Chevron natural gas carbon capture technology testing project

Cooperative Agreement No. DE-FE0031944
August 13, 2021

Mr. Justin Freeman

Project overview

- **Award Period:** 10/01/2020 through 04/30/2023
- **Project Funding**
  - Total Funding: $16,242,126.00
  - Federal Funding: $13,000,000.00
  - Cost Share Funding: $3,272,127 (Cash Contribution by Chevron)
- **Project Participants**
  - Chevron U.S.A. Inc., Prime Contractor, host site and cost share provider
    - Principal Investigator: Justin Freeman
    - Project Manager: Stan Cross
  - Technology Provider: Svante, Inc.; Carbon capture technology provider.
  - ISBL Engineering, Procurement and Construction: Kiewit Engineering Group Inc (KEGI) and Kiewit Power Constructors (KPC)
  - Program Administrator: Electricore, Inc.
  - System Operation: Offshore Technology Services (OTS)
- **DOE-NETL Team**
  - Project Manager: Andrew P. Jones / Contracting Officer: Lisa A. Kuzniar / Contracting Specialist: Kelly Haught

CCUS at scale has a critical role in advancing a lower carbon future

CCUS Opportunity

Reduce emissions and unlock markets for lower carbon products (e.g., blue hydrogen) to meet growing energy demands

Chevron is one of few companies well-positioned to execute across value chain and scale CCUS to reduce costs and maximize value

Our CCUS strategy

Leverage capabilities

Advancing CCUS opportunities at our assets

Leverage investments in technology

Partnerships to drive results

Advancing CCUS through investments and partnerships

Capture	Utilization/Storage	Academia/Industry	Government
• Carbon Clean Solutions • Carbon Engineering • CarbonPoint Solutions • Svante	• Blue Planet • Cereus Downhole Technology • Savteq • Silixa	• Stanford Center for Carbon Storage • The University of Texas, Austin • Global CCS Institute • Oil and Gas Climate Initiative	• Jet Propulsion Laboratory • National Energy Technology Laboratory • Singapore National Research Foundation

We are advancing the global energy transition
in three action areas

Lower carbon intensity
cost-efficiently

$2B

by 2028 in carbon-reduction projects

Increase renewables and offsets
in support of our business

$750MM

by 2028 in investments in renewables and offsets

Invest in low-carbon technologies
to enable commercial solutions

$300MM

committed to the Future Energy Fund II

Project objectives

The project will validate a transformational solid sorbent carbon capture technology at engineering scale under indicative natural gas flue gas conditions and continuous long-term operation at Chevron's Kern River oil field.

1. Successfully complete the design, construction, commissioning, and long-term (12 month) testing of an engineering scale plant of approximately 25 tonnes per day (TPD) under steady-state conditions at varying flue gas carbon dioxide (CO_2) concentrations (~4–14%);
2. Conduct a techno-economic analysis (TEA) on the VeloxoTherm™ technology as integrated into a nominal 550 MW (net) natural gas combined cycle (NGCC) power plant;
3. Conduct a comprehensive gap analysis addressing the current stage of VeloxoTherm™ technology development for NGCC application; and
4. Summarize the research, development, and demonstration requirements to close identified gaps to approach achievement of DOE's carbon capture performance goal of CO_2 capture with 95% CO_2 purity at a cost of $30/tonne of CO_2 captured by 2030.

Project objectives

San Joaquin Valley, CA USA

Natural gas-based flue gas testing

Understand and measure capture plant performance on indicative boiler, NGCC and SMR feed flue gas

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Skid-mounted modular design of second-of-a-kind (SOAK) capture plant

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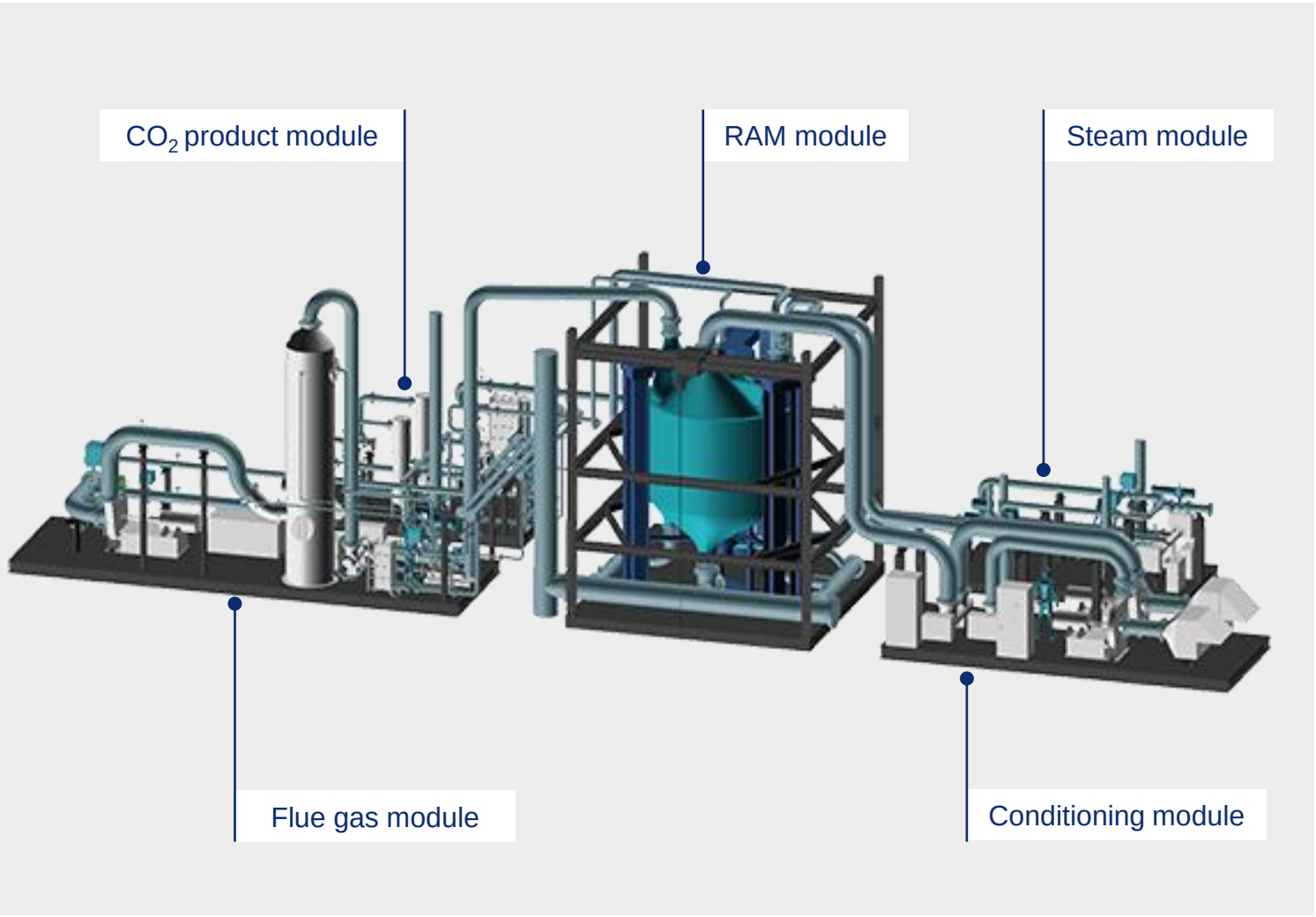
New MOF sorbent beds

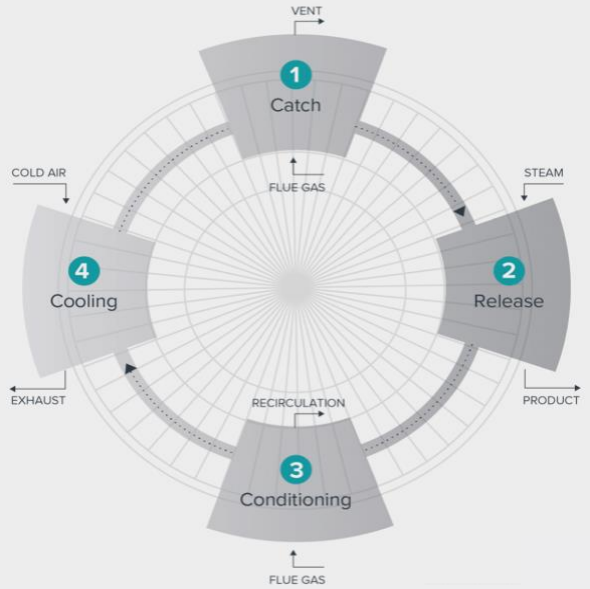
95% CO_2 product purity and lower steam ration (1.5-1.7)



Svante carbon capture technology

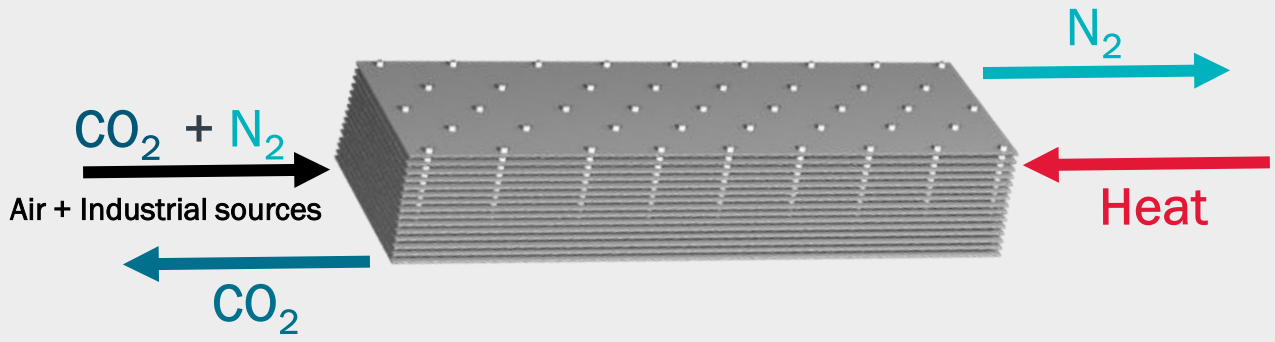
Rapid Cycle Thermal Swing Adsorption (RC-TSA)

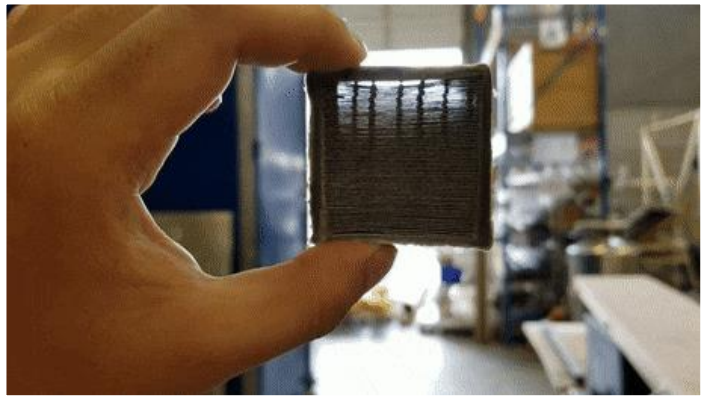
VeloxoTherm™



Engineered CO_2 filter

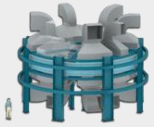
Structured Adsorbents with low pressure drops, fast mass transfer, high surface area, enable Rapid Cycling TSA process (RC-TSA)



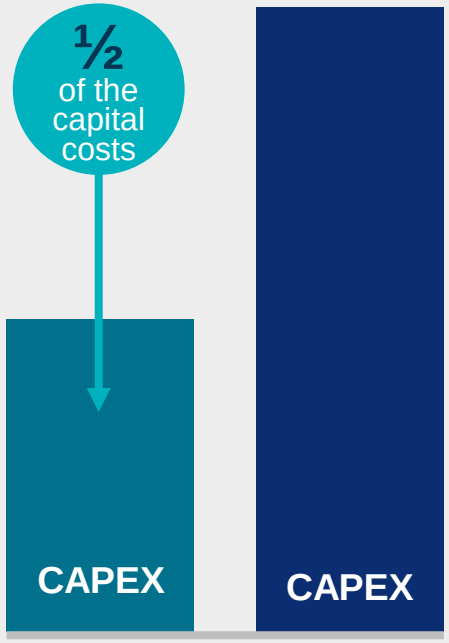


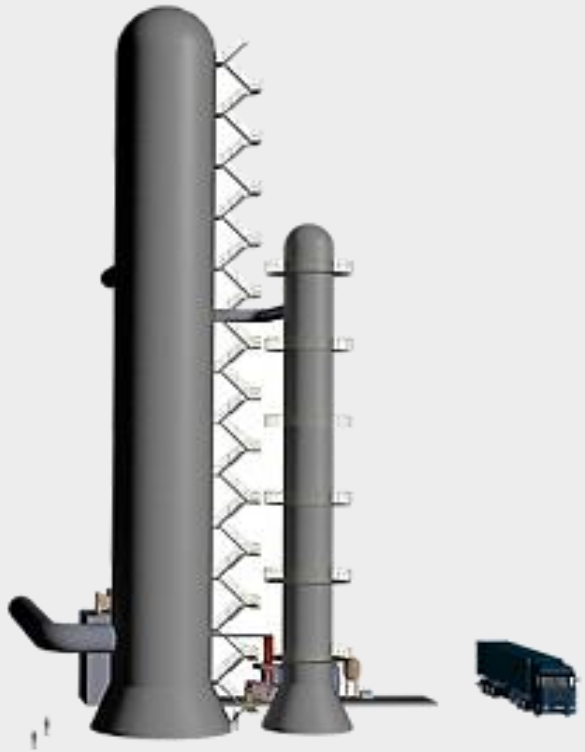
Svante's technology – capital advantage

- High capital cost is currently a barrier to widespread **deployment of carbon capture**
- By replacing large chemical solvent towers (conventional approach) with a single piece of compact equipment, Svante's technology potentially **enables a 50% reduction in capital costs compared** to first generation approaches



Svante technology

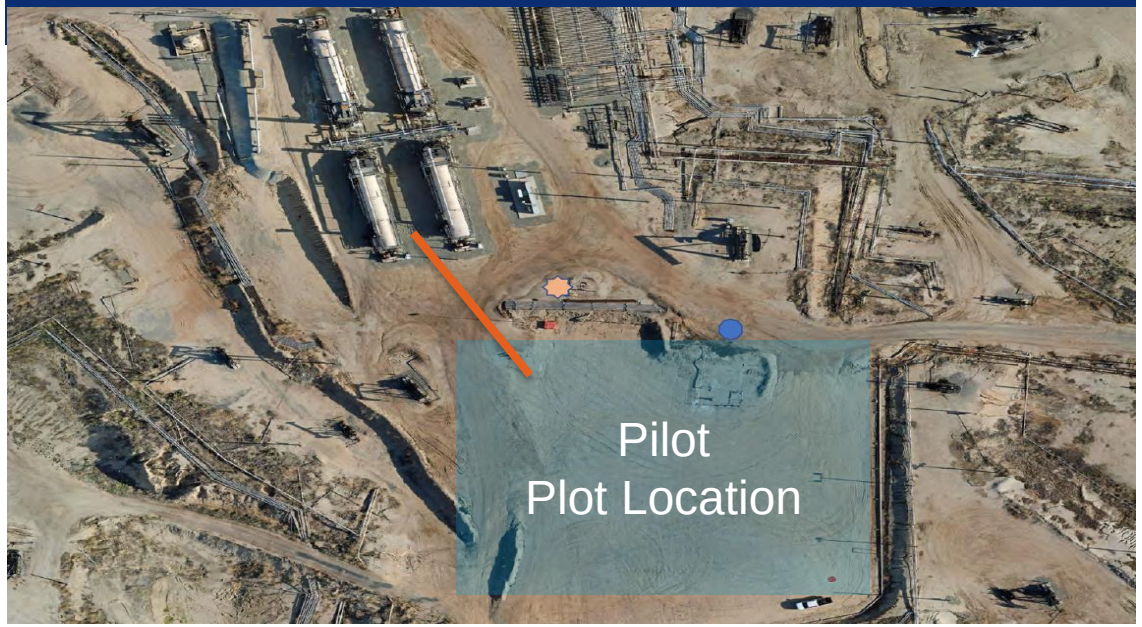




Conventional approach

Project site

Chevron operates the Kern River Oil Field in the San Joaquin Valley of California. Yielding a cumulative production of close to 2 billion barrels (320,000,000 m3) of oil by the end of 2006, it is the third largest oil field in California.



Technical approach

The project will be conducted in three (3) budget periods

Budget Period 1: *Complete*

- Process Engineering
- Design Criteria
- Sorbent Certification

Budget Period 2: *In Progress*

- Detailed Engineering
- Procurement, Fabrication and Installation
- Pre-Startup Safety Review, Commissioning and Test Planning

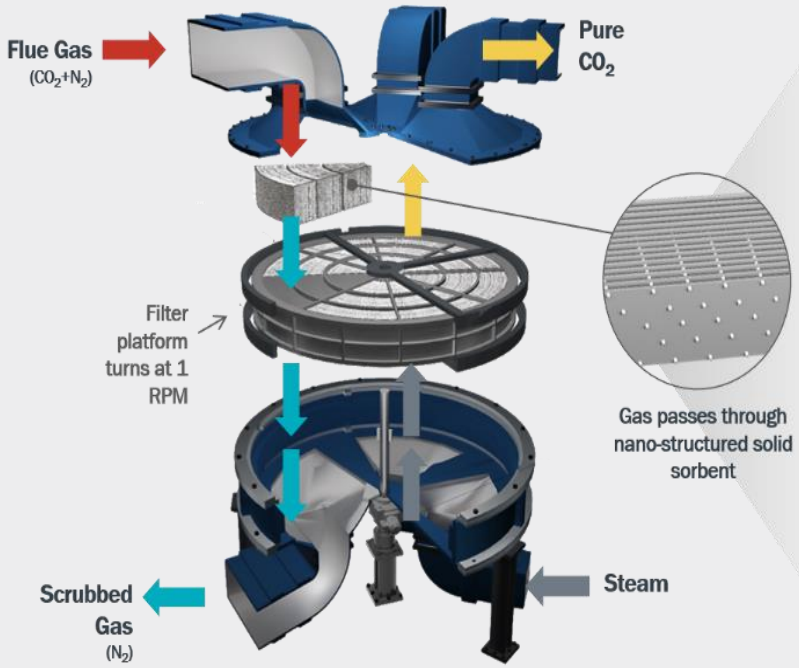
Budget Period 3

- Engineering Scale Testing and Analysis
- Technology Assessment

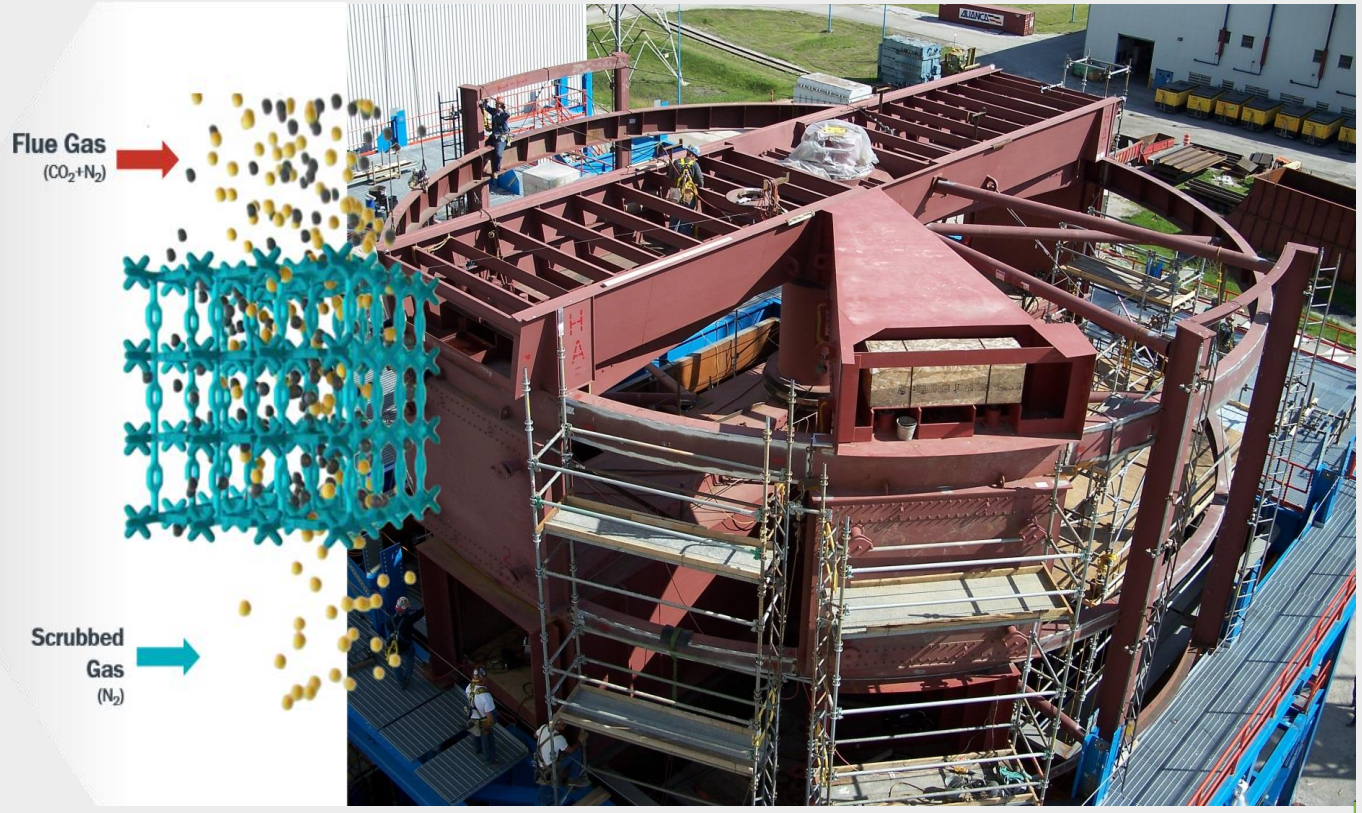
Success criteria	
	Successful completion of all work proposed
	Completion of engineering scale VeloxoTherm™ testing with natural gas flue gas.
	Completion of engineering scale VeloxoTherm™ testing with natural gas flue gas.
	Submission of a Final Report that details pathway to achieve DOE's performance goals of CO_2 capture with 95% CO_2 purity at a cost of $30/tonne of CO_2 captured by 2030.

Progress and current status of project

Innovation – rotary contactor



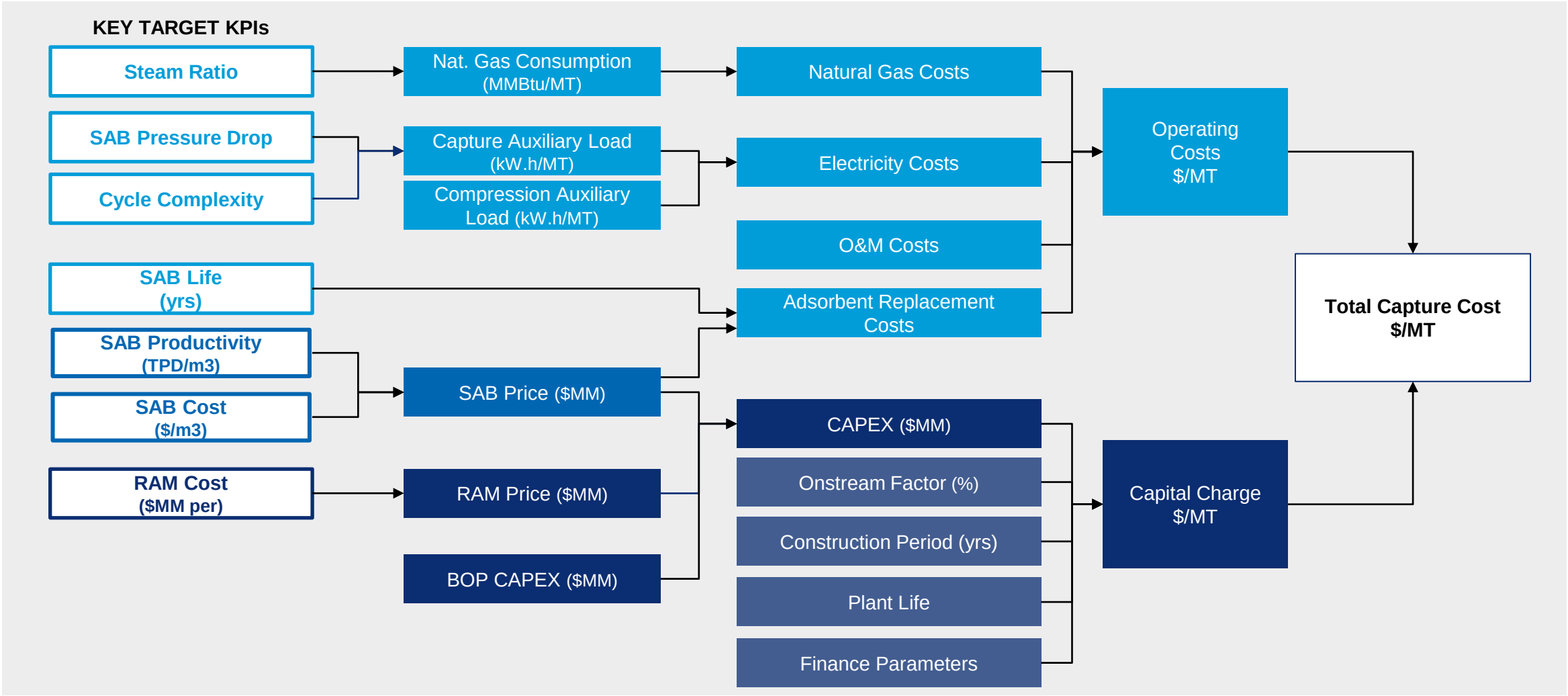
ARVOS rotary technology



New adsorbents + proven machine

PARTNER ARVOS GROUP

Mapping technology and product KPIS to capture cost



Progress and current status of project

Significant Engineering Progress made, 56% detailed engineering

- Process design complete
- ISBL Facility Design Manual complete
- HAZOP review complete
- 100+ drawings & documents issued in detailed engineering

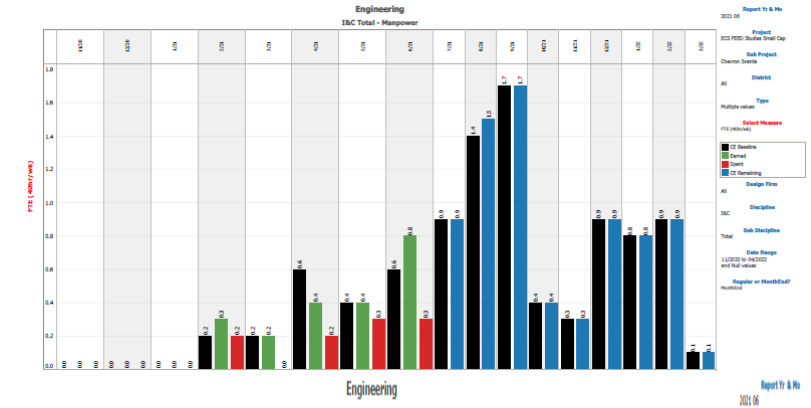
Concept review of the RAM subsystems

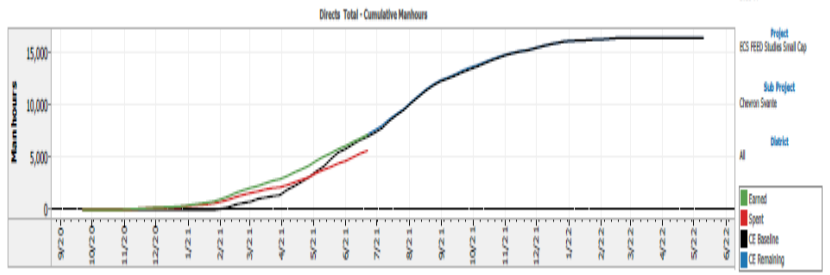
- Bellows, Ducts, SABs, Seal system, Drive Train and Structure
- Addressed risk items related to maintenance access, design for manufacturing and design for assembly

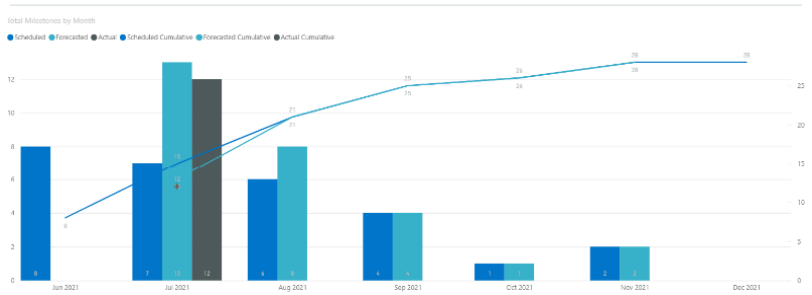
90% of engineered equipment procurement placed

Test Plan

- Recycling part of the CO2 product back to the feed flue gas to test multiple CO_2 concentrations
- ~8% Base Performance and Steady State
- 14% Indicative Coal Flue Gas Feed
- 4% Indicative NGCC Flue Gas Feed
- Load Following & Intermittence







Progress and Current Status of Project

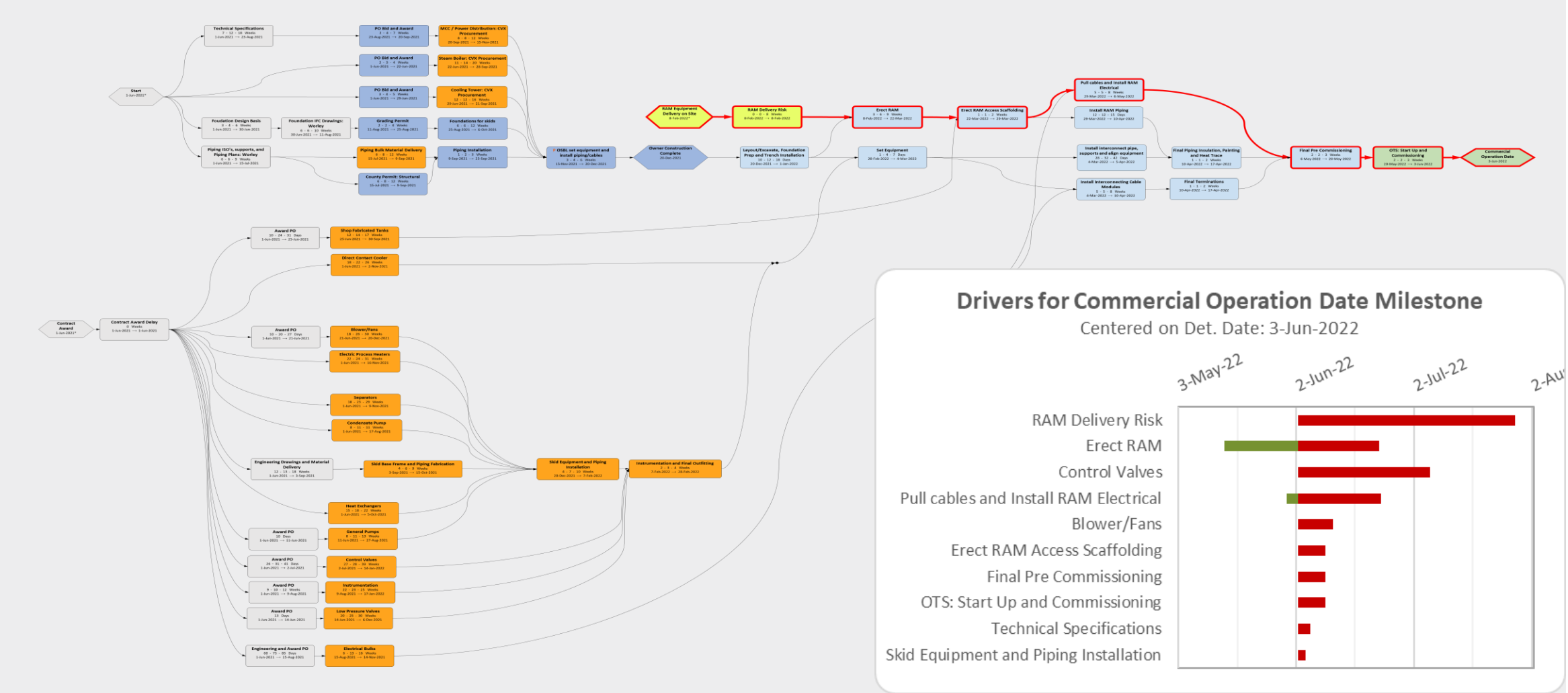
Rotary Seal Test Station (RSTS) Upgrade and Testing

- The upgraded RSTS allows for design validation of key parameters that cannot be replicated on the smaller material seal test station. The RSTS upgrade including design, procurement, assembly, programming and commissioning was completed.
- RSTS has been upfitted with a new gearbox to enable operation at expected rotational speed, along with true size seal segments and counterface parts similar to actual RAM seal parts for design validation.
- A 50-day Rotary Seal Validation Testing was completed.

Sorbent Certification

- Svante in collaboration a world leader manufacturer for sorbent materials, has demonstrated sorbent scale up production required for project execution.
- Additional and complementary tests conducted at Svante confirm material properties, sorbent characterization and slurry process-ability into coated laminates are meeting current specifications developed from Svante internal synthesized materials.

Svante DOE trial cost schedule risk assessment

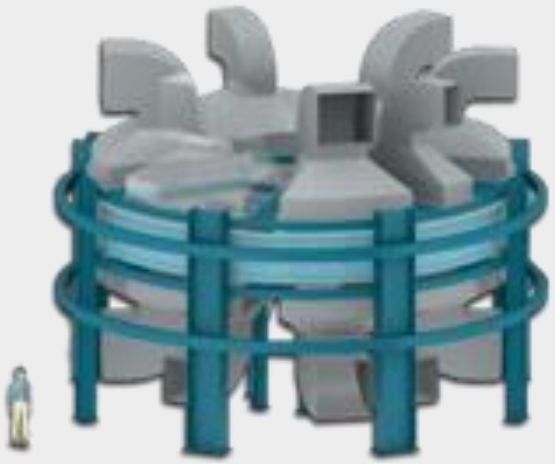


Project milestones – budget period 1

Milestone log					
Budget Period	Task	Milestone Description	Planned Completion Date	Actual Completion Date	Verification Method
1	1.0	Kickoff Meeting	4/30/2021	04/16/2021	Presentation File
1	1.1	Updated PMP	11/30/2020	11/13/2020	PMP file
1	1.2	Technology Maturation Plan	12/31/2020	12/23/2020	TMP file
1	1.3	Preliminary Technology EH&S Risk Assessment (ISBL)	12/31/2020	12/23/2020	Preliminary ISBL EH&S file
1	1.4	Preliminary Techno-Economic Analysis (TEA)	12/31/2020	12/23/2020	Preliminary TEA file
1	1.5	Host Site Approval Letter	12/31/2020	12/30/2020	Signed Letter
1	1.6	HAZOP Report	1/31/2021	1/29/2021	HAZOP Report
1	1.7	Preliminary Test Plan	1/31/2021	1/28/2021	Preliminary Test Plan
1	2.0	ISBL/OSBL design with refined costing	05/31/2021	5/31/2021	Summary Cost Table
1	2.2	Design Criteria	05/30/2021	5/28/2021	Facility Design Manual
1	2.3	RAM rotary seal material selection and RSTS upgrade for design validation	05/30/2021	5/10/2021	Seal Material Selection Test Report Submitted
1	3.0	Sorbent Certification	12/31/2020	12/23/2020	Certification Letter

Project milestones – budget periods 2 & 3

Svante technology



Milestone log					
Budget Period	Task	Milestone Description	Planned Completion Date	Actual Completion Date	Verification Method
2	4.0	Detailed Engineering	12/31/2021		RPPR File
2	4.1	Rotary Seal Validation Testing	07/26/2021		Design Validation Test Report Submitted
2	5.1	Sorbent Procurement (Phase II)	12/31/2021		Purchase Order and Receiving Report
2	5.3	SAB Manufacturing	3/31/2022		Hardware Shipment
2	5.4	Shop testing and inspection report	5/31/2022		Shop testing and inspection report file
2	5.5	System Installation	4/29/2022		Turnover Package
2	6.1	Pre-Startup Safety Review (PSSR)	5/30/2022		Continuation Application
2	6.3	Test Plan	4/30/2022		Final Test Plan
3	7.1	Start-up and operator hand-off	6/30/2022		RPPR File
3	7.2	Parametric testing and steady state operation performance report	6/30/2023		Preliminary Test Report
3	7.3	14% Indicative Coal Flue Gas Feed Testing	11/30/2022		Updated Test Report
3	7.4	4% Indicative NGCC Flue Gas Feed Testing	1/31/2023		Updated Test Report
3	7.6	System Decommissioning	4/30/2023		Final Report file
3	8.1	Technology EH&S Risk Assessment	4/30/2023		Topical Report and summary in Final Report
3	8.2	Techno-Economic Analysis (TEA)	4/30/2023		Topical Report and summary in Final Report
3	8.3	State-Point Data Table	8/31/2022		State-Point Data Table file
3	1.0	Draft Final Report	5/31/2023		Final Report file

Five principles guide our approach

| 1 |

Set ambitions and favor results

| 2 |

Shape a lower-carbon economy for all

| 3 |

Lead in transparency

| 4 |

Enable commercial solutions

| 5 |

Build partnerships to achieve impact

Thank you

Thank you
to our project sponsors

U.S. Department of Energy

Office of Fossil Energy

NETL – National Energy Technology Laboratory

Contracting Officer
Lisa Kuzniar

Program Manager
Andrew Jones

Contract Specialist
Kelly Haught

Questions and answers