MONOLITH

Upgrading natural gas to carbon and hydrogen with sustainable technology

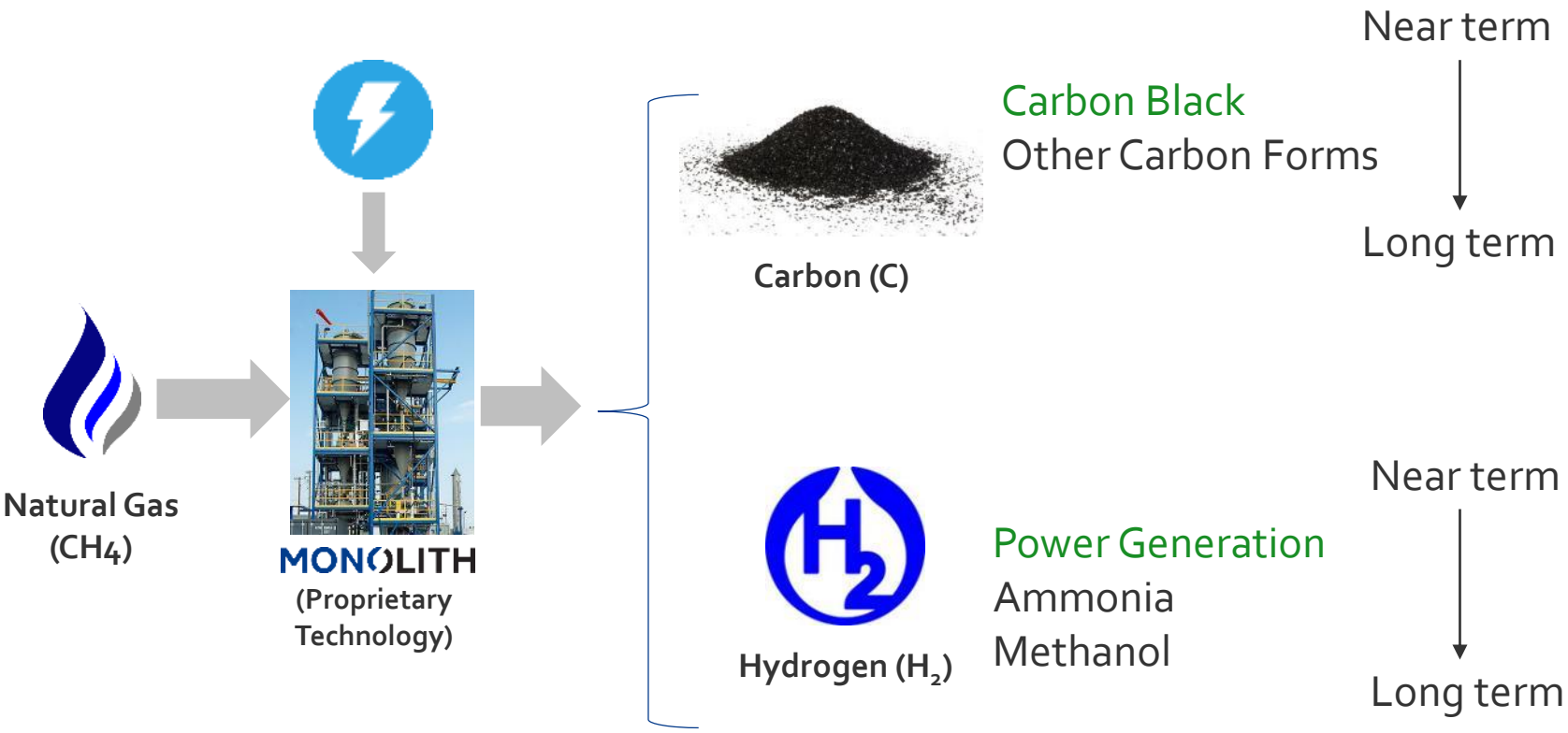
AIChE

Ammonia Production from Natural Gas Pyrolysis

November 13, 2019

Electric Pyrolysis of Methane

MONOLITH



Monolith has developed a differentiated, proven and protected platform technology to upgrade natural gas in a cost and environmentally advantaged way.

High Level Economics

MONOLITH

Enthalpy of Formation

	MJ/kmol	kWh/kg H2
$CH4_G$	74.9	5.2
$H20_G$	237	32.9
$H20_L$	285.8	39.7

Unit Economics

MONOLITH

70 MMBtu

Natural Gas (CH_4)

MONOLITH
(Proprietary Technology)

1,000 kg

Carbon (C)

Carbon Black: $1.2 -$3.0/kg
Other Forms: $0 - 1.2 /kg
Bury it: $0/kg

300 kg
(99.9%)

Hydrogen (H_2)

Power Generation
Ammonia
Methanol
Other Uses

Technology Maturity

Seaport Demonstration Plant

MONOLITH

Facility overview

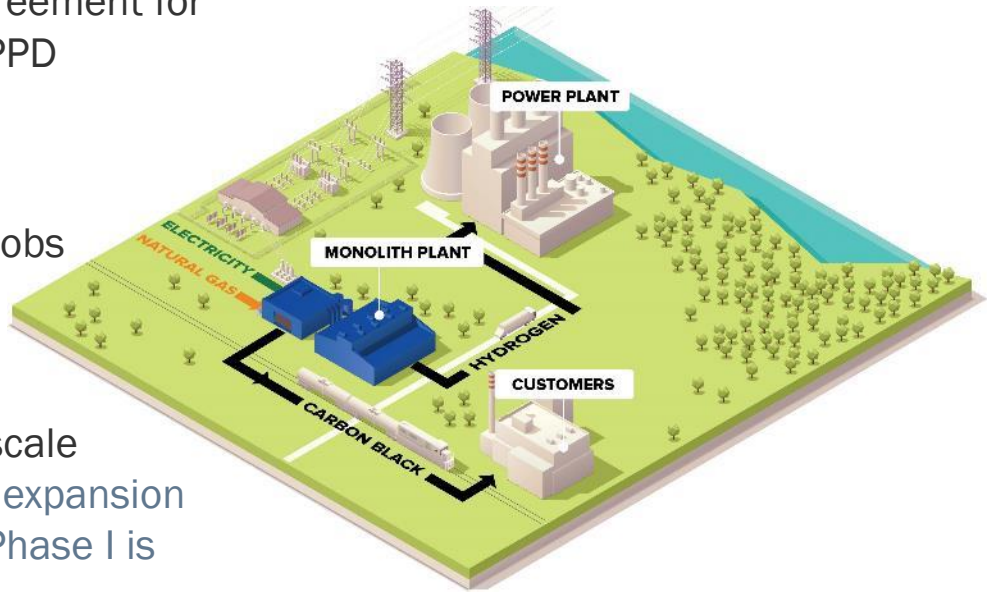
- The Seaport Demonstration Plant located in Redwood City, CA (“Seaport”) was completed in September 2014
- Carbon black production started in April 2015
- First greenfield carbon black facility in the United States in ~30 years
    - Permitted and operating on the San Francisco Bay, approximately 200 yards away from the Don Edwards National Wildlife Refuge
- Reactor with 700 metric tons of carbon capacity and 200 metric tons of Hydrogen capacity per year.
- Plant was decommissioned in the fall of 2018 after successfully demonstrating technology.

Over 3,700 operating hours achieved

Overview of First Commercial Project (Nebraska)

MONOLITH

- First commercial greenfield carbon black facility to be built in the U.S. since 1980s
  Contemplated build-out in three distinct phases: 14kT → 80kt → 160kT
- Lowest cost supply of electricity from Nebraska Public Power District ("NPPD")
  Co-located with NPPD's Sheldon Power Station near Lincoln, Nebraska
- Competitive supply dynamics for natural gas from major hubs and firm transport agreement in place
  Located at cross-roads of natural gas pipelines coming from every major shale hub
- Long-term, fully contracted offtake agreement for hydrogen co-product executed with NPPD
  Sheldon Station will switch boiler unit from coal over to hydrogen
- Creates construction and permanent jobs
  100 direct and 550 indirect jobs for Phase I and Phase II combined
- Olive Creek Phase I is essentially full-scale
  Olive Creek Phase II and further plant expansion process is modular once Olive Creek Phase I is complete



2016- 2018: Site Planning

February 2019 – Foundation work

February 2019 – Module fabrication in Shanghai, Shipped via Barge.

September 2019 – 300+ workers onsite during construction.

September 2019 – Olive Creek Site

November 2019 – Olive Creek Site

Summary

Summary

MONOLITH

- Basis – Electrical pyrolysis of methane
- Cost of H2 – depends on carbon value:
  - With high value for carbon: least expensive way to produce H2.
- Technology Maturity – Full scale unit operating by end of 2020.
- Environmental – no direct CO2 produced. Full lifecyle depends on CO2 intensity of electricity consumed in process.


MONOLITH