

Agricultural residues. Agricultural residues were not used as a source of biomass in this project.

Characterization of the bio-oil. Toxicity tests were performed on the bio-oil produced by AECN and the bio-oil was found to be non-hazardous.

Working conditions. Charm Industrial had implemented health and safety procedures to ensure safe working conditions for employees. Procedures included training and the provision of personal protective equipment, where applicable.

Social Impact Assessment: Charm Industrial has analyzed relevant social risks in its PDD. These include the following:

- The risk that the project proponent would fail to meet applicable labor rights and working conditions.
 - Charm Industrial mitigated this risk with its establishment of an environmental health and safety department and the establishment of appropriate policies and the selection of business partners who at a minimum are subject to relevant legal requirements for human rights, worker safety, and non-discrimination.
- The risk that the project would fail to meet land acquisition and involuntary resettlement requirements.
 - Charm Industrial mitigated this risk by its utilization of land that has a long-standing association with industrial activity and no known claims of involuntary resettlement.
- The risk that the project proponent would fail to respect and uphold environmental and social justice, Indigenous Peoples, Local Communities, cultural heritage, human rights and gender equality (equal opportunities and pay).

- Charm Industrial mitigated this risk by operating and working with established partners with long records of successful commercial operations.

Recognition and Stakeholder Assessment. Charm Industrial intended its project activity to be recognized as a Carbon Dioxide Removal project in accordance with the terms of the Isometric Standard and related protocols and modules. The intended users of the project information included Isometric as the certifier of project CDRs, investors who provide financing to Charm Industrial or who purchase CDRs, and the broader communities of interested parties.

With respect to recognition by intended users, the validation team finds that intended users will find the GHG-related activity to meet eligibility criteria specified in the Isometric Standard and associated protocols and modules (see Table 1 above). The validation team also finds that the scope of the Isometric Standard is worldwide, and that no geographic or temporal restrictions impede the project from creating eligible CDRs. The validation team finds that the GHG-related activity is real, quantifiable, verifiable, permanent and enforceable and that confirmation of the calculations provided in the PDD support the recognition of the project.³

The Isometric Standard (3.5) requires project proponents to inform relevant stakeholders of the project's proposed and current activities. Charm Industrial selected the Vaulted Deep injection well facilities in Hutchison, KS, in part because of community support for the continued operation of the cavern operators there. The PDD cited the cavern operator's community outreach initiatives which occurred as a result of Vaulted Deep's KDHE permit requirements and its own development of a CDR project. New activities at the site required coordination with the state regulator (KDHE) and public engagement activities via notices and public hearings. According to information quoted in Charm Industrial's PDD, "multiple sessions were held to solicit feedback from the surrounding community on the site. A site tour was conducted as well as two community meetings to address concerns and questions. The main voiced question was to inquire about job opportunities at the site. The second question was around maintaining safe drinking water at and around the site. The community was told about the regular monitoring for containment of the formation and the regular groundwater checks." Vaulted Deep asserted that it received regular input from the public "via their elected representatives, responses to public notices, feedback from public presentations, and other vehicles." The validation team has found Vaulted Deep's assertions in this regard to be credible and in conformity with the Standard's requirements.

Ownership. The Isometric Standard (3.1) required project proponents to demonstrate that they have legal ownership over the rights to all removals that will be claimed by the project. Charm Industrial has obtained rights to ownership of CDRs in contracts that it executed with the bio-oil provider AECN and with Vaulted Deep. After review of the relevant contracts, the validation team

³ Assessment of "Recognition" of GHG-related activities is a requirement of ISO 14064-3:2019, 7.1.4.2.

found that Charm Industrial had established an unambiguous claim to the ownership of any CDRs issued by Isometric for Charm Industrial's project activities.⁴

Activity measurements. Charm Industrial included within its PDD a table of included and excluded greenhouse gas sources, sinks, and reservoirs (SSRs). This table incorporated SSRs that would be expected to contribute to both baseline and project emissions within the assessment boundary of the project. The table began with upstream biomass-related SSRs related to biomass creation, sourcing, and replacement of feedstock function. These SSRs did not contribute to the quantification of project emissions because the project only used lumber mill residues and this woody biomass did not affect harvesting activities in any way. The validation team concluded that the identification of SSRs was complete and in accordance with the requirements of the Isometric Standard and associated protocol and modules.

The only baseline-related SSR included within the assessment boundary was counterfactual storage eligibility described in the Biomass Feedstock Accounting module as Eligibility Criterion EC10. Per Eligibility Criterion EC10, the project would have had to apply a discount to the carbon content of the biomass for carbon that would not have decayed within 15 years. Charm Industrial had set this parameter to "0" on the basis of literature reviews that indicated that decomposition to CH₄ and decay of molecular C would occur within 15 years. The validation team accepted this analysis as meeting the requirement in the module to provide "a qualitative assessment that the expected fate of the biomass would have a durability lower than the threshold given the most economically viable option in a given sourcing area."

Project activities included SSRs associated with the pyrolysis process itself, transportation of produced bio-oil to Kansas, pretreatment of the bio-oil injectate at Charm Industrial's facility at El Dorado, KS, and injection of the bio-oil into Vaulted Deep's salt cavern in Hutchison. Charm Industrial sourced LCA data from commonly used data sets, from operational data provided by AECN and Vaulted Deep, and quantified truck and rail bio-oil transportation emissions using distances obtained from Google Maps (for truck transportation) and from railroads (for rail transportation). Activity measurement techniques used included the use of GREET, GHGenius, and GLEC emission factors as well as monitored data from the pyrolysis facility, the pre-treatment facility, and Vaulted Deep's salt cavern operations. In some instances, life cycle emissions associated with the production of project-related equipment were estimated using cost-based calculation methods. The Isometric Standard (2.5.10) prefers the application of consequential LCA and permits the use of attributional LCA only when justified and approved by Isometric. Charm Industrial applied consequential LCA techniques based on questioning what the consequences would be of GHG-related activities. The validation team assessed for completeness and methodological

⁴ Assessment of the "Ownership" of GHG-related activities is a requirement of ISO 14064-3:2019, 7.1.4.3.

soundness the resulting activity measurements calculated for a hypothetical truckload shipment of bio-oil from Quebec to Kansas and found them suitable.⁵

Secondary Effects (Leakage). The Isometric Standard, 2.5.4, addresses leakage. Charm Industrial assessed the risks of market-based leakage and found none. This appears to be based on the supposition that the AECN pyrolysis facility will have access to an inexhaustible supply of mill residues to process into bio-oil. In criterion EC5, the Biomass Feedstock Accounting module v. 1.1 defined as eligible the “forest residues [that] are sourced from a regulated forest management project.” A note further defined a forest residue as “non-marketable wood, for example beetle kill, sticks and twigs, mill residue, etc.” At the time of validation, the sawdust and mill shavings that were processed at the AECN pyrolysis facility constituted mill residues. The validation team concluded that the piles of woody biomass generated by the lumber mill were residues as described in EC5 of the Biomass Feedstock Accounting module. See also 47, a Forward Action Request, asking subsequent verifiers to determine the continued use of mill residues that are not supplemented by merchantable timber.⁶

Quantification Methodologies and Measurements. Charm Industrial established quantification methodologies and methods in line with Isometric’s cradle-to-grave approach to determining carbon emissions and requirements to address byproduct accounting, to use consequential LCA, and to consider the temporal aspects of emissions. Project emissions, removals, and leakage were presented in units of CO₂-e (Isometric Standard, 2.5.10).

ISO 14064-3 further requires that quantification methodologies and associated measurements or monitoring be:

- of acceptable accuracy and reliability
- conservative
- appropriately applied, and
- noted for disclosure and materiality purposes when operational ranges, operational conditions or assumptions have not been met.⁷

Futurepast confirmed Charm Industrial obtained emission factors primarily from three sources, all widely used and considered reputable. These included GHGenius, an LCA data source widely used

⁵ Assessment of the “Activity measurements” of GHG-related activities is a requirement of ISO 14064-3:2019, 7.1.4.6.

⁶ Assessment of “Secondary effects” of GHG-related activities is a requirement of ISO 14064-3:2019, 7.1.4.7.

⁷ Assessment of “Quantification methodologies and measurements” of GHG-related activities is a requirement of ISO 14064-3:2019, 7.1.4.8.

in Canada, the GREET module developed by Argonne National Laboratory in the US and widely used for quantification of transportation emissions, and the GLEC framework developed by the Global Logistics Emissions Council. GLEC has been recognized by the GHG Protocol and its framework was used as an input into the development of ISO 14083:2023, *Greenhouse gases — Quantification and reporting of greenhouse gas emissions arising from transport chain operations*.

Charm Industrial's Monitoring Plan for the project included the weighing of transportation vehicles on calibrated scales at the injection site in Hutchison, KS. Mass was monitored by scale tickets provided by injection well personnel. The values were measured by weighing the delivery truck prior to and after injection on a certified scale. The validation team reviewed a recent calibration record for this scale and found the scale to be within its calibration tolerances. Other project parameters that would be measured by calibrated instruments included a truck weigh scale located at the pyrolysis facility in Port Cartier, QC. These values would be recorded on bills of lading for transportation of the bio-oil to Charm Industrial's pre-processing facility in El Dorado, KS.

GHG Information System and Controls. Charm Industrial developed a relational database it called "Ledger" to manage data for this project. Inputs from original sources such as weigh tickets and invoices will be entered into Ledger via a user interface by Charm Industrial personnel. The database stored point-to-point distances from Google Maps for truck transport or from rail operators for delivery by rail. Similar operations captured information from other monitored activities. The software identified batches of bio-oil and tracked them as "lots" to allow for cases where a batch was split or combined. Lots, or batched combinations of lots, became removals once they were injected into a salt cavern. Futurepast confirmed this approach permitted Charm Industrial to maintain records of mass balance and chain of custody throughout the process of monitoring bio-oil from its delivery to Charm Industrial to its ultimate injection into salt caverns.

Futurepast also confirmed that Charm Industrial's Ledger software incorporated quality controls to ensure the consistent use of calculation methods including conversion of units and standard emission factors. The software was designed to limit the need for manual data entries and to provide for audit and review of data inputs. An application programming interface was intended to transfer data from Ledger into Isometric's data platform.⁸ As a result of this review, the validation team concluded that Charm Industrial had developed an information system suitable for tracking parameters described in the BiCRS protocol, section 7.4.

The validation team reviewed sample data presented in a spreadsheet that quantified CDRs associated with a hypothetical truckload of bio-oil shipped from Port Cartier to Kansas. Charm Industrial titled this document "GHG Statement Supplemental Doc AECN_Vaulted.xlsx". The spreadsheet provided a sample calculation representing the first injection of bio-oil into a Vaulted

⁸ Assessment of "GHG information systems and controls" of GHG-related activities is a requirement of ISO 14064-3:2019, 7.1.4.9.

Deep salt cavern. After reviewing this spreadsheet, the validation team concluded that all required parameters for a shipment of bio-oil were included in the calculation of CDRs

The validation team planned further testing of the integrity of the Ledger information system during its verification of data during the project's first reporting period. See Forward Action Request 53.

Functional equivalence. ISO 14064-3 requires a determination that the project activity and the baseline are “functionally equivalent”.⁹ The validation team has assessed the GHG-related activities to be functionally equivalent because the carbon in the mill-waste residue is simply transformed via pyrolysis from one form (solid woody matter) to another form (concentrated carbon-rich bio-oil). The functional unit in both cases is organic carbon. The functional equivalence of the baseline scenario (storage of carbon in a pile of sawdust and mill shavings) is further demonstrated by the project type that leads to CDR issuance when unprocessed woody biomass is injected underground into a salt cavern as a slurry rather than in the form of bio-oil. Such a project type, submitted for certification by Vaulted Deep, earned CDRs from Isometric in December 2023.

Calculation of GHG Statement. Charm Industrial illustrated its approach to quantification of CO₂e removals by employing, as applicable, the following equations:

- Equations 1–8 in the Bio-oil Geological Storage protocol (7.3).
- Equations 1–5 in the Energy Use Accounting module (3)
- Equations 1–3 in the Transportation Emissions Accounting module (3)

Embodied emissions calculations followed approaches provided in the Embodied Emissions Accounting module.

Charm Industrial's Project Design Document provided detailed explanations for how Carbon Dioxide Removals would be calculated and data transferred to Isometric's registry platform. At the time of validation Charm Industrial had illustrated the calculation process with a sample calculation representing the CDRs that would be earned by shipping one truckload of bio-oil from Port Cartier, QC, to Hutchison, KS, and injecting the oil into a Vaulted Deep injection well.

Section 7.1 of the Bio-oil Geological Storage protocol describes the system boundary and GHG emissions scope for quantification of net CO₂ removals. The protocol requires the scope to include, at a minimum, emissions calculated in the following activities:

- Biomass production
- Biomass transport

⁹ Assessment of “Functional equivalence” of GHG-related activities is a requirement of ISO 14064-3:2019, 7.1.4.10.

- Bio-oil injection
- Embodied emissions associated with each of the above processes

This section of the protocol included a Table 1 which constituted a non-exclusive list of carbon fluxes and associated GHG emissions, with indications of whether they should be included or not in calculating project GHG emissions. This section of the protocol specified that the time horizon for Global Warming Potentials was 100 years. Per the Isometric Standard, project proponents should use GWP values from the latest IPCC report, currently Assessment Report 6 (AR6). The validation team observed that the applicable SSRs in the table were included in Charm Industrial’s sample calculation. Due to the use of LCA datasets, the validation team was not able to confirm that all GWPs were sourced from the IPCC’s AR6. In the validation team’s judgment, however, the embedding of GWPs from earlier assessment reports in emissions factors used in LCA datasets would not likely occasion material misstatements of GHG emissions.

Section 7.2 of the Bio-oil Geological Storage protocol addresses baseline conditions. In Charm Industrial’s case, baseline conditions did not impact the calculation of CDRs and Equations 1–4 in the Biomass Feedstock Accounting module did not apply. Equation 4, $CO_2e_{Replacement}$, was not applicable due to Condition 1 which exempted “mill residues in a stockpile.” Equation 3, $CO_2e_{EnergyCounterfactual, p}$, was not applicable because no energy was used in the baseline scenario. Equation 1, $CO_2e_{DecayCounterFactual, p}$, was not applicable because 100% of the biomass stored was likely to have decayed within 15 years. Equation 2 was a summing equation for the other three equations and since the value of each of the other equations was “0” the total baseline adjustments also summed to “0”.

Section 7.3 of the Bio-oil Geological Storage protocol provides eight equations needed to quantify project emissions and resulting CDRs. Equation 1 summed production batches “n” for a reporting period:

$$CO_2e_{Removal, RP} = \sum_1^n CO_2e_{Removal, n}$$

This equation did not apply to Charm Industrial’s sample calculation.

Equation 2 provided the terms needed to calculate removals as the amount of CO_2e stored minus project emissions, described in the equation as $CO_2e_{LCA Emissions, n}$.

$$CO_2e_{Removal, n} = CO_2e_{Stored, n} - CO_2e_{Counterfactual, n} - CO_2e_{LCA Emissions, n}$$

Equations 3 and 4 determined the gross mass of carbon stored via injection into a geologic formation. If bio-oil production batches were blended prior to injection, Equation 3 was used. If not, Equation 4 was used.

Equation 3

$$CO_2e_{Stored, n} = \frac{C_{Bio-oil, n} \cdot m_{Inj, n}}{C_{CO_2}}$$

Equation 4

$$CO_2e_{Stored, n} = \sum_{p=1}^k \left(\frac{C_{Bio-oil, p} \cdot m_{Inj, p}}{C_{CO_2}} \right)$$

Charm Industrial’s sample calculation used Equation 3. The El Dorado pre-processing facility at the time of validation had one sparging tank and one blending tank. Bio-oil blended with salt was shipped from the blending tank as a single batch.

Equations 5 and 6 provide methods for representative sampling of batches to determine carbon content. At the time of validation these equations were not used as Charm Industrial’s procedure was to sample the contents of each blending tank prior to shipment to Hutchison, KS, for injection.

Equation 7 calculates the sum of GHG (project) emissions from operations and allocated embodied emissions for a batch “n” of bio-oil.

$$CO_2e_{GHGEmissions, n} = CO_2e_{Energy, n} + CO_2e_{Transportation, n} \\ + CO_2e_{Embodied, n} + CO_2e_{Monitoring, n} + CO_2e_{Misc. Project, n}$$

The “miscellaneous project” emissions, such as those from tailgas, were calculated using Equation 8:

$$CO_2e_{Tailgas, p} = \\ m_{Tailgas} \cdot C_{Tailgas, CH_4} \cdot GWP_{CH_4} \cdot t_p$$

Charm Industrial’s sample calculation from shipping of a truckload of bio-oil included all the necessary terms to calculate total CO₂e stored in accordance with Isometric’s methodology. Terms were included for the following:

- Bio-oil offtake from the pyrolysis facility (in metric tons, hereafter designated as “t”)
 - Bio-oil offtake tonnage was increased from the amount monitored by the application of an error band adjustment
- Pyrolysis process emissions (tCO₂e)
- Pyrolysis embodied emissions (tCO₂e)
- AECN to El Dorado truck fuel emissions for estimated kilometers travelled (tCO₂e)
- AECN to El Dorado truck embodied emissions (tCO₂e)

- El Dorado pre-processing fuel emissions (tCO₂e)
- El Dorado pre-processing electricity emissions (tCO₂e)
- El Dorado pre-processing equipment embodied emissions (tCO₂e)
- El Dorado pre-processing consumables (caustic soda) embodied emissions (tCO₂e)
- El Dorado to Hutchinson truck transport fuel emissions (tCO₂e)
- El Dorado to Hutchinson truck embodied emissions (tCO₂e)
- Injection at Vaulted Deep electricity use (tCO₂e)
- Injection at Vaulted Deep fuel use (tCO₂e)
- Injection at Vaulted Deep equipment embodied emissions (tCO₂e)
- Injection at Vaulted Deep sampling emissions (tCO₂e)
- Net carbon removed, gross tons sequestered minus tons emitted (tCO₂e)

The validation team found that, with respect to the sample calculations provided, Charm Industrial’s applied methodologies and associated monitoring were of acceptable accuracy and reliability; were conservative, were appropriately applied, were appropriately disclosed, and as a result, were acceptable to the intended user.¹⁰

Future estimates. Charm Industrial forecasted the CDRs believed will be generated over the first two years in a five-year project crediting period. The annual forecast for calendar years 2024 and 2025 is provided below in Table 1.

Estimated carbon removal capacity	
Year	Estimated carbon removal capacity (metric tonnes)
2024	10,000
2025	25,000
2026	TBD – 25,000 +
2027	TBD – 25,000 +
2028	TBD – 25,000 +

Table 5: Estimated carbon removal capacity

Charm Industrial based its forecast on contractual delivery obligations from AECN and the fact that delivery of bio-oil in 2024 was limited to a partial year. It expected CDRs to increase during the

¹⁰ Assessment of the “Calculation of GHG Statement” of GHG-related activities is a requirement of ISO 14064-3:2019, 7.1.4.11.

third through fifth years of the crediting period but did not provide specific forecasts.¹¹ The validation team has concluded that the forecasts for 2024 and 2025 were based on reasonable assumptions, given that injection rates in 2024 were based on project activity covering only a partial year and the expectation for 2025 was that injection would occur over a full year.

Uncertainty. Assessments of uncertainty are required by the Isometric Standard (2.5.7) and by ISO 14064-3:2019.¹² To address this requirement, Charm Industrial selected “variance propagation” as the option used. Other options available for consideration were “conservative estimate of input parameters” and “Monte Carlo simulation”. Charm Industrial identified four monitored parameters that it subjected to uncertainty adjustment based on calculations of carbon removals for a truckload of bio-oil transported from Port Cartier to the injection well site in Kansas. Each of the parameters selected was capable of affecting the accuracy of the CDR removal by 1% or more if its value was arbitrarily raised by 20%. The selected parameters were:

- bio-oil process emissions
- bio-oil transportation fuel emissions
- bio-oil pre-processing fuel emissions
- bio-oil pre-processing consumables emissions, specifically those associated with liquid caustic soda

The validation team assessed whether the uncertainties associated with quantification of CDRs affected disclosure or the ability of the validator to reach a conclusion and found that the effect of using the variance propagation approach produced conservative values consistent with the requirements of the Isometric Standard.

Sensitivity. Charm Industrial followed the requirement in the Isometric Standard (2.5.7) to perform a sensitivity analysis on any parameter that could potentially change quantified removals by 1% or more. It established a “sample calculation” for emissions for a single truckload of bio-oil shipped from Port Cartier, QC, to Hutchison, KS. The sensitivity analysis identified four out of fifteen parameters where a 20% increase in the parameter value would result in a greater than 1% change in the total sequestered carbon. The four parameters included: pyrolysis oil process emissions, truck transport fuel emissions, pre-processing fuel emissions, and pre-processing consumables embodied emissions. The identified parameters were subjected to uncertainty assessment. These project emissions were then quantified using values that were augmented by the maximum rate of

¹¹ Assessment of “Future estimates” of GHG-related activities is a requirement of ISO 14064-3:2019, 7.1.4.12.

¹² Assessment of “Uncertainty” of GHG-related activities is a requirement of ISO 14064-3:2019, 7.1.4.13.

measurement uncertainty.¹³ The validation team concluded that the application of sensitivity analysis was consistent with the requirements of the Bio-oil Geological Storage (BiCRS) protocol.

Description of Evidence-Gathering Procedures

The validation team examined documents provided by Charm Industrial to form an understanding of the project and to complete our strategic analysis. We used the planning stage of the validation to prepare evidence-gathering and validation plans. We reviewed the documents that Charm Industrial uploaded to our document portal in Microsoft Teams.

The validation team performed a site visit to the AECN pyrolysis facility in Port Cartier, QC. The lead validator also visited the Vaulted Deep salt caverns and the Charm Industrial pre-processing facility in Hutchison, KS, and El Dorado, KS, respectively. He was joined there by a technical expert with training in geology and familiarity with the geological formations found at Vaulted Deep. In both Quebec and Kansas, the validation team interviewed operational personnel and reviewed documents and data.

The validation team concluded on the basis of activities performed that evidence gathered was both sufficient and appropriate to reach validation conclusions.

Approved Deviations

The following deviations from the Isometric Standard or applicable Protocols or Modules have been approved for this project.

Item #	Document Reference	Deviation	Authority/Date
1	Biomass or Bio-oil Storage in Salt Caverns, 3.1.1	Instead of Futurepast, the salt cavern operator will notify Charm Industrial in the case where required alarms and automatic surface shut-off systems are activated.	Isometric, email dated 2024-04-15
2	Isometric Standard, 3.1	Isometric considered Section 3.1 to be sufficiently evidenced through the existing language in the affidavit provided by AECN and approved a deviation from the requirement for AECN to stipulate contractually that it would not advertise	Isometric, email dated 2024-04-15

¹³ Assessment of “Sensitivity” of GHG-related activities is a requirement of ISO 14064-3:2019, 7.1.4.14.

		that it was producing a “low emission product.”	
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Table 6. Approved Deviations

Forward Action Requests

Forward Action Requests are directed to future verifiers of the project proponent’s statements submitted for verification. The following Forward Action Requests were noted in the validation report List of Findings (see Appendix C) and are repeated here for convenience. Numbers in the item column below refer to item numbers used in the List of Findings.

Item #	Forward Action Requests
41	At verification, review the results of monitoring the tailgas produced at the AECN pyrolysis facility.
42	At verification, review whether emissions from the catalytic oxidizer in El Dorado remain below the threshold for requiring an operating permit.
43	At verification, review the ability of the multigas detector at Vaulted Deep to detect potential emissions of CH ₄ among other gases.
44	At verification, confirm that the project maintains records of laboratory analyses and evidence to demonstrate regulatory compliance related to injectate emplacement.
46	At verification, determine whether there are additional sites or facilities from which bio-oil is sourced that are material to the GHG statement and perform site visits as required.
47	At verification, confirm that the feedstock used to produce bio-oil at the AECN facility continues to be mill residues and that the supply of mill residues is not supplemented by merchantable chipped round wood.
52	At verification, confirm whether injection batches of bio-oil are the same as production batches or are blends of production batches.
53	At initial verification, confirm that a sample of data entered into Charm Industrial's Ledger database produces an identical output when uploaded in Isometric's data platform.
54	At verification, validate any updated forecasts for CDR generation in out-years.

Table 7. Forward action requests.

Validation Criteria



Futurepast conducted its validation activities based on the requirements of ISO 14064-3:2019, *Specification with guidance for the verification and validation of greenhouse gas statements*.

Validation Opinion

On the basis of work performed, Futurepast has concluded that Charm Industrial has developed its Project Design Document for the project: Charm Industrial Great Plains Bio-Oil Sequestration in accordance with the requirements of the Isometric Standard, the Isometric Bio-oil Geological Storage protocol and the corresponding modules Biomass Feedstock Accounting, Biomass or Bio-oil Storage in Salt Caverns, Energy Use Accounting, Transportation Emissions Accounting, and Embodied Emissions Accounting.

On the basis of worked performed, Futurepast has concluded that that it has found no evidence to indicate that Charm Industrial’s project design document did not provide an adequate basis for the calculation of Isometric Carbon Dioxide Removals for the years 2024 through 2028 with respect to the project titled Charm Industrial Great Plains Bio-Oil Sequestration. Actual CDRs earned in the period 2024 through 2028 may differ from forecast values since anticipated events frequently do not occur as expected and the variation may be material.

Validation Team Leader and Independent Reviewer Signatures

Validation Team Leader	 John C. Shideler, 24 June 2024	
Independent Reviewer	 Tina Sentner, 25 June 2024	
<i>This report and opinion is approved when signed and dated by the independent reviewer.</i>		

Annex A: References

Ellsworth, William L. *Injection-Induced Earthquakes*. Science, vol. 341, 12 July 2013, accessed from <https://www.science.org> on 20 July 2023.

Ground Water Protection Council and Interstate Oil and Gas Compact Commission. *Potential Induced Seismicity Guide: A Resource of Technical and Regulatory Considerations Associated with Fluid Injection*, March 2021. Accessed ...

Kansas Administrative Regulations (KAR). Agency 28. Kansas Department of Health and Environment, Article 46.—Underground Injection Control Regulations, accessed ...

Sandalow, D., R. Aines, J. Friedmann, C. McCormick, D. Sanchez. *Biomass Carbon Removal and Storage (BiRCS) Roadmap*. Lawrence Livermore National Laboratory (California), LLNL-TR-815200, October 2, 2020.

Thiel, Carmen. Final biomethane potential (BMP) report. University of Wisconsin, Oshkosh. Environmental Research and Innovation Center. 30 November 2022.

Annex B: Verification Plan



Verification-Validation Workbook: Validation Plan

CLIENT	Isometric	CONTACT:	Chris Podgorney
		Email:	[REDACTED]
ENGAGEMENT	Validate Project Design Document for Charm Industrial	Phone:	+44 (20) 3192 0250
CRITERIA	Isometric Standard v 1.2		
CRITERIA	ISO 14064-2:2019		
CRITERIA	Isometric Bio-Oil Geological Storage v. 1.0.1		
CRITERIA	Biomass Feedstock Accounting v. 1.1		
CRITERIA	Biomass or Bio-oil Storage in Salt Caverns v. 1.0.2		
CRITERIA	Embodied Emissions Accounting v. 1.0.2		
CRITERIA	Transportation Emissions Accounting v. 1.0		
CRITERIA	Energy Use Accounting v. 1.0.1		
CRITERIA	Note: Document Versions cited above current as of 2024-03-29.		

PLAN APPROVED BY:	JS	PLAN DATE:	26-Jun-2024	PLAN REV.:	3
LEVEL OF ASSURANCE:	Reas & Ltd	ENGAGEMENT TYPE:	Validation		

Note: Conformity of PDD to Isometric requirements validated to a reasonable level of assurance. Limited assurance only to be provided on the project proponent's forecast of removal enhancements.

OBJECTIVES Validate Project Design Document for Charm Industrial Project 1
 [Enter objective 2 here]
 [Enter objective 3 here]

SCOPE *Entries are required for all scope elements a-f.*

- a) **GHG sources, sinks and reservoirs**
 Sources of greenhouse gas emissions (CO₂, CH₄ and N₂O) were propane to start the exothermic reaction in the pyrolyzer; transportation emissions; and electricity consumed at the pyrolysis facility, pre-processing facility, and salt cavern.
- b) **Boundaries**
 Baseline and project: GHG emissions associated with the harvesting of biomass, its conversion to bio-oil, its transportation and pre-treatment, its injection into a class V permitted injection well and permanent underground storage.
- c) **Physical infrastructure, activities, technologies and processes within the scope**
 Activities included the generation of woody biomass residues produced from sustainably managed forests in Quebec; the production of bio-oil through pyrolysis at a production site in Port Cartier, QC; pre-processing the bio-oil in El Dorado, KS, to make it ready for injection in salt caverns; injecting bio-oil in salt caverns located near Hutchison, KS; and the transportation of the bio-oil from Quebec to Kansas and to the final injection site.
- d) **Data management details**
 Charm Industrial developed a database it called "Ledger" to store data from project activities. Data stored in Ledger were transferred to an Isometric database via an Application Programming Interface (API) software. Once resident on the Isometric platform data could be exported to an Excel spreadsheet for verification purposes.
 Note: Data entered into Ledger were not available for review during the validation engagement.

e) **Management controls**

During site visits validation team will assess the ability of the pyrolysis facility, the Charm Industrial pre-processing facility, and the injection well site to manage GHG activities in accordance with requirements.

f) **Time periods**

Not applicable to validation of the PDD.

IDENTITY AND ROLES OF VALIDATION TEAM MEMBERS

NAME:	John Shideler	ROLE:	Team Leader	(571) 278-9486
NAME:	Alexander Scott	ROLE:	Team Member	(509) 944-6502
NAME:	0	ROLE:	Choose Role	Phone
NAME:	0	ROLE:	Choose Role	Phone
NAME:	Chad Milligan	ROLE:	Technical Expert	(316) 573-1169

VERIFICATION CRITERIA: ISO 14064-3 f

VERIFICATION CRITERIA: None

MATERIALITY THRESHOLD (%): 5 (quantitative)

PERFORMANCE MATERIALITY (%):

DATE PLAN SENT TO RESPONSIBLE PARTY: 29-Mar-2024

REASON(S) FOR PLAN REVISION:

r2: finalize plan
r3: Plan after completion

SCHEDULE OF VALIDATION ACTIVITIES

(Include **all** activities; update as required during the validation.)

Use the "Time" column for scheduled site visit activity times.

DAY	DATE	TIME	ACTIVITY	TEAM MEMBER
Friday	9-Feb-2024		Send notification letter	J. Shideler
Wednesday	21-Feb-2024		Workbook preparation and kick-off call	J. Shideler
Thursday	22-Feb-2024		Document review, findings log begins	J. Shideler
Monday	11-Mar-2024		Document review substantially complete	J. Shideler
Tuesday	12-Mar-2024		Validation Plan preparation	J. Shideler
Sunday	17-Mar-2024		Evidence-gathering planning begins	J. Shideler
Wednesday	27-Mar-2024		Evidence-gathering plan substantially complete	J. Shideler
Friday	29-Mar-2024		Update list of findings; verification plan	J. Shideler
Monday	8-Apr-2024		Begin site visits in QC	J. Shideler
Wednesday	10-Apr-2024		Complete site visits in KS	J. Shideler
Friday	10-May-2024		Begin writing validation report	J. Shideler
Friday	30-May-2024		End writing validation report and opinion	J. Shideler
Monday	8-Apr-2024	13:30	Meet with Tony Chabot, Manon Bouchard, and Jean-Christophe Amado at AECN <ul style="list-style-type: none"> • Opening meeting (15 mins) • Tour AECN sawdust waste piles (15 mins) • Tour pyrolysis facility (45 mins) 	J. Shideler
Monday	8-Apr-2024	14:45	Meet with Tony Chabot and/or Manon Bouchard at AECN (cont.) <ul style="list-style-type: none"> • Roles and responsibilities • Data management system and associated procedures • Review evidence of sustainable harvesting of timber • Review BOLs for selected bio-oil shipments 	J. Shideler

Monday	8-Apr-2024	16:30	Validation team departs	
Tuesday	9-Apr-2024	8:00	Meet with Tony Chabot/Manon Bouchard/Jean-Christophe Amado at AECN <ul style="list-style-type: none"> • Verify AECN's bio-oil production compared to nameplate production capacity (2022, 2023, 2024 Q1) • Verify values that are used to produce emissions estimates, including tailgas • Review data inputs to AECN LCA 	J. Shideler
Tuesday	9-Mar-2024	10:30	Validation team departs	
Wednesday	10-Apr-2024	8:00	Meet Adriana Ovalle at Vaulted Deep at Injection Well <ul style="list-style-type: none"> • Data management system and associated procedures • Roles and responsibilities • Bio-oil testing prior to injection • Observe injection, if available • Conformity with KDHE permit requirements • Assess durability assumptions/data; risk of reversal • Leakage and spills (Storage, 3.1.3) • Assess records against monitoring plan requirements 	J. Shideler C. Milligan
Wednesday	10-Apr-2024	15:00	Meet with Caleb Osborn at Charm facility in El Dorado, KS <ul style="list-style-type: none"> • Review process for pre-treatment of injectate 	J. Shideler C. Milligan
Monday	15-Mar-2024		Continue the review of data	J. Shideler
Monday	8-May-2024		Complete validation; start report writing	J. Shideler
Saturday	1-Jun-2024		Submit validation documents to Tina Sentner for independent review	J. Shideler
Friday	31-May-2024		End writing validation report and opinion	
Monday	3-Jun-2024		Begin independent review	T. Sentner
Tuesday	25-Jun-2024		End independent review	T. Sentner
Wednesday	26-Jun-2024		Issue report and opinion	J. Shideler

NOTE 1: Validation plans incorporate the use of the following techniques and activities, as appropriate:

- | | | | |
|------------------------|-------------------|----------------------|-------------------|
| a) observation; | e) recalculation; | l) control testing; | m) reconciliation |
| b) inquiry; | f) examination; | j) sampling; | |
| c) analytical testing; | g) retracing; | k) estimate testing; | |
| d) confirmation; | h) tracing; | i) cross-checking; | |

NOTE 2: Indication of time is approximate and may change in accordance with the needs of the assessment.

Annex C: List of Findings



Verification-Validation Workbook: List of Findings

Client Name: Isometric

Lead Verifier: John Shideler

Client ID: IMT23

Engagement #: 8

Instructions to Verifiers

In executing the validation/verification, validators/verifiers shall undertake the following activities:

- a) collection of sufficient objective evidence on original data/information, ensuring its traceability through the data/information management process, any further analysis and calculation;
- b) identification of misstatements and consideration of their materiality;
- c) assessment of conformity with specified requirements, taking into account the validation/ verification program.

Record findings of **Nonconformity (NC)** and **Clarification Requests (CR)** on this form. Findings of **Immaterial Nonconformity (INC)** may be listed (or, where a GHG program requires their reporting, shall be listed). **Forward Action Requests (FAR)** and **Recommendations (R)** may also be included as items on this form.

Finding/Clarification: State the requirement that was not met, or ask for clarification of information related to audit objectives.

Reference (Ref.): Cite a relevant requirement in a protocol, standard or procedure; or cite information provided by the Responsible Party in a monitoring plan, report or other document.

Audit Evidence: Cite evidence that supports the finding of nonconformity, or (optionally) a reason for requesting clarification.

Responsible Party Action: Summarize the response provided by the Responsible Party with respect to the Finding or Clarification Request.

Lead Verifier Conclusion: State if the response has been accepted, and the disposition of the finding (closed, rewritten as a new NC, etc.).

NOTE: If a matter comes to the verifier's/validator's attention that causes the verifier/validator to believe in the existence of intentional misstatement or noncompliance by the responsible party with laws and regulations, the verifier/validator shall communicate the matter to the appropriate parties as soon as practicable. Intentional misstatements include the possibility of fraud.

#	Type	Issue/Clarification	Ref.	Audit Evidence	Responsible Party Action	Lead Validator Conclusion
1	CR	Please identify the pyrolysis technology deployed by AE Bioénergie Côte Nord (Manufacturer, Model, serial number).	ISO 14064-3, 7.1.4.6		Ensyn RTP pyrolysis technology is being used at the AECN facility. For details please see the link below: http://www.ensyn.com/technology.html	Clarification accepted. Finding closed.

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#	Type	Issue/Clarification	Ref.	Audit Evidence	Responsible Party Action	Lead Validator Conclusion
2	CR	Please provide a copy of the Bio-oil LCA produced for the bio-oil processor.	Charm PDD baseline table.		We have recently received an updated version of this document from AECN using more recently-published emissions factors. This will be uploaded to the Microsoft Teams folder specified.	Clarification accepted. Finding closed.
3	CR	Please provide evidence that woody biomass procured by the lumber mill was sourced from harvesting operations that complied with the forestry harvesting laws/ regulations of Quebec.	Biomass Feedstock Accounting v. 1.1, 2.1, EC5		<p>The Provincial Management Plan is in the teams folder. From the main folder, open the AECN Docs folder and then the AECN Feedstock Docs folder. The Provincial Management Plan in both French and English is there.</p> <p>The Provincial Management Plan, SFI certification, and AECN Affidavit have all been provided to substantiate this point.</p>	Clarification accepted. Finding closed.
4	CR	Please provide a copy of the Vaulted Deep Class V injection well permit issued by the Kansas Department of Health and Environment.	Charm PDD Storage Well Overview.		The injection well permit from KDHE was uploaded to the Microsoft Teams folder.	Clarification accepted. Finding closed.
5	CR	Please provide a copy of the agreement that governs the procurement of bio-oil from Bioénergie AE Côte Nord.	ISO 14064-3, 7.1.4.3		The agreement and two subsequent amendments have been uploaded to the Microsoft Teams folder specified.	Clarification accepted. Finding closed.

#	Type	Issue/Clarification	Ref.	Audit Evidence	Responsible Party Action	Lead Validator Conclusion
6	CR	If there is a separate document governing the procurement of woody biomass from Groupe Remabec's lumber mill, please provide a copy.	ISO 14064-3, 7.1.4.2		N/A -- Groupe Remabec is the parent company of both the Arbec lumber mill and AECN. N/A -- Groupe Remabec is the parent company of both the Arbec lumber mill and AECN. Point of clarification: AECN is actually a joint venture between Remabec and Arbec, I had misunderstood the company structure previously.	Clarification accepted. Finding closed.
7	CR	Please provide a copy of the PDD produced by Vaulted Deep for the sequestration of bio-oil in their underground injection wells.	ISO 14064-3, 7.1.4.2		This PDD for biomass injection has been provided via a link from the Isometric registry.	Clarification accepted. Finding closed.
8	CR	Please specify in which documents the ownership of the carbon removals is addressed.	ISO 14064-3, 7.1.4.3		Documents from both AECN and Vaulted modifying existing agreements to reflect this point have been signed and uploaded to Microsoft Teams	Clarification accepted for AECN (see 2nd amendment) and for Vaulted Deep (see ACS_Charm carbon credits amendment). Finding closed.
9	CR	Please direct me to the location in the PDD where you "consider specific alternative uses of biomass that would have occurred in the absence of the project."	Biomass Feedstock Accounting, v. 1.1, p. 3.		See "Counterfactual Fate of Feedstock" in Appendix 1: Biomass Feedstock Information.	Clarification accepted. Finding closed.

#	Type	Issue/Clarification	Ref.	Audit Evidence	Responsible Party Action	Lead Validator Conclusion
10	CR	Please provide records of calibration for scales used to weigh biomass and bio-oil at both Bioénergie AE Côte Nord and Vaulted Deep sites.	Biomass or Bio-oil Storage in Salt Caverns, 1.0.1, 3.1.1		AECN scale calibration records are in AECN Documents > AECN Documents — Other. They are titled AECN Scale Calibration 2022 and “” 2023. A scale calibration record from Vaulted is found in the Vaulted folder.	Clarification accepted. Finding closed.
11	CR	Please provide evidence that KDHE has approved bio-oil emplacement into the class V salt cavern injection well operated by Vaulted Deep.	Biomass or Bio-oil Storage in Salt Caverns, 1.0.1, p 3		See KDHE Authorization of Bio Oil Sequestration.pdf dated 2023-10-27.	Clarification accepted. Finding closed.
12	CR	Please provide a citation, if applicable, to KDHE’s requirement for buffering of bio-oil pH, or the raising of the bio-oil’s salinity, and an explanation of how this operation is performed.	Biomass or Bio-oil Storage in Salt Caverns, 1.0.1, p 3		See KDHE Authorization of Bio Oil Sequestration.pdf dated 2023-10-27. I want to note that this point is not addressed by the Vaulted Salt Cavern Characterization. The salinity Requirement is most directly addressed in the “KDHE Authorization of Bio Oil Sequestration” doc. The pH requirements are documented in the Class V permit on page 6, Table 3. Both of these documents are in the Vaulted docs folder. The pH buffering procedure is described in the Minifinery Operational SOP, which is in the EI Dorado Pre-Processing Docs folder.	Clarification accepted. Finding closed.

#	Type	Issue/Clarification	Ref.	Audit Evidence	Responsible Party Action	Lead Validator Conclusion
13	CR	Please provide documentation of the completion of the salt cavern characterization as required by the protocol.	Biomass or Bio-oil Storage in Salt Caverns, 1.0.1, p 6		See Vaulted Salt Cavern Characterization.docx (2024-01-24).	Clarification accepted. Finding closed.
14	CR	Please explain how the project meets the requirement for $\delta^{13}\text{C}$ monitoring of injectate.	Biomass or Bio-oil Storage in Salt Caverns, 1.0.1, p 7		This is not a requirement within the protocol, only encouraged.	Clarification accepted. Finding closed.
15	CR	Please explain how the project maintains records of laboratory analyses and relevant permit limitations to demonstrate compliance related to injectate emplacement.	Biomass or Bio-oil Storage in Salt Caverns, 3.1.1		Data from laboratory analyses will be stored in the ledger as described in the "Data Collection and Storage" section of PDD V1.0. Applicable tests will be associated with the appropriate injection batch and recoverable as needed.	Clarification accepted. Finding converted to a Forward Action Request. See Finding 44.
17	CR	Please clarify whether injectate analysis includes monitoring of the following parameters: <ul style="list-style-type: none"> • Total carbon content • Water density 	Biomass or Bio-oil Storage in Salt Caverns, 3.1.1		Measurement of the Total Carbon Content of injectate is referenced in several places in the PDD, including the Project Boundary and the GHG Statement. It is measured by sampling each injection batch and sending the samples to SGS laboratory. Monitoring water density is not required by the Isometric Protocol.	Clarification accepted. Finding closed.

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#	Type	Issue/Clarification	Ref.	Audit Evidence	Responsible Party Action	Lead Validator Conclusion
18	CR	Please explain how Vaulted Deep monitors injection operations including by the deployment of required alarms and surface shut-off systems.	Biomass or Bio-oil Storage in Salt Caverns, 3.1.1		Alarm set points are set below notifiable limits in order to identify issues before they require notification to KDHE.	Clarification accepted. Finding closed.
19	CR	Please explain how Vaulted Deep has taken into account the Protocol's requirement that the cause of tripped operational alarms or shut-offs be investigated and reported to the validation/ verification body (in this case, Futurepast).	Biomass or Bio-oil Storage in Salt Caverns, 3.1.1		Charm has described a process by which Vaulted has agreed to notify Charm Industrial about tripped alarms. It is also noted that Charm, Isometric, and the VVB have agreed that it is more appropriate for the well operator to notify Charm regarding a wellhead gas alarm being triggered rather than the VVB as prescribed in Salt Cavern Storage module Section 3.1.1. This is due to 1) additional context-specific investigation is necessary to establish whether the triggering alarm is or is not indicative of a reversal, and 2) the well operator has their alarms set to conservative trigger points below levels that would indicate a reportable event so that any anomaly is investigated before it becomes a larger issue.	Isometric has approved a deviation from this requirement. See validation report. The issue is closed.

#	Type	Issue/Clarification	Ref.	Audit Evidence	Responsible Party Action	Lead Validator Conclusion
20	CR	Please explain how Vaulted has adopted Cavern integrity monitoring procedures consistent with protocol requirements and how these procedures are documented in the PDD.	Biomass or Bio-oil Storage in Salt Caverns, 3.1.3		See "Durability Assessment" section of the PDD for language quoted from Vaulted's own PDD regarding their cavern integrity monitoring program.	Clarification accepted. Finding closed.
21	CR	Please explain how the displaced brine stream is monitoring for volume and total organic carbon concentration.	Biomass or Bio-oil Storage in Salt Caverns, 3.1.3		See "Monitoring Plan" section of the PDD V1.0.	Clarification accepted. Finding closed.
22	R	Consider updating the title of the project in the PDD and using a digit (e.g. "1") to denote the instance of the project (assuming there may be others of a similar nature).			Recommendations do not require a response.	No response required.
23	R	Consider deleting the word "Template" from the overall title of the PDD and the directions for using the template.			Recommendations do not require a response.	No response required.
24	CR	Please provide geographic coordinates (decimal versions of latitude and longitude) for the Groupe Remabec lumber mill, the AE Bioénergie Côte Nord pyrolysis facility, Charm's pre-processing facility, and Vaulted Deep's injection well facility.	ISO 14064-2, 6.2 c)		Coordinates found for the Vaulted injection well site (KDHE permit). Others pending. Coordinates for all sites can be found in the Project Locations section of the PDD V1.0. This should close the issue.	Clarification accepted. Finding closed.

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#	Type	Issue/Clarification	Ref.	Audit Evidence	Responsible Party Action	Lead Validator Conclusion
25	CR	<p>Given the statement that "Every project . . . must consider specific alternative uses of biomass that would have occurred in the absence of the project" please clarify why combustion of the biomass was the only alternative considered.</p> <p>Literature exists that describes the use of bio-oil to produce Sustainable Alternative Fuels for use in the aviation sector, for example. See also the counterfactual definition text for "Replacement Emissions" (p 4): "Emissions from any additional activities necessary to replace any environmental services the feedstock would have otherwise provided need to be accounted for".</p>	Biomass Feedstock Accounting, v. 1.1, Introduction, p 3.		<p>See "Counterfactual Fate of Feedstock" and "Counterfactual Storage Eligibility" -- The likely counterfactual fate outlined here is that sawdust would continue to be piled outside of the lumber mill due to the historical absence of an offtaker besides AECN. Combustion is only discussed regarding Counterfactual Storage.</p> <p>Eligibility comparing the GWP of a full biogenic release of carbon through combustion vs. the GWP of a pile of sawdust decomposing for 15 years.</p>	Clarification accepted. Finding closed.
26	CR	Please provide the calculated carbon removals from the project activities.	ISO 14064-2, 6.2 f)		Removals have not yet been completed. Calculated removals will be provided when executed, which is expected to occur prior to the end of the validation process. Specific calculations will be shared with Isometric via an API connection to Charm's Ledger system.	Finding closed as the scope of this engagement has been reduced to validation only.

#	Type	Issue/Clarification	Ref.	Audit Evidence	Responsible Party Action	Lead Validator Conclusion
27	CR	Please clarify how the table called "Project Participants" can be complete without mentioning the roles of such participants as the feedstock provider and the pyrolysis facility operator.	Isometric Project Design Document Template		PDD V1.0 "Project Participants" section will be updated to include AECN -- They are a subsidiary of Groupe Remabec, which also owns the Arbec sawmill from which feedstock is sourced.	Clarification accepted. Finding closed.
					V1.0 "Project Participants" section of the PDD has been updated to include AECN as well as Vaulted as project Participants. This should close the issue.	
28	CR	Please clarify how the project meets the Isometric Standard requirement that it "must do no net environmental or social harm," and that "remediation of any unintentional harm, caused directly or indirectly by a project, must be carried out by a Project Proponent."	Isometric Standard, 3.7		To give further clarity on this point within the PDD, Isometric has introduced a question within Section D (Environmental and Social Impacts) on "Additional Risks", giving the Project Proponent the opportunity to clarify that risks of potential harm arising from the Project have been assessed, and mitigated if necessary. More generally, Projects are expected to demonstrate compliance with this Standard requirement through meeting any specific environmental & social requirements outlined in the Standard & Protocol, including via the responses supplied in Section D of the PDD.	Clarification acknowledged with respect to the operations downstream of AECN. See new finding 32 CR.

#	Type	Issue/Clarification	Ref.	Audit Evidence	Responsible Party Action	Lead Validator Conclusion
29	CR	Please clarify how the project demonstrates how its carbon removal activities are consistent with relevant Sustainable Development Goals, including any positive impacts identified in relation to SDGs other than SDG 13, and any standardized assessment tools and methods used as part of this explanation.	Isometric Standard, 3.7.3		The question pertaining to this Standard requirement was previously missing from the PDD template Charm completed - this question has now been added to the end of Section D, to be completed. Please see "Sustainable Development Impact" at the end of Section D of PDD V1.0 for a discussion of the project's contribution to SDGs.	Clarification accepted. Finding closed.
30	CR	Please identify where the following information will be found in the PDD: 1) the date of initiating project activities; 2) GHG baseline time period; 3) date of termination of the project; 4) frequency of reporting and the dates of the project period, including relevant project activities in each step of the GHG project cycle; 5) frequency of verification and validation.	ISO 14064-2, 6.2 f); Isometric Standard 4.2		The question pertaining to this Standard requirement was previously missing from the PDD template Charm completed - this question has now been added to the end of Section D, to be completed. Re (4) and (5): Regarding the Reporting Period of the GHG Statement for this current verification, this should be supplied in Appendix 2 "Please specify the Reporting Period this GHG Statement has been prepared for".	Clarification accepted. Finding closed.

#	Type	Issue/Clarification	Ref.	Audit Evidence	Responsible Party Action	Lead Validator Conclusion
31	CR	Please describe how the project has applied quality management procedures to data and information.	ISO 14064-2, 6.9		<p>1. Date of initiating project activities is indicated in the "Project Timeline" and "Crediting Period" components of Section C — Duration and Crediting Period</p> <p>2. The "Baseline Scenario" section describes the scenario as it would be expected to exist at the time of project initiation had the project not been initiated</p> <p>3. Expected closure date of the project is specified by Isometric as optional — See "Project Timeline" in Section C —Duration and Crediting Period</p> <p>4. The Isometric Standard appears to leave this to the Project Proponent's discretion. "Removals may be Verified annually, or more or less frequently, according to the requirements of the relevant Certified Protocol, or at the Project Proponent's request. Given this language it would appear that declaring this cadence ahead of time should not be a requirement for project validation</p> <p>5. See above — Validation is expected to occur approximately every 5 years per the crediting period duration. See Section 3.4 of the Isometric Standard</p>	See Finding 36 R

#	Type	Issue/Clarification	Ref.	Audit Evidence	Responsible Party Action	Lead Validator Conclusion
32	CR	Please clarify how the discussion of environmental and social impacts meets the requirements of the Isometric standard given the lack of analysis relating to upstream feedstock acquisition and processing.	Isometric Standard, 3.7, "Projects must consider the material environmental and social impacts that could potentially arise as a result of their activities, both within and beyond its boundary."		PDD V1.1. includes new language in the project boundary table on the sourcing of sustainable feedstock upstream from the lumber mill.	Clarification accepted. Finding closed.

#	Type	Issue/Clarification	Ref.	Audit Evidence	Responsible Party Action	Lead Validator Conclusion
33	CR	Please clarify the method used at Vaulted for meeting the requirement to monitor the volume of emplaced material at the injection site (rate of injection or mass of bio-oil emplaced).	Isometric Standard, 3.7, "Projects must consider the material environmental and social impacts that could potentially arise as a result of their activities, both within and beyond its boundary."		Please see Vaulted/Charm Emplacement Agreement Section 9 Subsection A: ACS shall measure and report monthly (i) the weight of Product delivered by Provider to ACS at the Delivery Point via the on site weigh station ticket and (ii) the truck weight following the delivery prior to its exist from ACS facility via the on site weigh station ticket and (iii) on an experimental basis, as equipment delivery timelines enable, ACS shall measure the volume of Product emplaced and sequestered in the Emplacement Caverns calculated by a non-resettable meter installed, operated, and maintained by ACS.	Clarification accepted. Finding closed.
34	NC	Charm Industrial's purchase agreement with Bioénergie AE Côte Nord does not stipulate that AECN Bioenergy "will not advertise that they are producing a 'low emission product or practice' in connection with or benefitting from the Removals carried out by the project."	2nd Amendment to Bio-Oil Purchase Agreement	The cited stipulation is a requirement of the Isometric Standard, 3.1	(Email from 2024-05-23): "Isometric understands the challenge for AECN involving making claims around low-emissions and sustainability when discussing the production and sale of their product which is unrelated to Charm. The purpose of this clause is to mitigate the possibility of climate benefits being "double counted" in some way, for a product	Issue resolved with a deviation approved by Isometric. Finding is closed.

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#	Type	Issue/Clarification	Ref.	Audit Evidence	Responsible Party Action	Lead Validator Conclusion
					involved in the supply chain of a project. However, the additional contractual language is not necessary in this case, and we would consider Section 3.1 to be sufficiently evidenced through the existing language in the affidavit provided by Bioenergie AECN. As such we are happy to approve a deviation here."	
35	CR	Please clarify whether the LCA data found in the PDD, Appendix 2, and their subsequent utilization in removal calculations, constitute "consequential" or "attributional" LCA	Isometric Standard, 2.5.10		A clarifying document titled "Consequential LCA Clarification" has been uploaded to MS Teams in the Supporting Documents folder	Clarification accepted. Finding closed.
36	R	"Data quality" is not a defined term in the Isometric standard although it occurs twice in that document. The standard (7.4) links analysis of uncertainty to the concept of data quality. Other guidance documents on GHG quantification approach data quality from a management system perspective.	Isometric Standard, 7.4 and note 16.	Compare Chapter 7 "Managing Inventory Quality" in the WRI/WBCSD Greenhouse Gas Protocol, A Corporate Accounting and Reporting Standard, revised edition, for another perspective on data quality management.	Recommendations do not require a response.	No response required.

#	Type	Issue/Clarification	Ref.	Audit Evidence	Responsible Party Action	Lead Validator Conclusion
37	NC	The "project boundary" ["system boundary" in the PDD"] did not reference upstream biomass sustainability requirements.	Bio-oil Geological Storage, 4.0, applicability criteria	The protocol applies to projects and associated operations that meet the following project conditions, <i>inter alia</i> : "... the biomass feedstock utilized is sustainably sourced." Per Isometric, the project boundary includes upstream requirements even when emissions values are reported as "0".	1.The "Project Boundary" table has been expanded to include "Feedstock Sustainable Sourcing" noting the criteria for sustainable biomass satisfied by the feedstock.	Response accepted. Finding closed.
38	CR	Please clarify the Isometric Standard section reference for the sentence in the uncertainty assessment section 1.a. that reads: "i. An Uncertainty Factor has been calculated for this emissions factor based on process and data quality considerations as outlined in Section 7.4 of the Isometric Standard."	PDD Uncertainty Assessment table, Bio-oil	I do not find section 7.4 in the Isometric Standard	Section 7.4 is part of Appendix A of the Isometric Standard, titled Unknown Uncertainties. This references Section 10.1 of Ecoinvent's Overview and Methodology document as the basis for addressing uncertainty in emissions factors	Clarification accepted. Finding closed.

#	Type	Issue/Clarification	Ref.	Audit Evidence	Responsible Party Action	Lead Validator Conclusion
39	NC	Not all parameters necessary for assuring continued conformity with the Isometric Standard, Protocols, and Modules were addressed in the Monitoring Plan of the PDD.	Isometric standard, 2.5.3.2	Per the standard, "Project Proponents must demonstrate that the Project is not required by existing laws, regulations, policies, or other binding obligations." The following relevant regulatory issues were not found addressed in the PDD's monitoring plan: 1) at AECN, El Dorado, and Vaulted Deep: Monitoring of regulatory compliance was not included in the monitoring plan;	The monitoring plan in v. 1.2 of the PDD has been revised.	Conclusions are recorded below for each separate item 1-5. With regard to AECN regulatory compliance and upstream monitoring of forestry regulatory compliance, the monitoring plan in v. 1.2 of the PDD remains silent. See new finding 40. With regard to El Dorado's monitoring of regulatory compliance, the monitoring plan in v. 1.2 of the PDD remains silent. See new finding 40.

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#	Type	Issue/Clarification	Ref.	Audit Evidence	Responsible Party Action	Lead Validator Conclusion
						With regard to Vaulted Deep's monitoring of regulatory compliance, the monitoring plan in v. 1.2 of the PDD has been revised adequately. The finding is closed.
				2) the monitoring plan did not include monitoring of the tailgas produced at the AECN pyrolysis facility		This finding has been converted this to a "Forward Action Request" to be dealt with in a subsequent verification period when the stack test will have been performed.
				3) the monitoring plan did not include Bills of Lading for shipments of bio-oil from Port Cartier to El Dorado, or from El Dorado to Hutchison.	Bills of lading and weigh scale tickets have been added to the section on Transport Emissions in the Monitoring Plan.	Transportation documentation has been added to the Monitoring Plan. The finding is closed.

#	Type	Issue/Clarification	Ref.	Audit Evidence	Responsible Party Action	Lead Validator Conclusion
				4) the monitoring plan did not include tracking emissions from the catalytic oxidizer in El Dorado that are currently below the threshold for requiring an operating permit but that might exceed permit threshold criteria in the future.		This finding has been converted this to a "Forward Action Request" to be dealt with in a subsequent verification period when volumes of air emissions will have been increased to the point where an air permit will be required.
				5) the monitoring plan did not include testing for gas emissions other than propane at the Vaulted Deep facility in Hutchison.		This finding has been converted this to a "Forward Action Request" as the site is in the process of procuring and installing a multigas detection monitor.
40	NC	At AECN and El Dorado, general monitoring of regulatory compliance was not included in the monitoring plan.		The monitoring plan requirements for regulatory compliance are contained in a section limited to "Injection".		On-going regulatory compliance applicable to all third parties has been identified as a separate section. The finding is closed.
41	FAR	At verification, review the results of monitoring the tail gas produced at the AECN pyrolysis facility.	Isometric standard, 2.5.3.2	Tail gas emissions are not required to be monitored until later in 2024.	The vendor (AECN Bioenergy) has retained services to directly stack test emissions by the end of 2024.	Not applicable.

#	Type	Issue/Clarification	Ref.	Audit Evidence	Responsible Party Action	Lead Validator Conclusion
42	FAR	At verification, review whether emissions from the catalytic oxidizer in El Dorado remain below the threshold for requiring an operating permit.	Isometric standard, 2.5.3.2	At the time of validation the volume of air emissions from the catalytic oxidizer were below air permitting thresholds.	Forward Action Requests do not require a response from the responsible party.	Not applicable.
43	FAR	At verification, review the ability of the multigas detector at Vaulted Deep to detect potential emissions of CH4 among other gases.	Isometric standard, 2.5.3.2		Forward Action Requests do not require a response from the responsible party.	Not applicable.
44	FAR	At verification, explain how the project maintains records of laboratory analyses and relevant permit limitations to demonstrate compliance related to injectate emplacement.	Biomass or Bio-oil Storage in Salt Caverns, 3.1.1	Relevant records are uploaded for periods of verification.	Forward Action Requests do not require a response from the responsible party.	Not applicable.

#	Type	Issue/Clarification	Ref.	Audit Evidence	Responsible Party Action	Lead Validator Conclusion
45	CR	Please provide the assumptions, limitations and methods used to estimate the carbon removal capacity of the project .	PDD, v. 1.2, Section A, table of "Estimated carbon removal capacity"	The project proponent has estimated carbon removal capacities in metric tonnes for the years 2024 - 2028.	Isometric defines Projects based on an injection site, not a feedstock or supplier. As such, these values represent estimates that include not only AECN's production, but that of Charm's own general expectations for other third-party off take relationships. As a startup operating in an emerging market these estimates involve a high level of uncertainty. However, they do represent our current forecasts in terms of high-level operational planning.	Validator notes the revision of the table to include projections for 2024 and 2025, based on reasonable assumptions, and the revisions of forecasts for years 2026-2028 to conservative estimates of "25,000 + t". Revised projections now accepted by the Validator and the issue is closed.
46	FAR	At verification, determine whether there are additional sites or facilities from which bio-oil is sourced that are material to the GHG statement and perform site visits as required.	ISO 14064-3:2019, 6.1.4.2 f)	The project proponent has estimated material increases in the volume of carbon removal credits in years 2026 - 2028.	Forward Action Requests do not require a response from the responsible party.	Not applicable.
47	FAR	At verification, confirm that the feedstock used to produce bio-oil at the AECN Bioenergy facility continues to be mill residues and that the supply of mill residues is not supplemented by merchantable chipped round wood.	Biomass Feedstock Accounting, 2.1.	The eligibility criteria EC5 depends upon the use of residues, including mill waste, and leakage could occur if lumber mill sawdust and shavings were supplemented by merchantable round wood.	Forward Action Requests do not require a response from the responsible party.	Not applicable.

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#	Type	Issue/Clarification	Ref.	Audit Evidence	Responsible Party Action	Lead Validator Conclusion
48	CR	Please clarify in the assumptions provided that justify the estimated carbon removal capacity of the project the likely impact on the availability of woody biomass residues from the announced construction in Port Cartier of a new biochar production facility.	Press release from Suez Group dated 2023-07-05 announcing construction of a new biochar facility in Port Cartier, QC	The press release states that biochar would be manufactured using woody bio-mass residues from Groupe Rémabec's lumber mills.	Charm Industrial has restated its five-year forecast to include values for 2024 and 2025, with values for years 2026-2028 amended to read "TBD -- 25,000+"	The clarification is accepted. The issue is closed.
49	R	The project proponent may benefit from adding a Table of Contents to the PDD to facilitate finding sections of interest during consultation of the document.	Charm Industrial Great Plains Bio-oil Sequestration Project Design Document		A table of contents was added to the PDD.	Changes made following recommendations do not require validator approval.
50	CR	Please clarify what software Charm Industrial uses to manage project data and transfer it to Isometric's data platform.	PDD template section on "Data collection and storage"		Charm Industrial has clarified that it has developed a bespoke database it calls Ledger and will use an application programming interface to transfer its project data to Isometric's project platform.	Clarification accepted. The issue is closed.

#	Type	Issue/Clarification	Ref.	Audit Evidence	Responsible Party Action	Lead Validator Conclusion
51	CR	Please clarify whether GWPs from the IPCC AR6 have been consistently used in all GHG calculations, including those embedded in supplier provided LCAs (Bioenergie AE Cote Nord and Vaulted Deep) and supply chain CO2e emissions factors.	Bio-oil Geological Storage protocol, 7.1		Per Isometric (email from 2024-05-24), the "should" wording of the Isometric Standard (2.5.6) applies to the Bio-oil Geological Storage protocol.	Clarification accepted. The issue is closed.
52	FAR	At verification, confirm whether injection batches of bio-oil are the same as production batches or are blends of production batches.	Bio-oil Geological Storage protocol, 7.4.1		Forward Action Requests do not require a response from the responsible party.	Not applicable.
53	FAR	At initial verification, confirm that a sample of data entered into Charm Industrial's Ledger database produces an identical output when uploaded in Isometric's data platform.	Bio-oil Geological Storage Protocol, 7.3		Forward Action Requests do not require a response from the responsible party.	Not applicable.
54	FAR	At verification, validate any updated forecasts for CDR generation in out-years.	Project Design Document, Section A, Estimated carbon removal capacity		Forward Action Requests do not require a response from the responsible party.	Not applicable.

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