



# The Proof is in the pilots: Project Enterprise update (DE-FE0031950)

**2024 FECM Annual Project Review Meeting**

**August 7, 2024**

Nathan Fine, Ph.D. – Dir, Advanced Engineering

August 9, 2024

# The proof is in the pilots



NCCC  
Wilsonville, AL  
10 TPD CO<sub>2</sub>



TCM  
Mongstad, Norway  
200 TPD CO<sub>2</sub>



Enterprise Pilot  
Los Medanos Energy Center  
Pittsburg, CA  
10 TPD CO<sub>2</sub>



Bedrock Pilot  
Koch Headquarters  
Wichita, KS  
2.8 TPD CO<sub>2</sub>

## Peer-reviewed results on a variety of flue gases

Over 14,000 total hours of testing to date with NGCC gas, CHP gas, refinery gases, and coal flue gas.

## Long-term, stable operations

Throughout these test campaigns, ION has demonstrated steady-state operations and exceptionally low energy consumption with capture efficiency ranging from 90% - >99%.



# Project Overview

## Project Period of Performance:

October 1, 2020 – April 30, 2025

## Funding:

Federal Share: \$ 20,732,954

Cost Share: \$ 6,516,601

## Objective:

The overall objective of this project is to field test an engineering scale 10 tonnes per day (tpd) CO<sub>2</sub> capture system on a 1 megawatt-electric (MWe) slipstream flue gas from a commercially dispatched natural gas combined cycle (NGCC) power plant to empirically validate the low capital and operating costs for ION's 3rd generation solvent (ICE-31).





# Project overview

**Budget Period 1 (BP1)** created an engineering scale system design that had the necessary flexibility for solvent performance optimization and demonstration.

- **Completed September 2021**

**Budget Period 2 (BP2)** was the construction and commissioning of the CO<sub>2</sub> capture island and balance-of-plant connections.

- **Completed September 2023**

**Budget Period 3 (BP3)** includes baseline testing using 1st and 2nd generation solvents as well as parametric testing of the 3rd generation solvent ICE-31. Currently performing long-term testing of ICE-31 to demonstrate end-to-end process optimization and validate process parameters like chemical costs and emissions profiles.

- **Expected Completion April 2025**



# Project Team Members



## ION Clean Energy

- Award Recipient and Project Management
- Technology Provider
- Process Design and Oversight
- Operations and Data Analysis



## Koch Modular Process Systems

- Modular Fabricator
- Detailed CO2 Capture Island Engineering



## Calpine

- Host Site & Subrecipient
- Power Generation Engineering, Operational and Financial Expertise



## Montrose Environmental

- Detailed extractive sampling for air emissions monitoring and data evaluation



## Sargent and Lundy

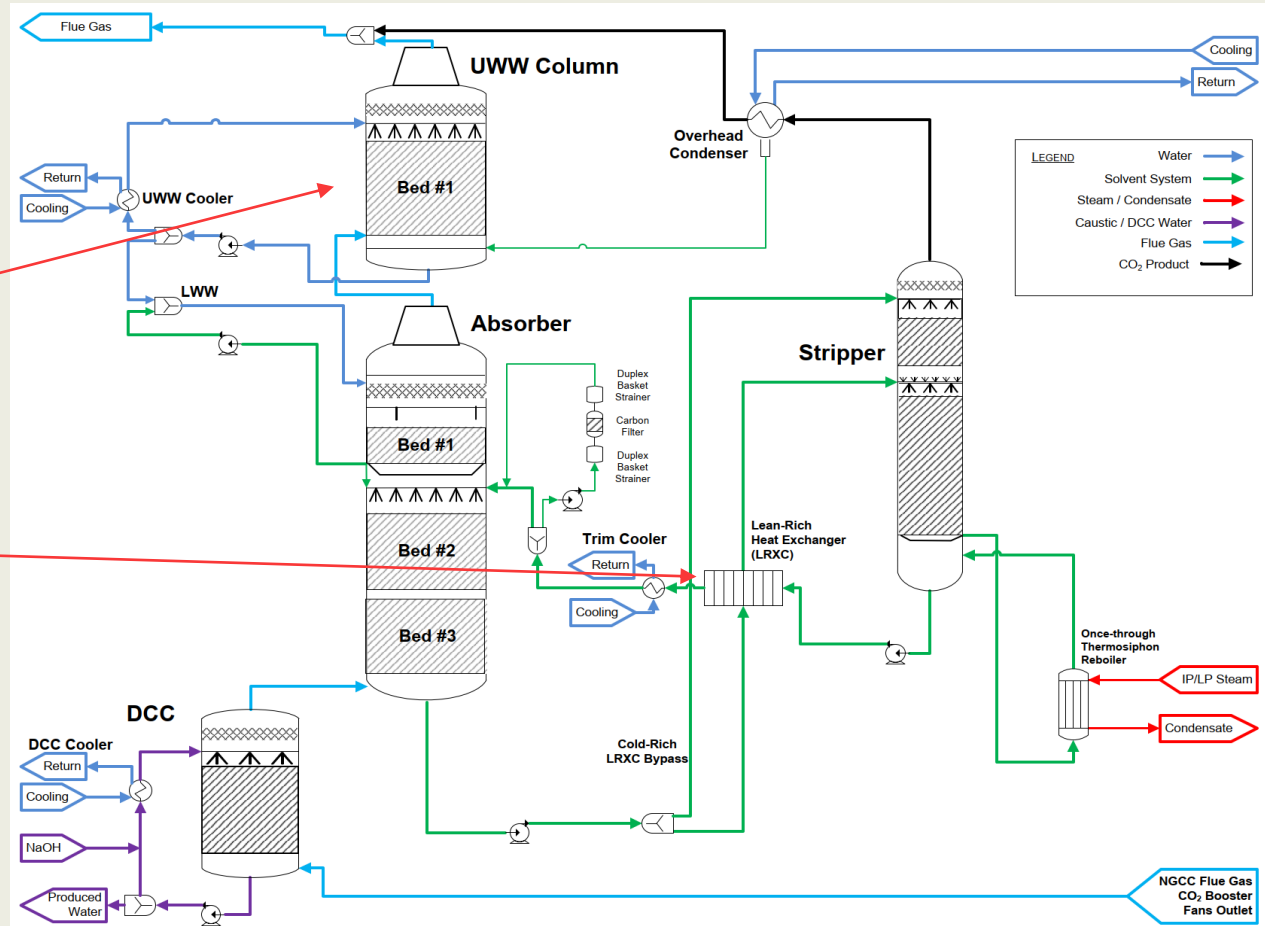
- Balance of Plant Engineering
- EPCm
  - Installation of Modular Pilot & BOP Systems via Graycor Construction



# Process Overview

## Key Features:

- Two-Stage Water Wash
- Lean-Rich Heat Exchanger with Cold Rich Bypass



# ICE-31: Setting A new solvent standard

## Extremely low emissions

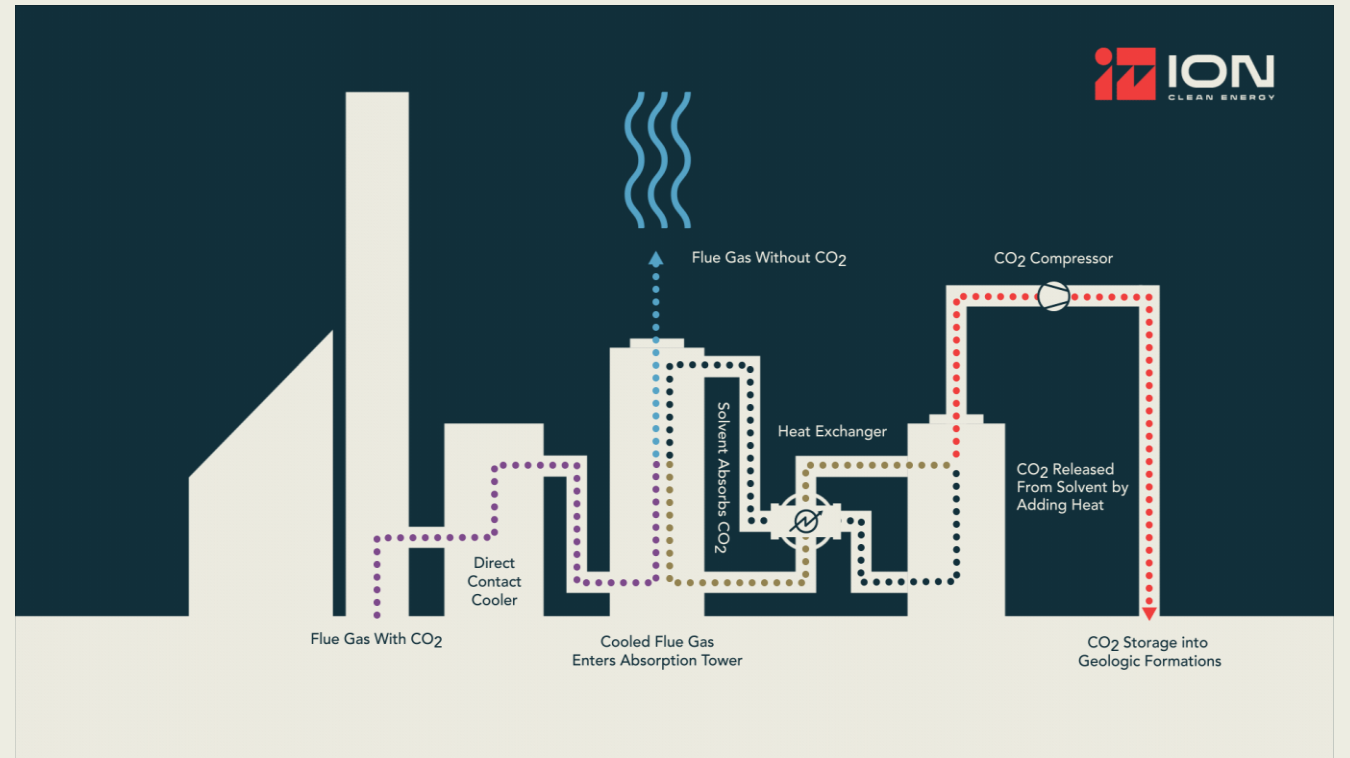
Emissions from our solvent fall below detectable levels of current CEMS.

## Unprecedented solvent stability

Extreme stability extends the life of the solvent without losing capture efficiency.

## Lower energy requirements

ION solvent requires less energy for operation. Lower operating costs as less energy is required, even at capture efficiency rates of  $\geq 95\%$





# Test Plan

- Commissioned system with water and then MEA
- Completed parametric testing with MEA & ICE-21 – baseline system
- Completed stability test with ICE-21
- Completed parametric testing with ICE-31
- Currently performing long-duration stability test with ICE-31
  - Dynamic system testing and steady-state operating solvent chemistry and performance
  - Preliminary results indicate impressive stability and minimal degradation







# Project Milestones

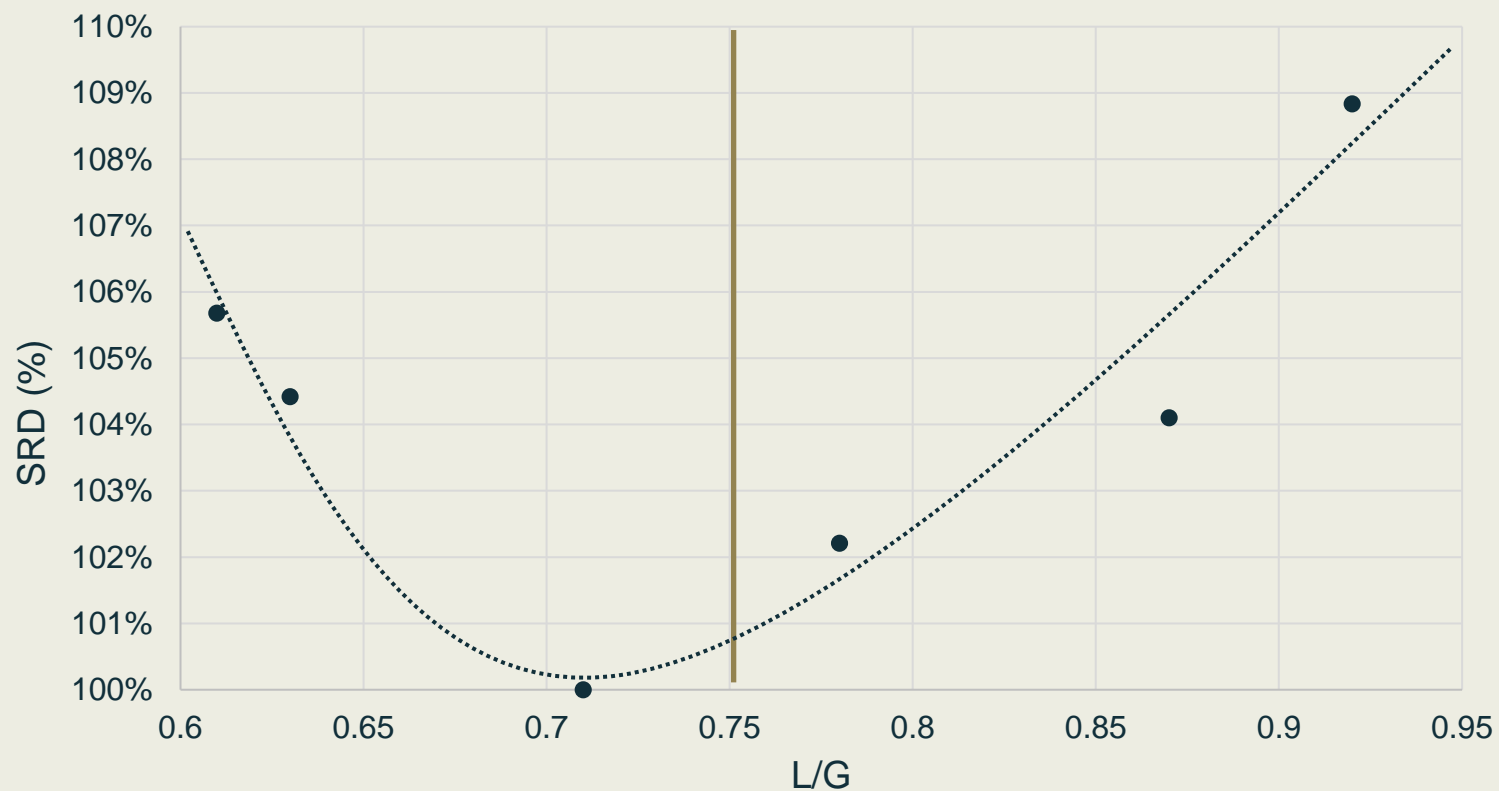
#	Milestone Title/Description	Completion Date
M6	Modular Pilot System Fixed Cost	6/18/2021
M10	All Required Permit Documents Submitted	4/29/2021
M11	Balance of Plant Host Site Preparation Complete to Accept Modules	1/27/2023
M12	Modular Pilot System Fabricated & Factory Acceptance Testing	2/13/2023
M13	Modules Delivered to Host Site	5/10/2023
M14	Commissioning of Pilot System Complete	9/12/2023
M16	Baseline MEA and ICE-21 Testing Complete	2/14/2024
M17	ICE-31 Testing Complete	12/31/2024



# Key results

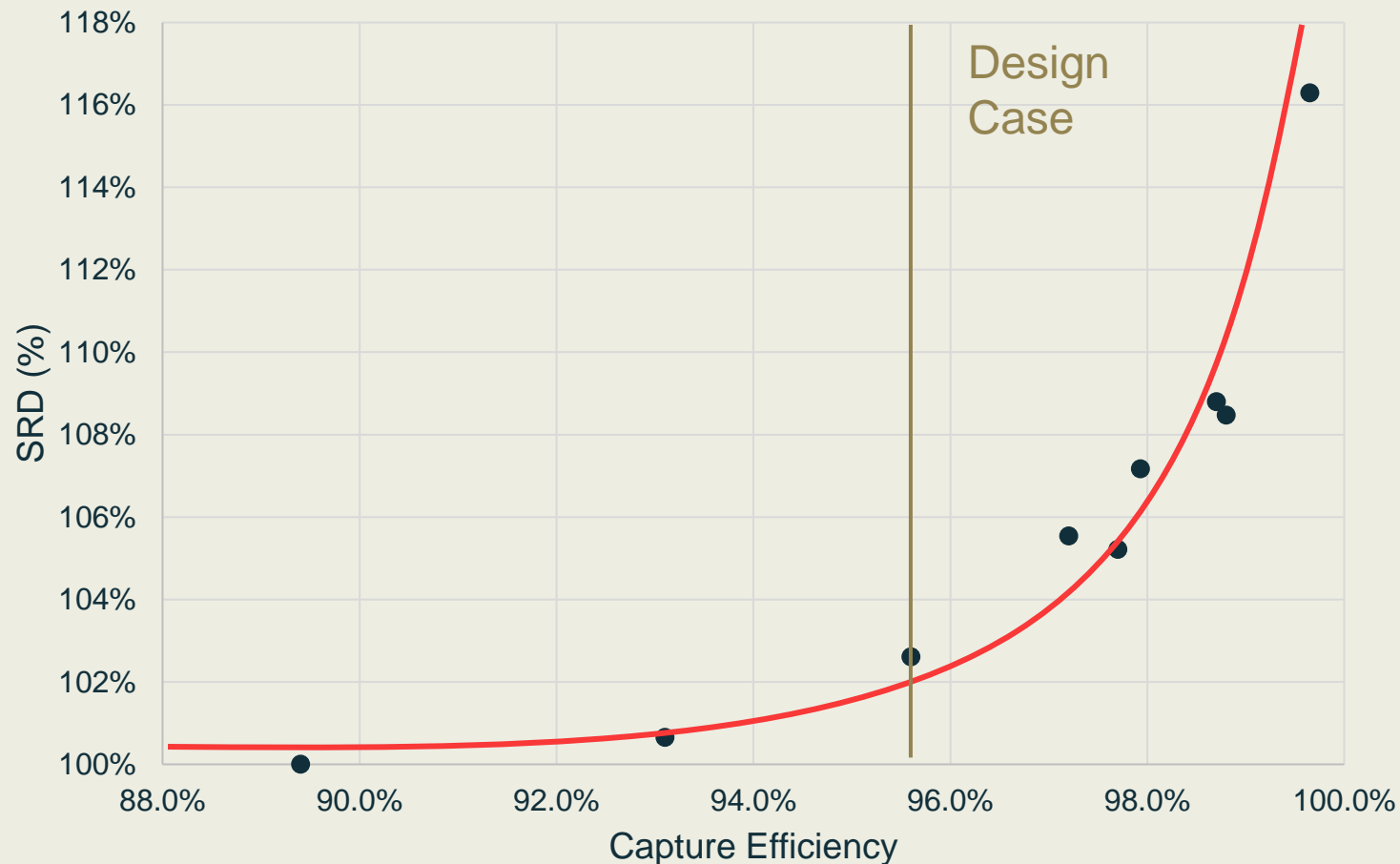


## L/G U-Curve at EnTP



- 95-96% Capture Efficiency
- L/G determined from lean solvent flow
- Minimum at L/G of 0.7
  - Design case L/G of 0.75

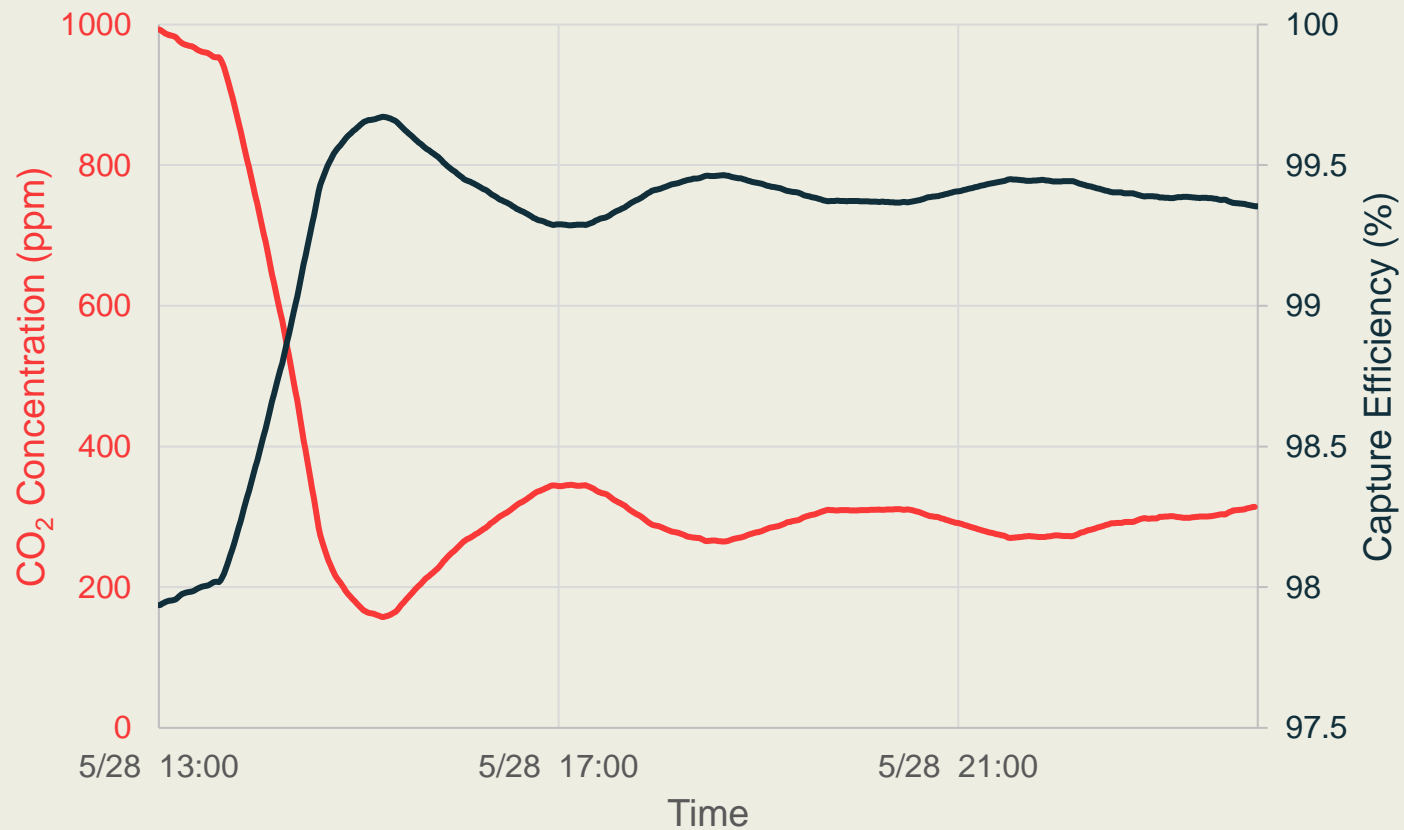
## Capture Efficiency Skew at EnTP



- Nominal 6,500 kg/hr flue gas flow
- L/G ratio approximately 0.7
  - Not all points run at absolute optimal L/G
- Design case located before rapid increase in SRD
- Heat loss corrected SRDs



# Deep Decarbonization



- Sustained net-negative CO<sub>2</sub> emissions
  - Approximately 4.8 Vol% CO<sub>2</sub> concentration in inlet flue gas
  - Approximately 300 ppm CO<sub>2</sub> in outlet flue gas
  - 400-500 ppm CO<sub>2</sub> in air





# Lessons learned & interim conclusions

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# Lessons Learned

- Validation of gas analyzers on inlet and outlet flue gas
  - PTR-TOF, host-site data, 3<sup>rd</sup> party validation
- Test plan flexibility for circumstances out of ION control
  - Host-site shutdowns, electrical/control issues, disposal permitting
- Close collaboration with host-site
  - Open communication ensures safe and efficient operations
- 3<sup>rd</sup> party staffing for operators



# conclusions

- Successful design, construction, and operation of a CO<sub>2</sub> capture pilot at a commercial NGCC facility
- ICE-31 performance mirrored previous pilots at NCCC & TCM
  - Extremely low emissions, net-negative CO<sub>2</sub> emissions
  - Competitive energy requirements
- Further validation of process model in OGT's ProTreat®
  - Key for scale-up of processes to commercial scale
- Continue to implement learnings from Enterprise into Commercial Scale projects including concurrent FECM and OCED Projects





# Acknowledgement & Disclaimer

## Acknowledgement

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# Thank you

