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An Update on Conversion of Biogas to NH_3

8th Annual NH_3 Fuel Conference
Portland, Oregon
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Update

WE DID IT!

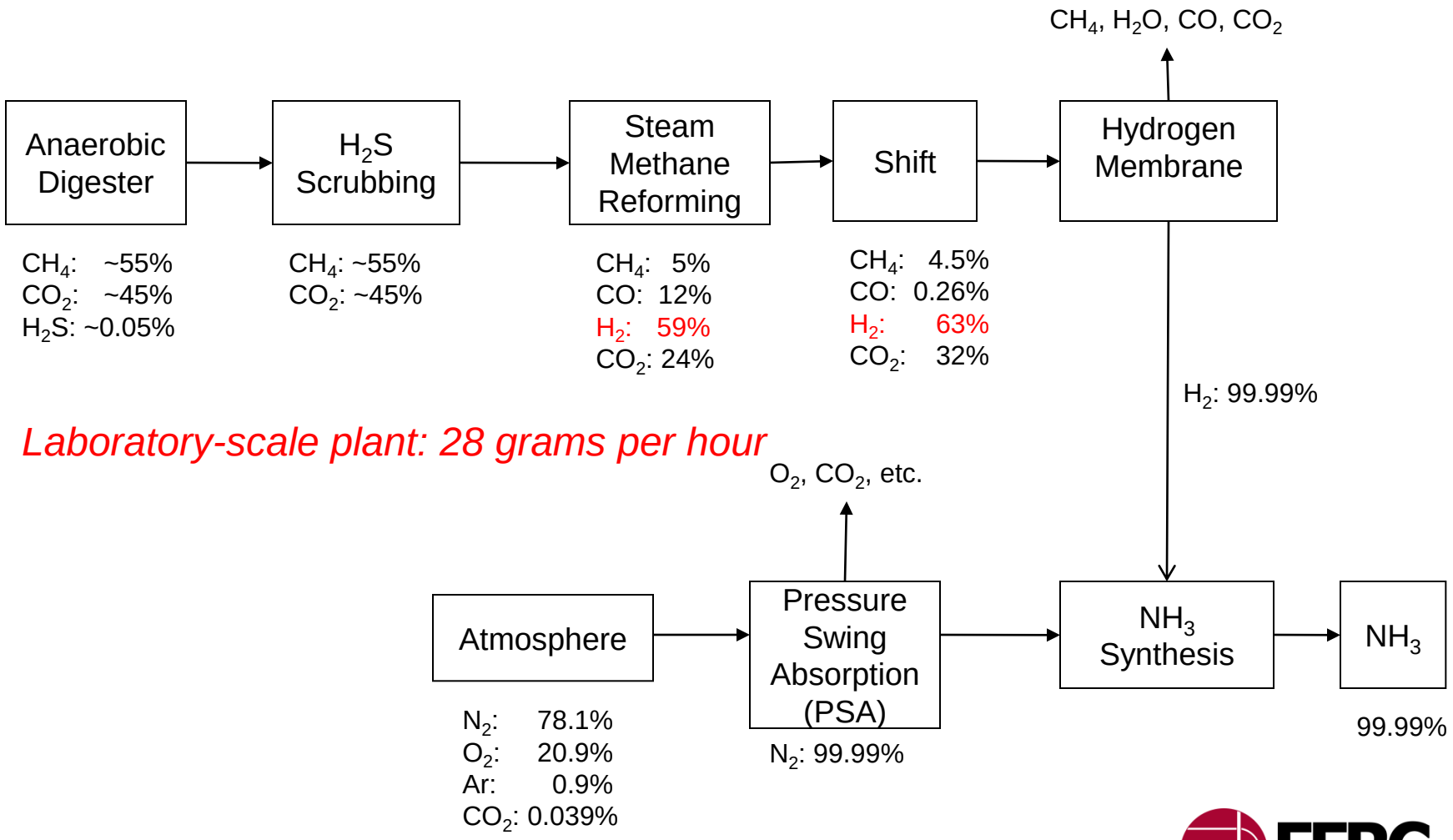
Update

QUESTIONS?

Features of EERC Renewable NH_3

- Modular design:
  - Processing units can be scaled.
  - Processing units can be added (i.e., urea capability).
  - Processing units can be upgraded with new technology.
- Anaerobic digestion provides feedstock.
- Stable ammonia costs:
  - Distributed-scale production.
  - Fixed operating costs.
- Reduced carbon footprint for nitrogen fertilizers and NH_3 fuel.

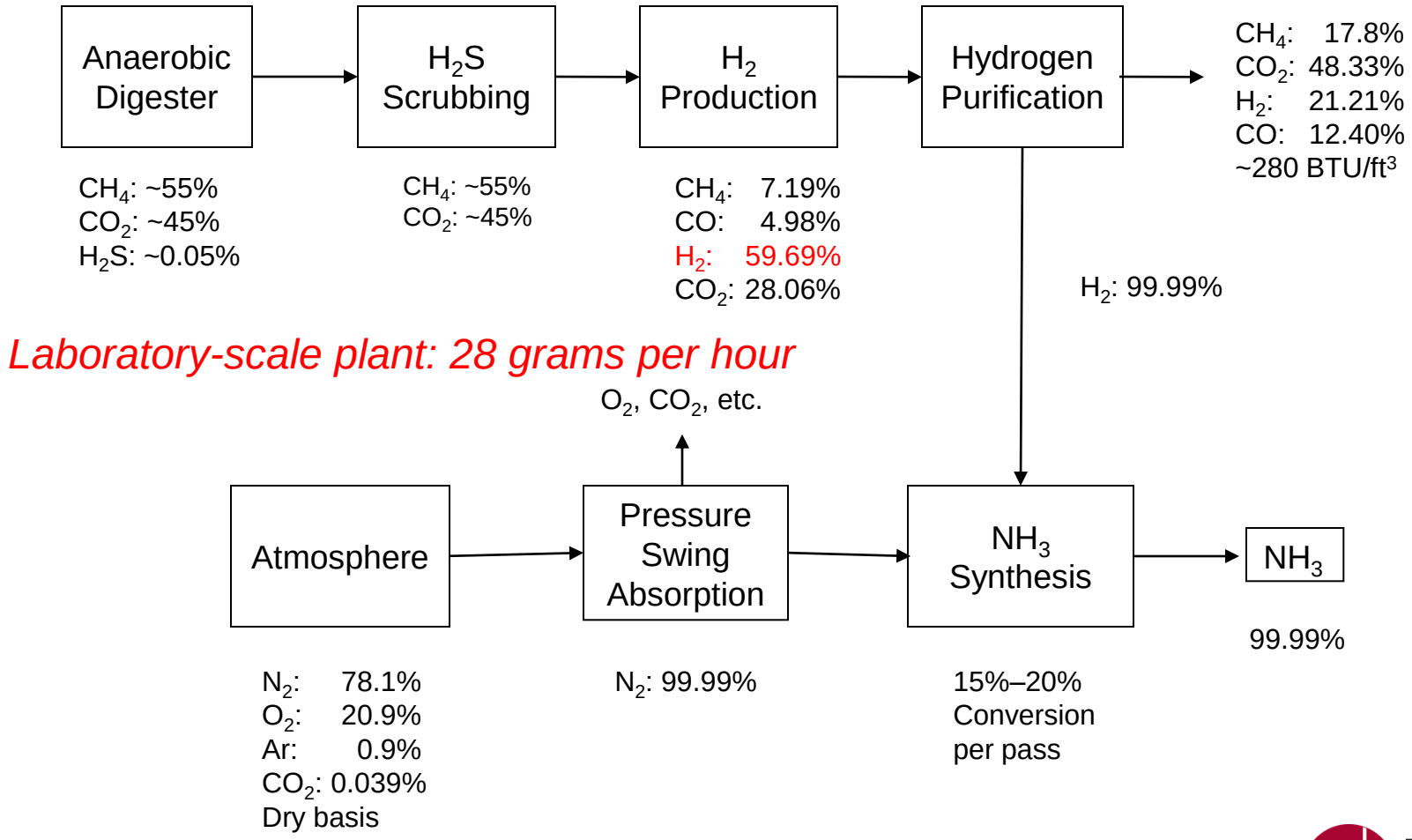
Last Year



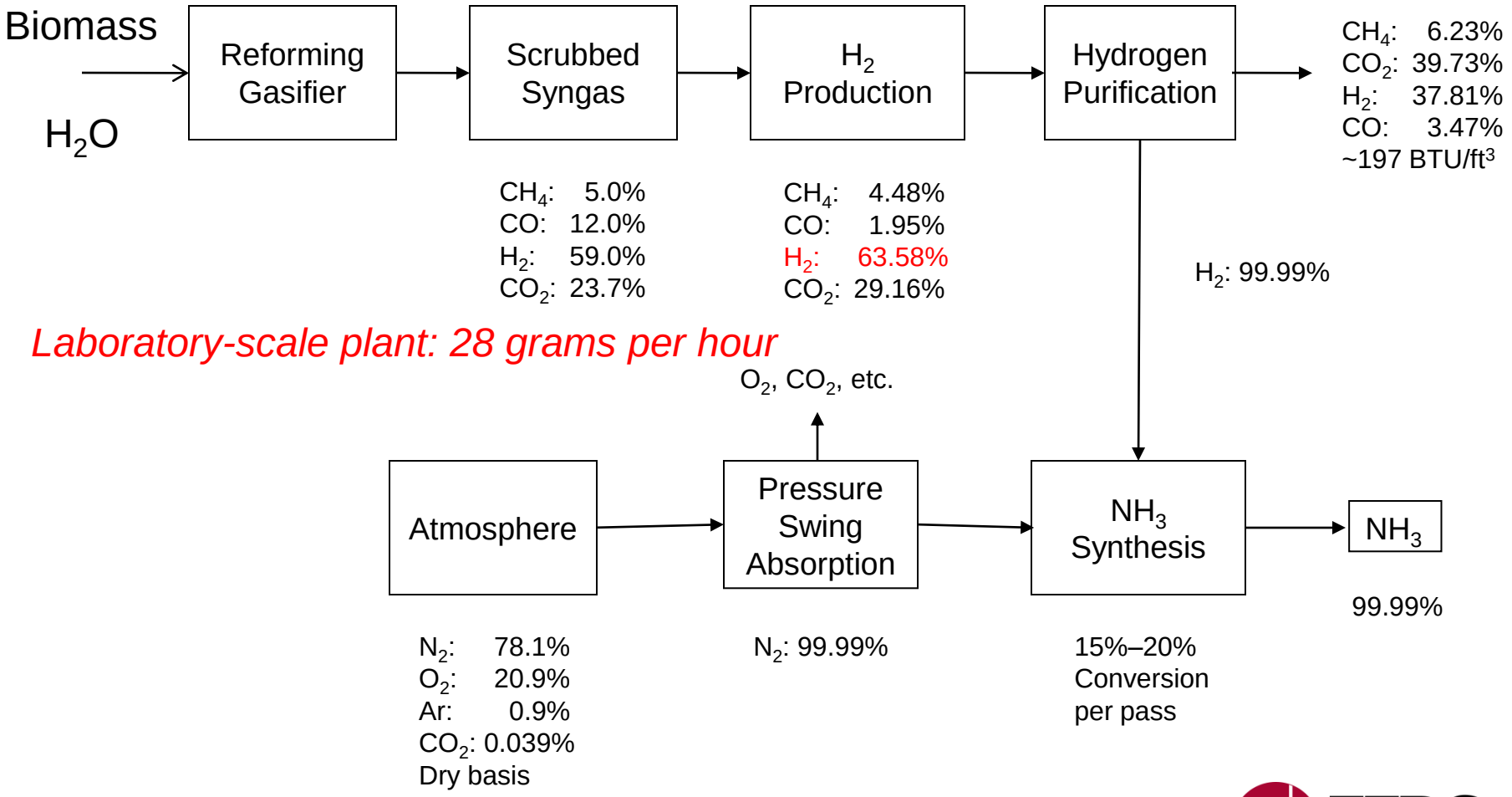
Accomplishments This Past Year

- Completed construction of lab unit.
- Designed and installed instrumentation and electronics.
- Commissioned various operating units.
- Simplified the design.
- Conducted two 1-week campaigns:
  - Simulated biogas: 1 week
  - Simulated gasifier output: 1 week
- Looked at various laboratory and commercial opportunities.

Block Flow Diagram: Anaerobic Digestion

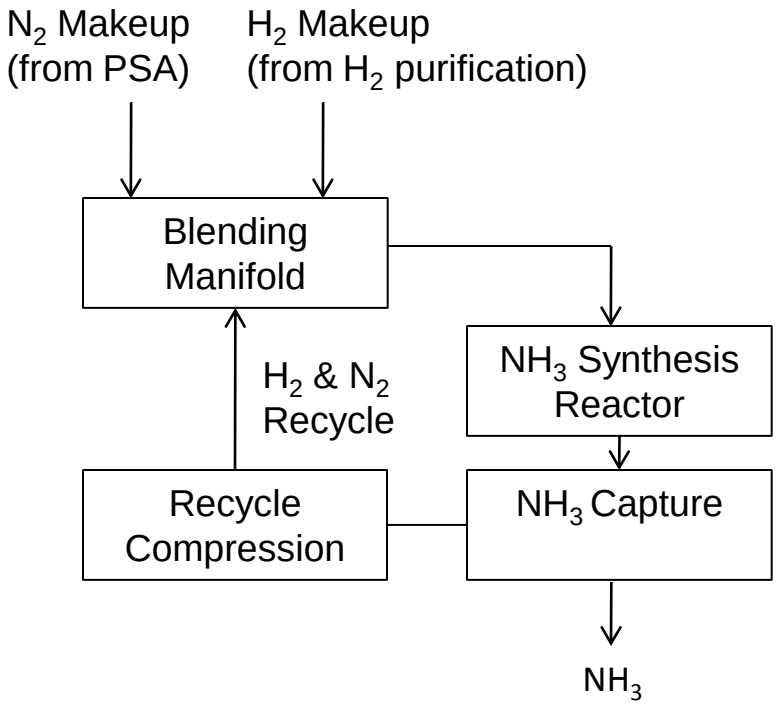


Block Flow Diagram: Reforming Gasifier



NH_3 Synthesis Loop

- NH_3 capture and recycle gas loop
  - NH_3 level by ΔP
  - Some NH_3 slip
    - ►<1% in recycle gas



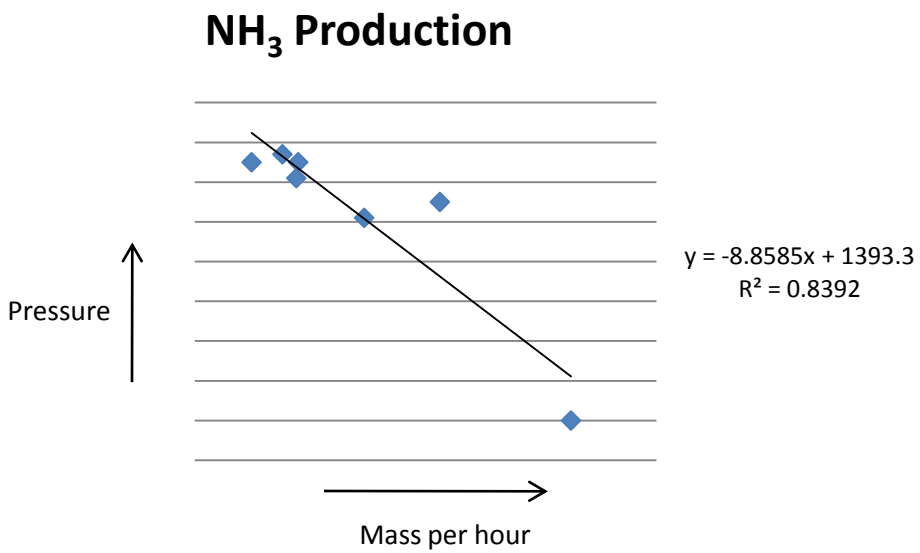
Review of Desired vs. Actual Goals

- Desired*
  - Reforming
    - CH_4 = 5%
    - CO = 12%
    - H_2 = 59%
    - CO_2 = 24%
  - Shift
    - CH_4 = 4.5%
    - CO = 0.26%
    - H_2 = 63.42%
    - CO_2 = 31.78%
- Actual
  - Reforming
    - CH_4 = 7.19%
    - CO = 4.98%
    - H_2 = 59.69%
    - CO_2 = 28.09%
  - Shift
    - CH_4 = 4.48%
    - CO = 1.95%
    - H_2 = 63.58%
    - CO_2 = 29.16%

*Twigg, M., Ed. *Catalyst Handbook, 2*nd ed.; Manson Publishing: London 1996.

NH_3 Productivity

- Depends on:
  - Control strategy
  - Gas flow rate
  - Pressure
  - Temperature
- Actual productivity
  - Low: 1.0 g/hour
  - High: 160 g/hour
  - Common: 7 g/hour



1st Generation System

- 20 tons per day
  - Agricultural purpose
- Renewable feedstock
- Relies on modular design
- Timelines: 18 to 21 months
  - Basic engineering
  - Detailed engineering
  - Procurement, construction, & commissioning

Other Renewable NH_3 Project(s)

- Funding sources
  - Investors (private equity)
  - Grant sources (based upon availability)
    - U.S. Department of Energy
    - U.S. Department of Agriculture
- Typical cash breakdown:

	Government	Investors
Research & Development	80%	20%
Commercial	50%	50%

Acknowledgment of Partners

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

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Acknowledgment

The estimates presented are for discussion purposes only and do not obligate the University of North Dakota. After a final scope of work is determined, the Energy & Environmental Research Center will provide a formal proposal with the appropriate signatures.

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