LIBERTY H_2 HUB FRONT-END ENGINEERING AND DESIGN

Status Report

(for the period November 1, 2023 – April 30, 2024)

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DESCRIPTION OF PROJECT

The objective of this Energy & Environmental Research Center (EERC) project is to support the Clean Sustainable Energy Authority (CSEA) goal of deployment of large- scale commercial projects that reduce environmental impacts and increase sustainability of energy production and delivery. The proposed Prairie Horizon Energy Solutions (PHES) front- end engineering and design (FEED) study will result in critical development and support investment decisions by the project sponsors, MPLX and TC Energy, to develop large- scale facilities and infrastructure for a complete supply chain of clean energy.

The focus of this project is to complete a FEED study that will provide the information needed for the project sponsors to invest in commercial deployment of clean H_2 production, transport, and storage systems. That investment and subsequent construction and operation will generate clean H_2 product that diversifies North Dakota's economy, leverages existing resources, creates sustainable jobs, and reduces the environmental footprint of energy production and use in the region and beyond. Key attributes of the PHES design include 1) H_2 production at a rate of 190 tonnes per day (tpd); 2) H_2 production with autothermal reforming (ATR) of natural gas with carbon capture and storage (CCS); 3) geologic storage for clean H_2 product and CO_2; 4) logistics infrastructure consisting of pipelines for transport of CO_2, H_2, and potentially H_2–natural gas blends and H_2/NH_3 transit terminals for truck and/or rail; and 5) increased ammonia production through expansion of existing or new manufacturing facilities to produce and competitively supply regional and global markets.

Attributes 1 and 2 have been adjusted due to changes in scope in the project. See details below for additional information.

PROJECT TASKS

The work and progress achieved for each task during the reporting period are detailed as follows.

Task 1.0 – Project Management and Planning

The project team continued to hold weekly meetings with representatives from the EERC and PHES to discuss general project management topics as well as detailed discussions regarding the technical scope and progress. A summary of the proposed milestones and deliverables are tracked in Table 1.

Table 1. Project Milestones and Deliverables

Milestone (M)/Deliverable (D)	Expected Completion Date	Actual Completion Date
M1 – Kickoff Meeting	11/30/2022	1/23/2023
M2 – H_2 Pipeline FEL[1]-2	9/30/2025	
M3 – CO_2 Pipeline FEL-2	1/12/2024	2/29/2024
M4 – Clean Ammonia FEL-1	7/31/2023	4/30/2023
M4.1 – Clean Ammonia FEL-2[2]	N/A	11/30/2023
M4.2 – Clean Ammonia FEL-2 Update[2]	N/A	3/31/2024
M4.3 – Clean Ammonia FEL-2/FEL-3 Bridging[2]	3/31/2025	
M5 – Environmental Studies FEL-1	7/31/2023	4/1/2023
M6 – H_2 Subsurface Storage FEL-1	7/31/2023	8/31/23
M7 – CO_2 Subsurface Storage FEL-1	7/31/2023	10/31/23
~~M8 – H_2 Production FEL-3~~	Deferred beyond CSEA grant	
M8.1 – H_2 Production FEL-2[2]	N/A	11/30/2023
M8.2 – H_2 Production FEL-2 Update[2]	N/A	3/31/2024
M8.3 – H_2 Production FEL-2/FEL-3 Bridging[2]	3/31/2025	
~~M9 – H_2 Pipeline FEL-3~~	Deferred beyond CSEA grant	
~~M10 – CO_2 Pipeline FEL-3~~	Deferred beyond CSEA grant	
M11 – H_2 Subsurface Storage FEL-2	9/30/2025	
M12 – CO_2 Subsurface Storage FEL-2	9/30/2025	
D4 – Final Report	10/31/2025	

[1] Front-end loading.
[2] Scope additions, see content of report for additional clarifications.

Based on the projected timeline, shifts in scope, and the ongoing dynamic nature of the commercial support for the project, some scopes originally listed as CSEA-covered tasks are being proposed to occur outside the time frame of the CSEA grant. Those scopes and their associated milestone or deliverable associated are listed below:

- M8 – H_2 Production FEL-3
- M9 – H_2 Pipeline FEL-3
- M10 – CO_2 Pipeline FEL-3

On a similar note, scopes that were not originally called out in the proposal but are essential to project development are listed in Table 1. These have been advanced to support the ultimate goal of reaching an investment decision for the project. Those scopes and any milestone or deliverable associated are listed below:

- M4.1 – Clean Ammonia FEL-2
- M4.2 – Clean Ammonia FEL-2 Update
- M4.3 – Clean Ammonia FEL-2/FEL-3 Bridging
- M8.1 – H_2 Production FEL-2
- M8.2 – H_2 Production FEL-2 Update
- M8.3 – H_2 Production FEL-2/FEL-3 Bridging

Task 2.0 – Engineering and Design – Surface Facilities

The engineering progress will be reported using FEL terminology. For this reason, Figure 1 describing FEL terminology was provided.

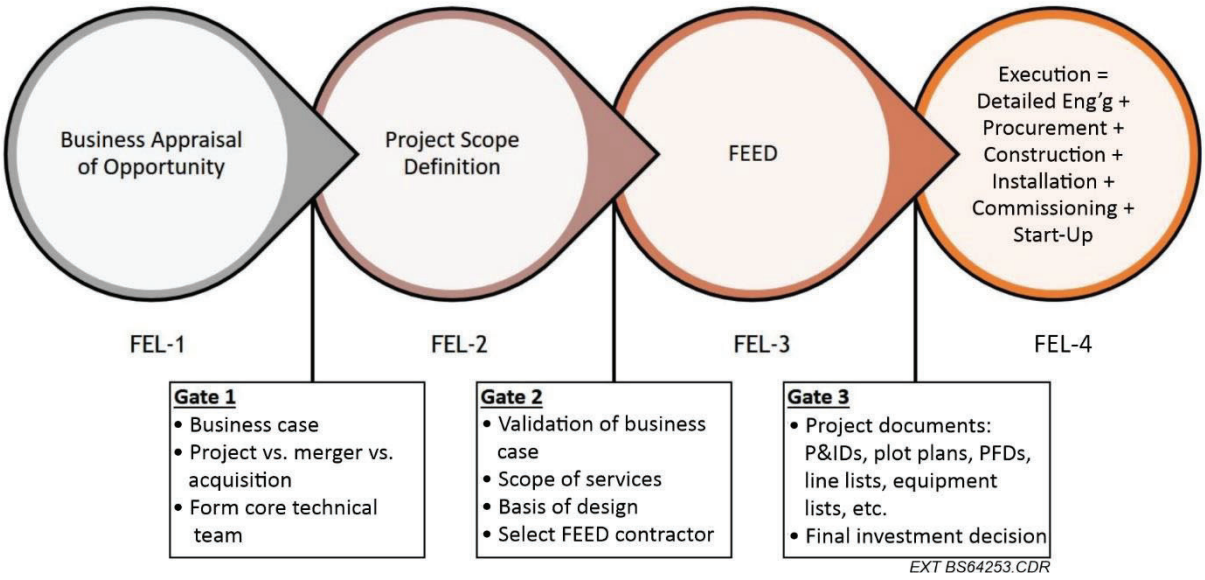

Figure 1. FEL terminology definition (source: Freeman, D., LinkedIn, accessed 2023).

Subtask 2.1 – FEED of H_2 Production

During the previous reporting period, Black & Veatch (B&V) was contracted to perform FEL-1 and FEL-2 engineering design for the H_2 production facility based on a phased approach using electrolysis and ATR. This service was completed.

This past reporting period included a step-back review of the project, resulting in two major scope changes and a rework of past deliverables. Changes are summarized in the bullets below:

- Change 1: Removed electrolysis production and increased the ATR to 200 tpd
  - Team updated FEL-2 deliverables according to the change in scope as described; update completed in March 2024.

- Change 2: Downstream hydrogen uses shifted; ATR downsized to 190 tpd
  - The engineering team is currently in the process of completing a request for proposal (RFP) with technology licensors to select a licensor for updating FEL-2 bridging deliverables accordingly, which will feed into finalizing the FEL-3 stage.

Based on projected cost-share contributions and development timeline, the FEL-3 scope is being projected to occur outside the time frame of the CSEA grant. However, the team will

continue to advance engineering development beyond FEL-2, and tasks such as those listed below are expected to be completed prior to the end of the CSEA project time frame:

- Technology licensor selection
- FEL-3 level process flow diagrams, heat and mass balance, process and instrumentation diagrams, final plot plans, equipment lists
- Field geotechnical investigations

Progress is also advancing on supporting scopes to the H_2 production facility design. This includes the continued development of the interconnection pipelines between the new production facility and the existing Marathon Dickinson Plant.

Subtask 2.2 – FEED of H_2 Pipeline

Based on projected cost-share contributions and development timeline, the FEL-3 scope is being projected to occur outside the time frame of the CSEA grant.

Subtask 2.3 – FEED of CO_2 Pipeline

The project team elected to shift consultants on the CO_2 pipeline development from Sargent & Lundy (S&L) to Wood. During this reporting period, Wood updated the FEL-1 completed by S&L for the new sequestration site, identified approximately 25 miles away.

Wood also conducted and completed the FEL-2 phase of the pipeline development.

Based on projected cost-share contributions and development timeline, the FEL-3 scope is being projected to occur outside the time frame of the CSEA grant.

PHES has officially onboarded a land services company—Gray Hawk Land Solutions (Gray Hawk)—to assist in the landowner engagement effort. Gray Hawk agents have been onboarded and are actively engaging landowners in pipeline and seismic survey permissions. At this time, the team has acquired approximately 75% pipeline surveys permissions. Route adjustments are also being reviewed to avoid landowners wishing to not partner with PHES; it is the goal of PHES to have 100% voluntary participation by landowners for pipeline easements.

Subtask 2.4 – Clean Ammonia

While not originally indicated in the CSEA proposal, the project team has continued to advance the clean ammonia scope of the project beyond FEL-1. This scope continues to advance alongside the hydrogen production at the same pace and will continue to do so. B&V is the contracted consultant to complete this scope.

Similar to Subtask 2.1, the project advanced a FEL-2 level development, changed scope, and completed an update to that FEL-2. The team is currently advancing deliverables for a

FEL-2 bridging phase to include the technology data obtained through the ongoing licensor selection/RFP process.

Progress is also advancing on supporting scopes to the clean ammonia production facility design. This includes the continued development of the interconnection pipelines between the new production facility and the existing rail loading facility as well as the advancement of the new rail loading rack for loading ammonia onto railcar for shipping.

Subtask 2.5 – Environmental Studies

Nothing new to report in this subtask.

Task 3.0 – Engineering and Design – Subsurface Storage for H_2 and CO_2

FEL- 2 is in progress for chosen H_2 and CO_2 storage areas of interest (AOIs) to characterize target formations more accurately. A comprehensive screening effort was completed for determining potential H_2 storage sites; a summary report has been started to provide recommendations to PHES for consideration. Planning and designs have been completed for drilling a stratigraphic test well and are underway for conducting a geophysical (seismic) survey, both necessary to obtain the required subsurface data for ultimate permitting and implementation of the potential CO_2 storage site. The application for permit to drill (APD) was formally submitted to the North Dakota Industrial Commission's (NDIC's) Department of Mineral Resources (DMR) on April 5, 2024.

Several updates (scope only, not total budget) have been made to the CO_2 subsurface characterization approach, summarized in Table 2, with details supporting these changes provided in the Subtask 3.2 section.

Table 2. Updates for CO_2 Subsurface Activities (no overall budget changes)

Subsurface Activity	Proposed	Update
CO_2 Rate of Investigation	*One rate:* 1 MMtpy*	*Two rates:* 1.2 MMtpy, 2.0 MMtpy
Existing 2D Seismic Data	Not included in initial scope	Acquired 290 linear miles total
3D Seismic Survey	*Area:* 35 sq mi *Timeline:* Quarter (Q)1 2024	*Area:* 64 sq mi *Timeline:* Q4 2024 or Q1 2025
Laboratory Analysis	Not included in initial scope	Analyses of core and fluid samples collected during drilling of the stratigraphic test well.

* Million tonnes per year.

Subtask 3.1 – H_2 Storage Characterization and Designs

The EERC completed review of the hundreds of existing well logs and 2D seismic data within the study region of about 20×30 miles directly west of Dickinson, North Dakota. This site screening activity generated maps of salt thickness in formations potentially suitable for solution mining and H_2 storage/recovery. Salt formations of focus in the region continue to be the Dunham and Pine, 6700 ft and 7000 ft depth, respectively. The AOI was assessed for sites with the greatest

continuous thickness and minerology (solubility) and the lowest surface and subsurface structural risks. The purchased existing 2D seismic data (discussed further in the Subtask 3.2 section) was utilized in the technical assessment of the study region, identifying regions of high- and low-risk as well as formation thicknesses and depths. These findings are being summarized for PHES consideration to ultimately drill a stratigraphic test well at a selected site (not included in project scope).

In addition, major equipment requirements were determined for the development (i.e., solution mining) and operations of a salt cavern for up to 5000 tonnes H_2 storage. Considerations for high-level, conceptual designs and/or parameters for obtaining cost estimations included estimated number of caverns, cavern dimensions and layout, surface facility layout, and the overall lateral "footprint." These findings are being summarized for PHES consideration of site selection.

Subtask 3.2 – CO_2 Storage Characterization and Designs

As mentioned previously, several activities in this subtask have been updated from the proposed scope (Table 2), as new information has become available during the investigations of this project. For example, refining designs from the potential capture system during Task 2 activities have similarly resulted in a refined CO_2 output and potential injection rate for geologic storage. As PHES explores varying H_2 production rates, estimated CO_2 rates could subsequently vary between 1.2 MMtpy and 2.0 MMtpy. The EERC will therefore explore both rates for storage suitability at the selected site.

On April 17, 2023, the EERC was able to acquire existing 2D seismic data (with Seitel Data Ltd.) to provide a more detailed site-screening of the geology in the study region for site selection for a stratigraphic test well and the 3D seismic survey. Although these data were not initially proposed, the data have proven crucial in evaluating the suitability of AOIs for geologic storage, ranking the chosen AOIs from high to low risk. These data also proved useful for the Subtask 3.1 geology evaluation for potential salt cavern H_2 storage. With a total of 290 linear miles purchased and assessed diligently, a site location was determined for drilling the test well and conducting the 3D survey.

Drilling is anticipated to occur in Q3 2024, with the seismic survey conducted in Q4 2024 or Q1 2025. Designs for the test well (including drill plan) have commenced in collaboration with PHES and potential contractors. An APD was formally submitted to NDIC's DMR on April 5, 2024, to drill a stratigraphic test well, which will be subsequently plugged and abandoned, fully reclaiming the site as close to the original state as possible. During drilling, about 400 ft of core samples (including the proposed injection formation and portions of the upper and lower confining zones) and formation fluid samples will be collected for subsequent laboratory analyses. Although not initially proposed because of time constraint concerns, the project contract extension allows for this laboratory activity to occur simultaneously with the 3D seismic survey field acquisition. All the generated data will assist in final evaluation of the site for safe and permanent storage and are required for development of a North Dakota CO_2 storage facility permit application.

An in-person meeting was held in Sacramento, California, to discuss PHES project eligibility with the California Air Resources Board (CARB) under the Low Carbon Fuels Standard (LCFS)

on March 19, 2024. A few members of the EERC and PHES technical team met with CARB–LCFS staff to provide an overview of project plans for H_2 production and CCS to garner feedback specifically on drilling data collection plans and subsequent laboratory analyses for compliance with the LCFS CCS Protocol. The team also discussed several CCS Protocol requirements that could conflict with the North Dakota Century Code, such as maximum allowable injection pressure. The result was a starting dialogue that is expected to continue as subsurface characterization progresses.

Designs and permitting for the 3D seismic survey are also underway in collaboration with PHES and respective contractors. With a potential increase in anticipated CO_2 injection (up to 2 MMtpy), the seismic survey design was increased to a 64-sq mi radius, situated about 20 miles southeast of Dickinson, North Dakota. PHES has been heavily engaging landowners within the planned survey footprint, which includes choosing the drilling location and potential CO_2 pipeline route (see Subtask 2.3) as well as acquiring survey permissions, easement acquisition, and pore space acquisition.

Task 4.0 – Permitting

Similar to the last reporting period, information continued to be gathered from previous design activities as well as data generated from this project to develop the required permits. Specifically, Wood and Barr Engineering performed the following activities:

- Development and updating of the facility permit matrix.
- Engagement with regulatory agencies.

During this reporting period, the team elected to end the permitting scope with Wood. PHES is currently in the process of conducting interviews and performing an RFP to hire a new consultant to assist in permitting moving forward.

Task 5.0 – Cost Estimating

PHES staff have continued to secure bids for large-cost and long-lead-time items to ensure it is using the most up-to-date information. Furthermore, with each iteration and scope change conducted over the last reporting period, updated cost estimates were compiled to support project advancement.

EXPENDITURES

Summaries of the expenditures for this reporting period and cumulative expenditures to date are provided in Tables 3 and 4.

Table 3. Expenditures for This Reporting Period Only (November 1, 2023 – April 30, 2024)

Project Expense	NDIC	CSEA Recipient	Other Sponsor	Total
Labor	$853,085	$0	$0	**$853,085**
Travel	$4,920	$0	$0	**$4,920**
Supplies	$678	$0	$0	**$678**
Communications	$0	$0	$0	**$0**
Printing and Duplicating	$130	$0	$0	**$130**
Operating Fees and Services	$3,405	$0	$0	**$3,405**
Subcontracts	$0	$0	$1,162,297	**$1,162,297**
Facilities and Administration	$448,352	$0	$0	**$448,352**
Total	**$1,310,572**	**$0**	**$1,162,297**	**$2,472,869**

Table 4. Cumulative Expenditures

Project Expense	NDIC	CSEA Recipient	Other Sponsor	Total
Labor	$1,763,768	$0	$0	**$1,763,768**
Travel	$10,100	$0	$0	**$10,100**
Supplies	$2,174	$0	$0	**$2,174**
Communications	$0	$0	$0	**$0**
Printing and Duplicating	$189	$0	$0	**$189**
Operating Fees and Services	$301,805	$0	$0	**$301,805**
Subcontracts	$0	$0	$2,606,377	**$2,606,377**
Facilities and Administration	$1,068,420	$0	$0	**$1,068,420**
Total	**$3,146,458**	**$0**	**$2,606,377**	**$5,752,835**