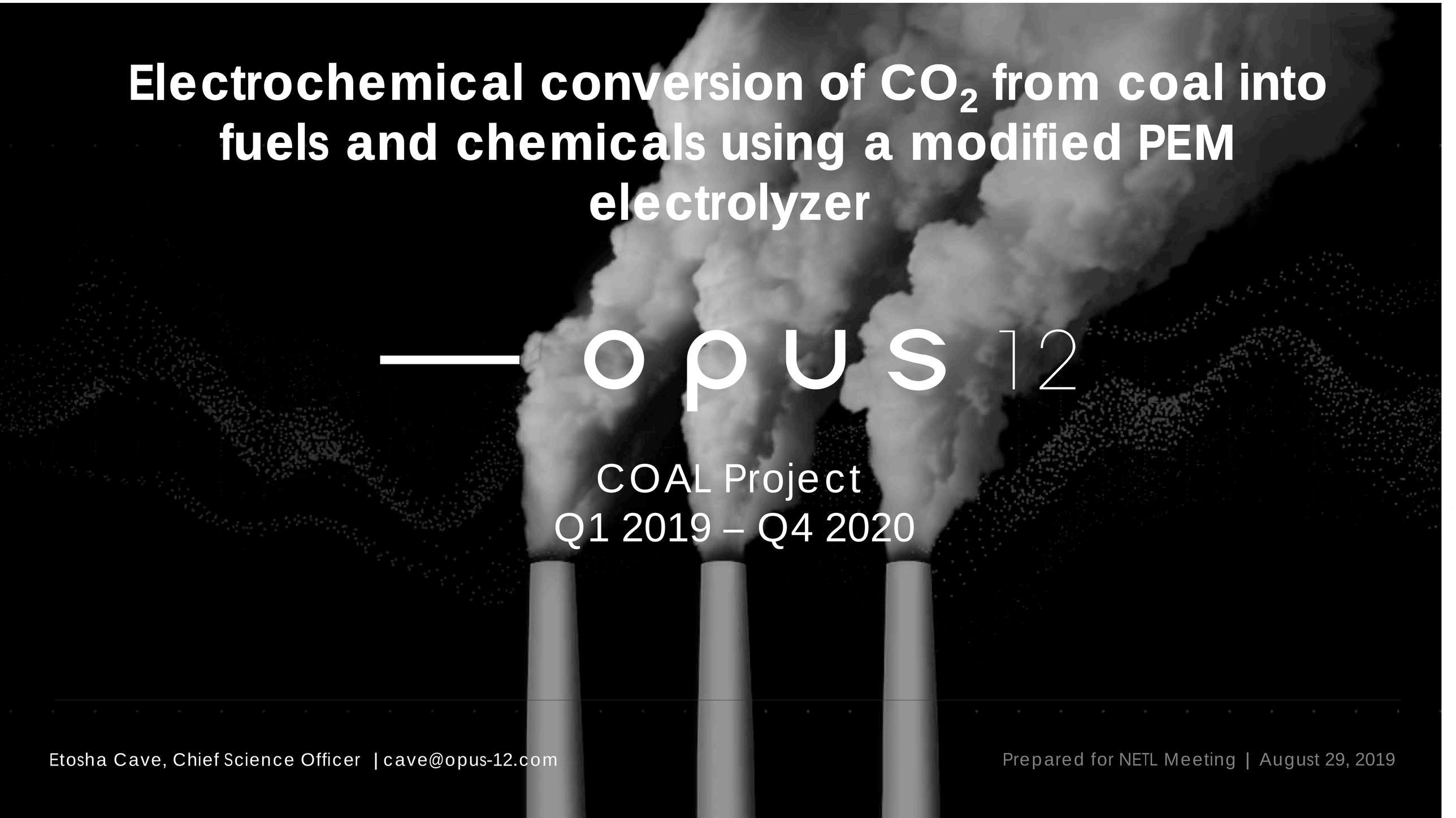
Electrochemical conversion of CO_2 from coal into fuels and chemicals using a modified PEM electrolyzer

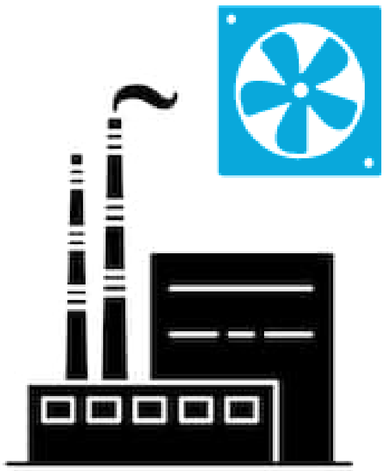


COAL Project
Q1 2019 – Q4 2020

Etosha Cave, Chief Science Officer | cave@opus-12.com

Prepared for NETL Meeting | August 29, 2019

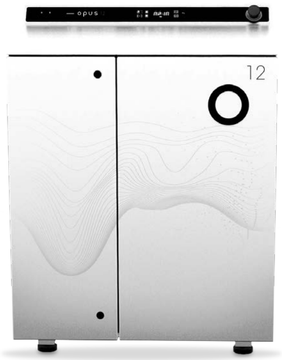
Electrochemical CO_2 Reduction (ECO2R): "Industrial carbon cycle"



CO_2

water

electricity



CO/syngas

ethylene

methane

oxygen

One platform, many value chains

“Intel Inside”

A drop-in component that enables existing reactors to convert CO_2 into new products

We have multiple patents pending related to our membrane electrode assembly (MEA) architecture

Known Scale-up Pathway

Integration into existing electrolyzer designs

1

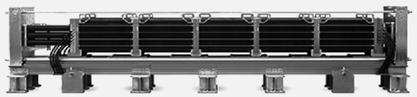
Lab

2-10 kW

2

Commercial

50-250 kW



3

Industrial

1-2 MW

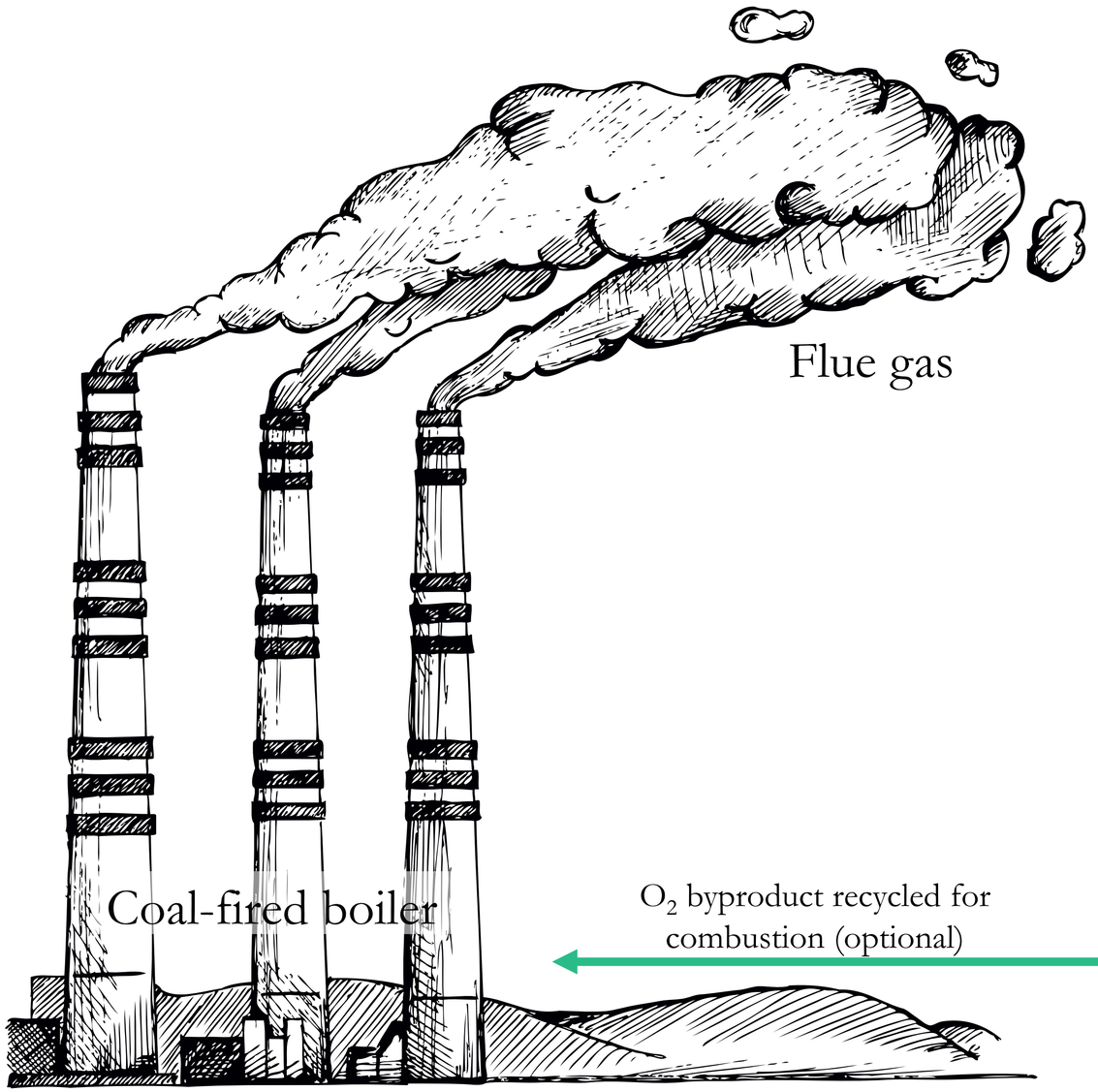
4

Plant

5-100 MW

We partner with electrolyzer producers to build CO_2 conversion systems

CO_2 Conversion from Coal Emissions



Flue gas

Coal-fired boiler

Gas cleanup/ scrubbing

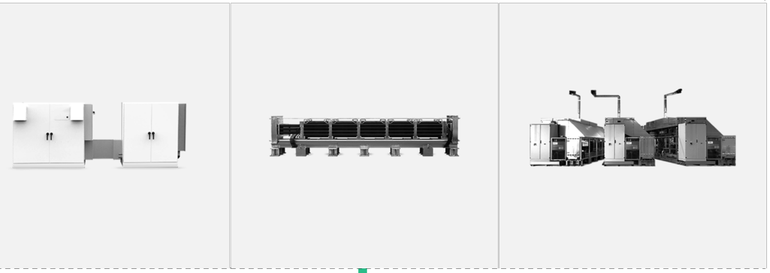
CO_2 capture (as needed)

$CO_2 + H_2O$

Increased energy efficiency and refined techno economics are major technical goals

CO_2 electrolysis

(focus of grant)



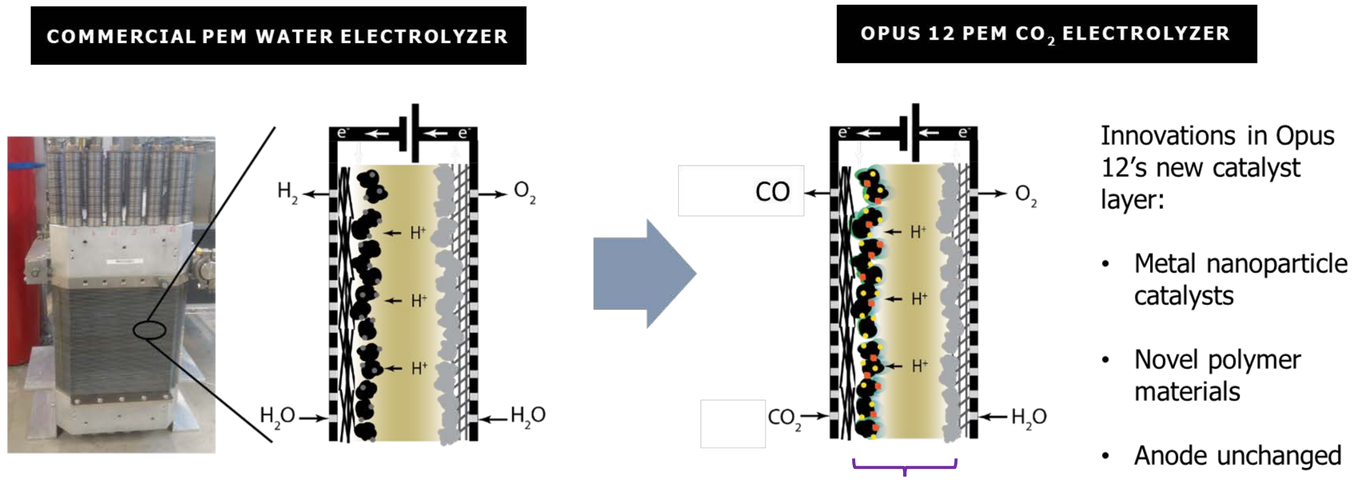
Products e.g., CO, ethylene

Downstream synthesis

O_2 byproduct recycled for combustion (optional)

O_2

Opus 12 Membrane for CO_2 Conversion



Membrane plays an critical role in the devices

Membrane Prep @ opus-12

- ✓ Membrane solution prep and spray
- ✓ Screening 22 different membranes
- ✓ Membrane ion exchange
- ✓ Membrane conductivity measurement
- ✓ Membrane solution spectrum analysis
- ✓ membrane environmental expansion measurement
- ✓ membrane pretreatment
- ✓ membrane pinhole testing/H2 pump
- ✓ Surface morphology/ cross section image

Membrane Features:

- Ion exchange capacity (IEC)
- Water uptake, hydration and swelling ratio
- Ion conductivity
- Mechanical stability
- Hydrophobic / Hydrophilic
- Aerophobic/aerophilic
- Solubility (powder form ionomer)
- Porosity

Membrane Optimization in Electrolyzer:

- Thickness
- Testing conditions
- Membrane fabrication method
- Concentration control and solid ratio
- Compatibility with catalyst

Acknowledgements

Thank you to the DOE COAL Program