Port Arthur Project Update: Demonstration of CO2 Capture and Sequestration for Steam Methane Reforming Process for Large Scale Hydrogen Production

Cooperative Agreement Number:
DE-FE-0002381

August 2011

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Company Background

Who Is Air Products?

- Global atmospheric, process and specialty gases, performance materials, equipment, and services provider
- Serving industrial, energy, technology, and healthcare markets worldwide
- Founded in 1940
- Fortune 500 company
- Operations in over 40 countries
- ~19,000 employees worldwide
- Industry safety leader
- $9.0 billion in 2010 revenue

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Project Overview

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- 1 of 12 projects selected for DOE Phase I - $900k (funding for preliminary design and cost estimate)
- 1 of 3 projects selected for DOE Phase II (funding for design, construction, and operation)
- Funding
  - DOE Funding: $284 MM
  - DOE Cost Share: 66%*

  * Design, Procurement, Construction, and Operating Costs through end of Demonstration Period
- Overall Project Performance Milestones
  - DOE Funding Awarded
  - Denbury Supply Agreement executed
  - Valero Utilities Supply Agreement/Lease executed
  - Finding of No Significant Impact (FONSI) issued
- Project Participants
  - Air Products and Chemicals, Inc.
  - Denbury Onshore LLC (sub-recipient)

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Overall Project Objectives

- **DOE Objectives**
  - Compliance with the American Recovery Act Objectives
  - Capture at least 75% of the CO_2 from a treated industrial gas stream comprising at least 10% CO_2 by volume that would otherwise be emitted to the atmosphere
  - Project size shall be a large-scale industrial CCS project producing in excess of 1 MM metric tons/year
  - CO_2 must be sequestered in underground geologic formation including oil-bearing formations
  - Monitoring, verification, and accounting (MVA) of sequestered CO_2
  - Must be on-stream prior to September 2015
- **Additional Air Products' Objectives**
  - No negative impact to Hydrogen business
  - Demonstrate real-world CO_2 capture economics

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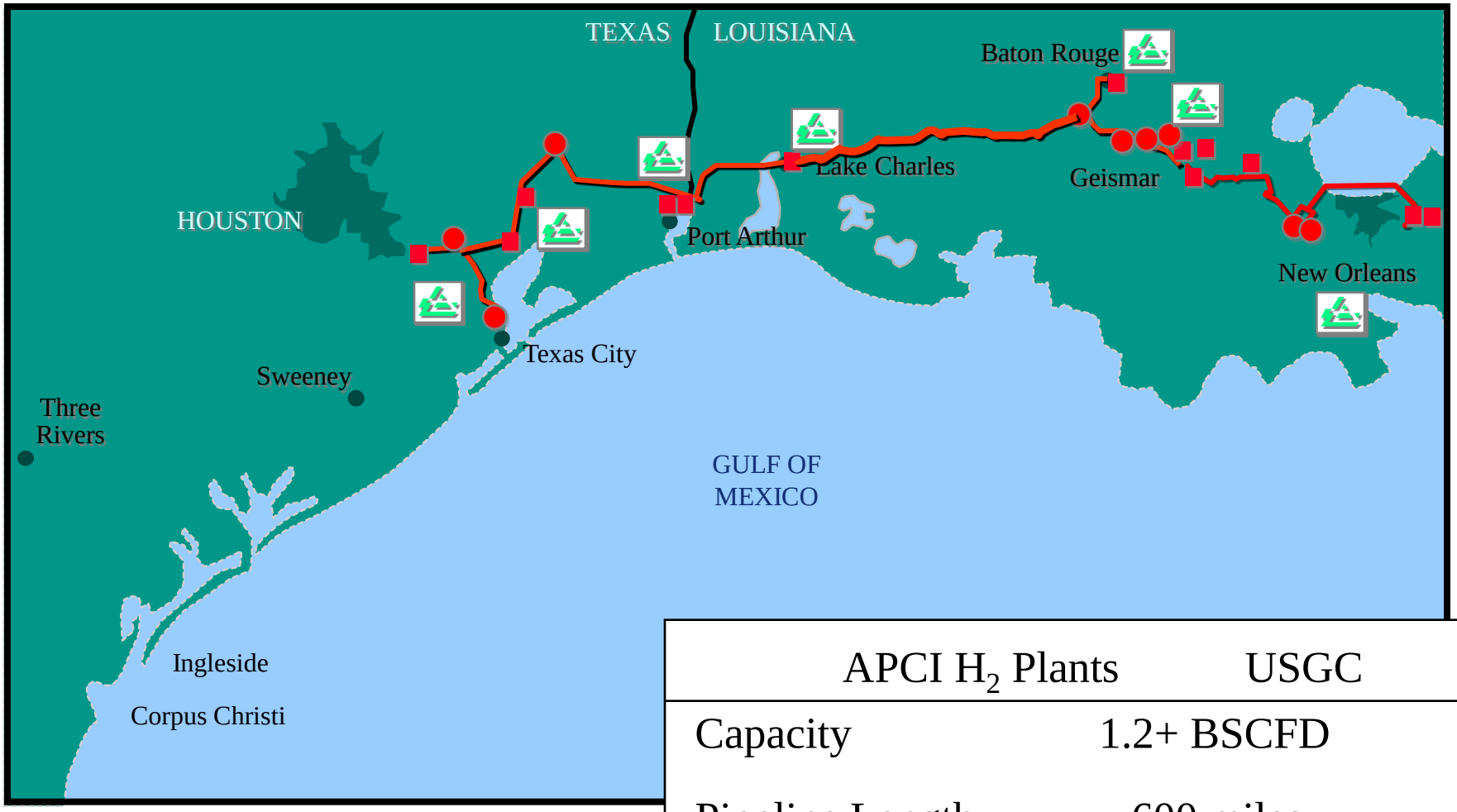
Technology Fundamentals/Background

Air Products' Gulf Coast Hydrogen Pipeline Network – 2012



APCI H_2 Plants	USGC
Capacity	1.2+ BSCFD
Pipeline Length	~ 600 miles

Hydrogen Pipeline
- Air Products
- Offgas H_2 Plant
- SMR / POx Hydrogen

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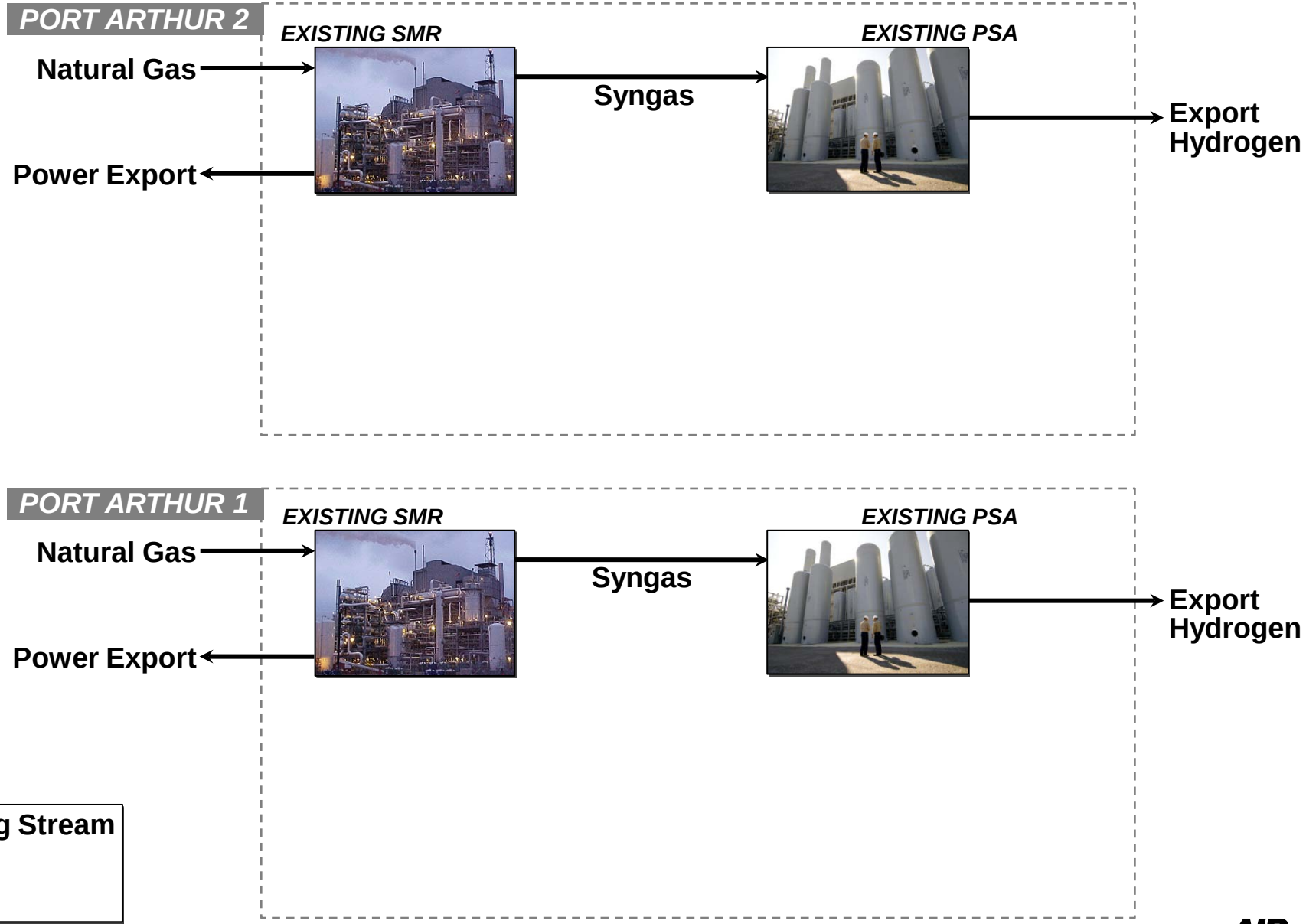
Simplified CO_2 Capture Block Flow Diagram



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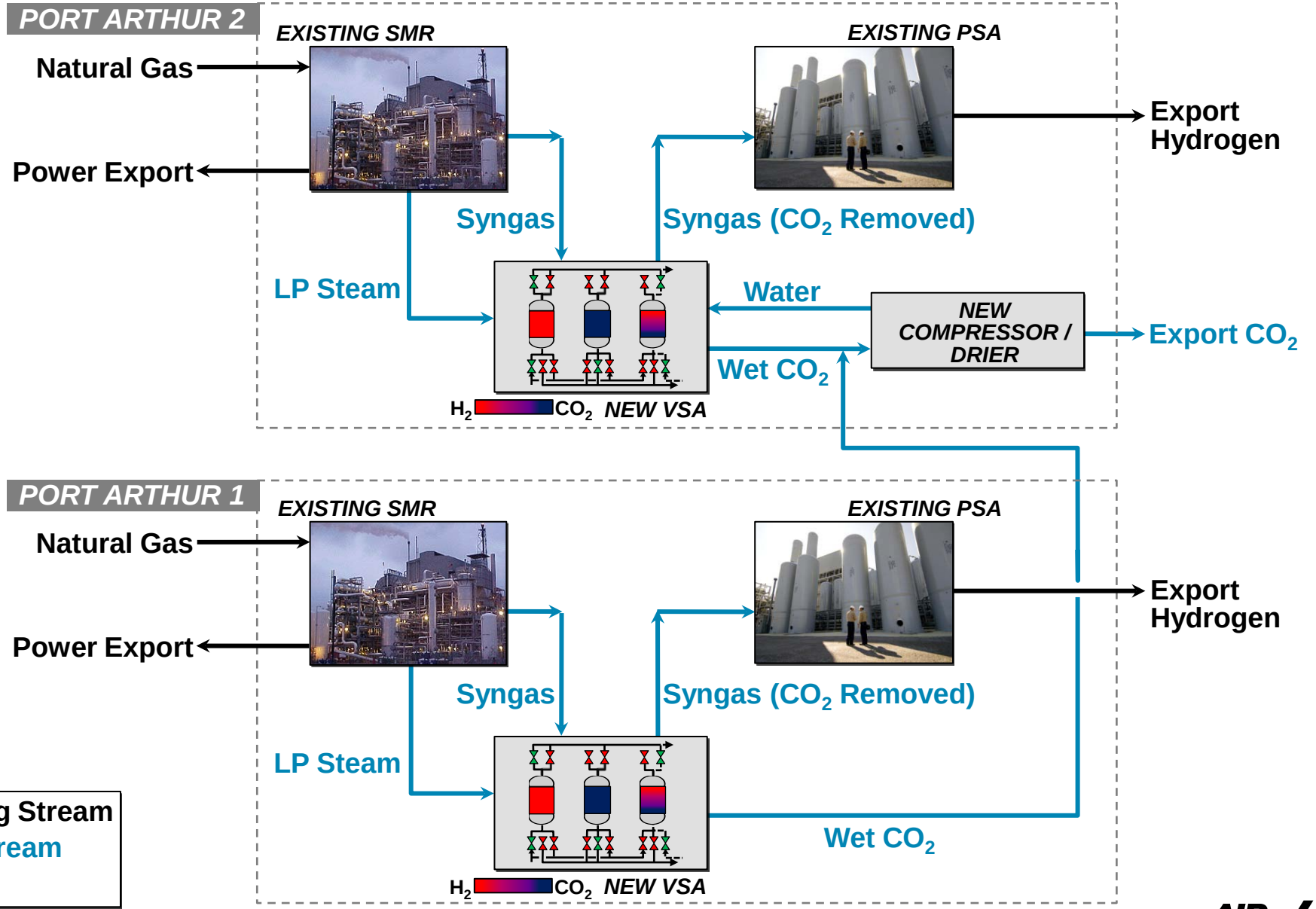

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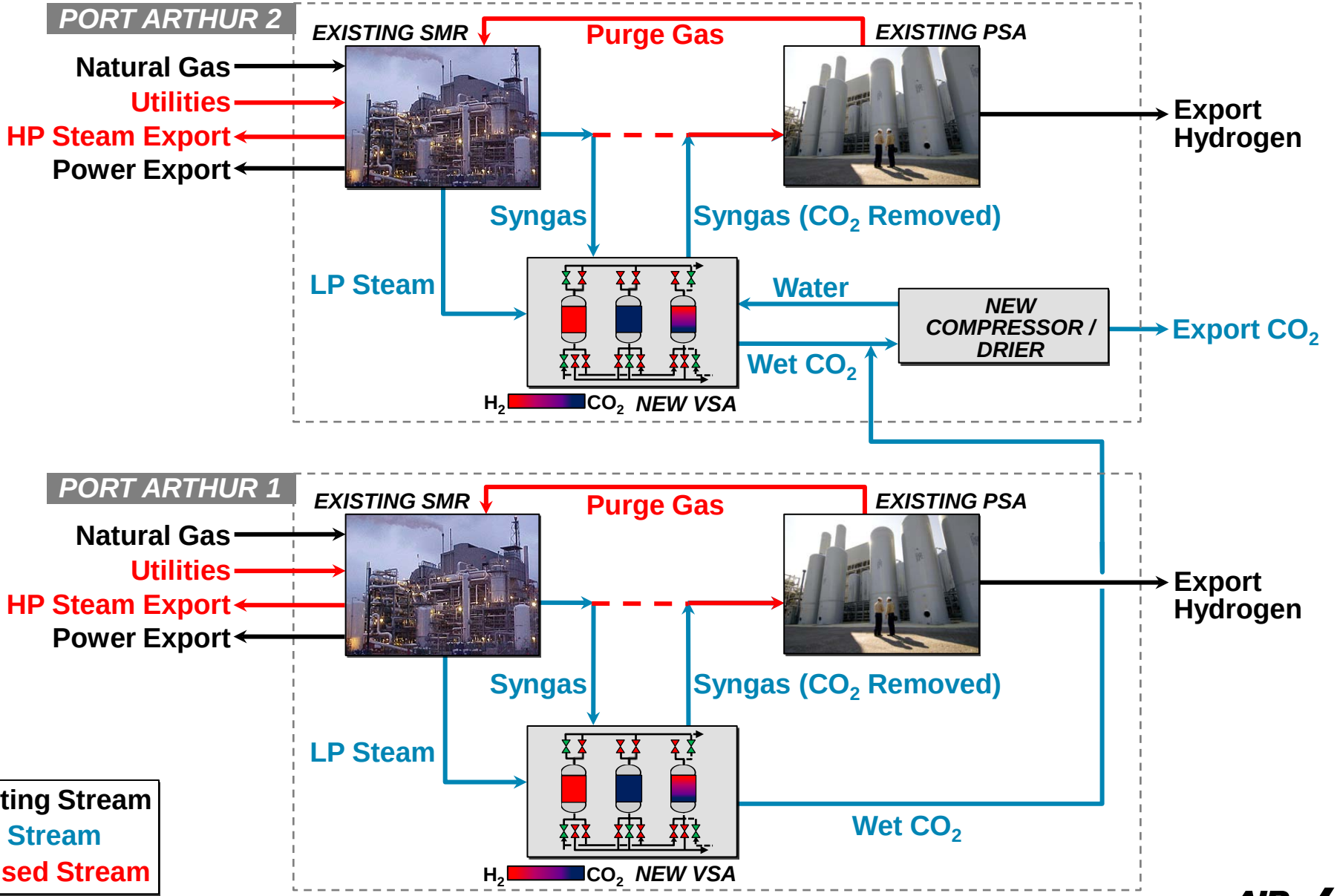
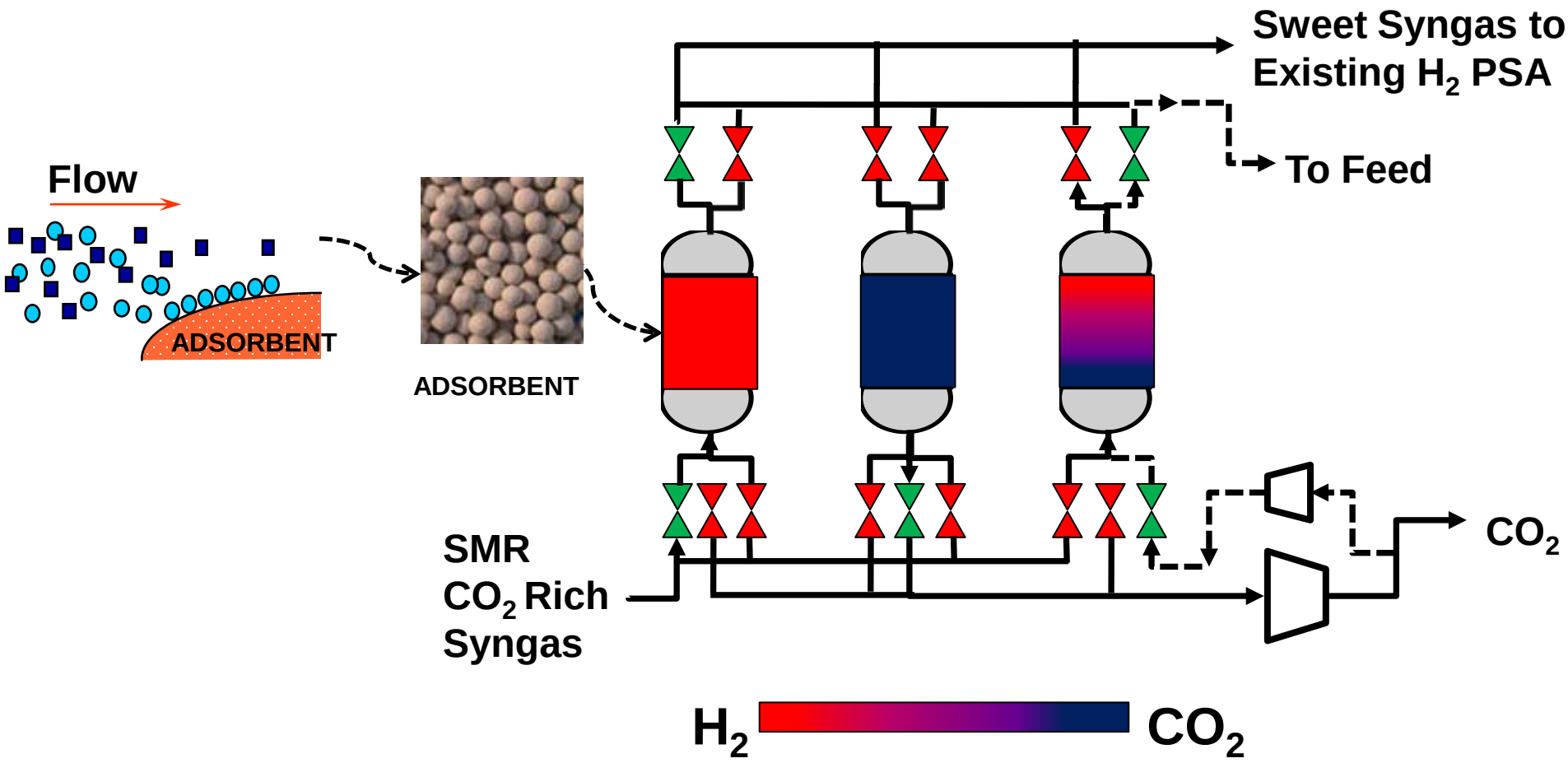
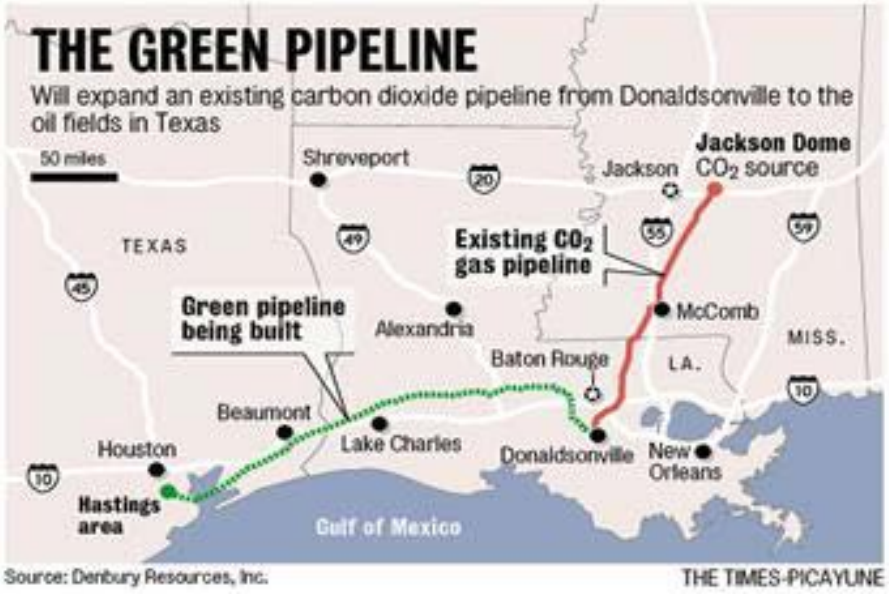


VSA CO_2 Process



Major Equipment Items

- Vacuum swing adsorption (VSA) vessels
- Tri-ethylene glycol (TEG) drier system
- CO_2 export compressor
  - 8 stages
  - Export pressure over 2000 psig
- 13 mile CO_2 Pipeline



Progress and Current Status of the Project

Progress and Current Status of Project

- **Site Demo – May 2011**
- **FONSI issued – July 2011**
- **Pilings – August 2011**
- **Foundations – September 2011**
- **Mechanical Construction – January 2012**
- **Projected On-stream:**
  - **PA-II: Late 2012**
  - **PA-I: Early 2013**

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Progress and Current Status of Project

- **Technical Challenges**
  - **Eliminate risk to Hydrogen Business**
  - **Technology Scale-up**
- **Economic Challenges**
  - **45Q Tax Credits**
  - **Schedule**
  - **Capital – retrofit project within active operating facility**
  - **Operating and Maintenance Costs**

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Plans for Future Testing/Development/Commercialization

Plan for Future Commercialization

- **Technical and economic results from this project are key to determining the most effective commercialization path**
- **DOE award funding has enabled demonstration**
  - **Existing CO_2 market does not support current CO_2 capture economics without external funding**
- **www.airproducts.com/co2_capture**

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Thank you

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