# CO From $CO_2$ via Chemical Looping

Dominick Battaglia, Jace Carsten, William McPhaul, Zacharia Nyambega
Mentors: Dr. Luke Neal

## 1. Motivation

- Addressing the climate crisis by using waste gas sources for CO production
- Conversion of $CH_4$ and $CO_2$ to CO reduces greenhouse gas presence
- CO and $H_2$ produced from the redox process have various uses in industry:
  - ➢ Reducing agent, cleaning detergent, methanol production, food packaging

## 2. Goals

- Enhance environmental sustainability
- Determine engineering and economic viability of the process
- Determine best case gas source

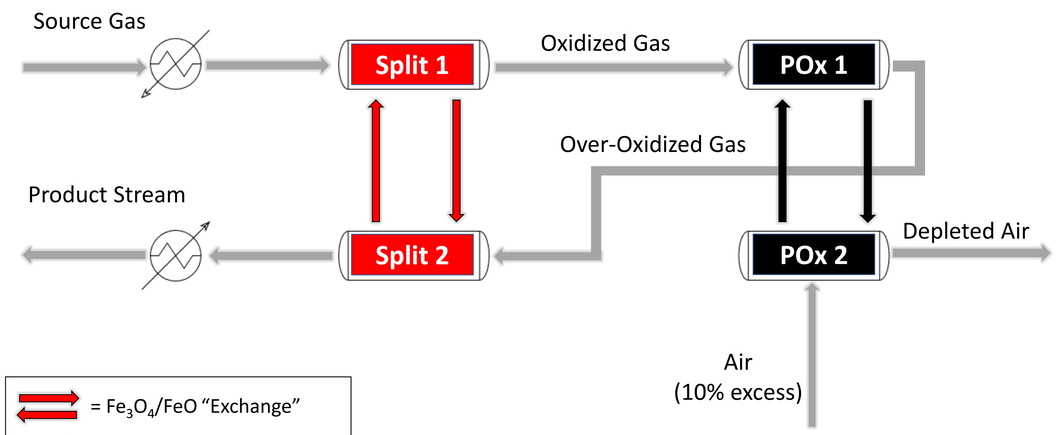
## 3. Gas Sources

**Natural Gas (Pure $CH_4$)**
- Upsides: high concentration of $CH_4$
- Downsides: Expensive, non-renewable, fracking

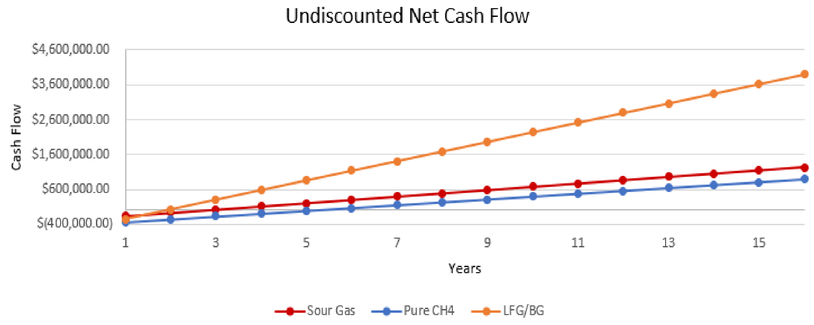
**Landfill / Biogas (LFG/BG)**
- Upsides: relatively high concentration of $CH_4$, renewable, cheap
- Downsides: Landfill gas relies on highly polluting landfills; biogas gas may contain high $CO_2$ content and impurities

**Sour Gas (SG)**
- Upsides: cheap, natural gas collection byproduct
- Downsides: High $H_2S$ content, low $CH_4$ content, source is underdeveloped

## 4. Process Flow Diagram




## 5. Financial Analysis

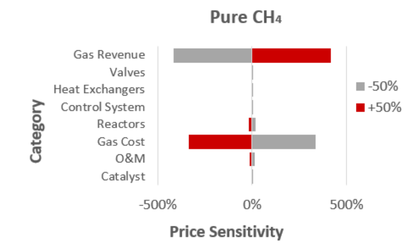


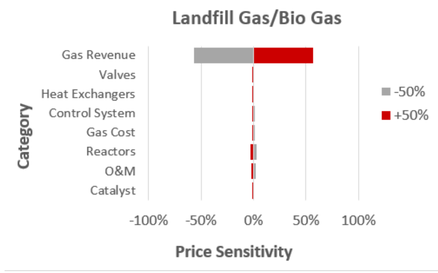

| Source Gas | Product Produced | Costs | Revenue |
|---|---|---|---|
| Pure $CH_4$ | 822 tons syngas/year<br>15 tons $H_2$/year | $413,000/year | $495,000/year |
| LFG/BG | 493 tons syngas/year<br>9 tons $H_2$/year | $20,000/year | $297,000/year |
| SG | 181 tons syngas/year<br>3 tons $H_2$/year | $16,000/year | $109,000/year |

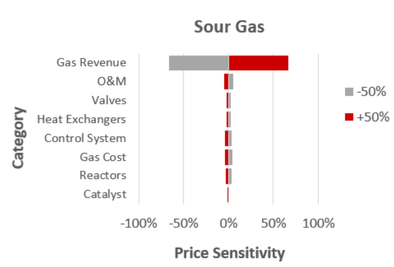
| Source Gas | Capital Cost | ROROI |
|---|---|---|
| Pure $CH_4$ | $340,000 | 23% |
| LFG/BG | $249,000 | 111% |
| SG | $165,000 | 57% |

## 6. Price Sensitivity

- **Low Impact:**
  - ➢ Valves
  - ➢ Heat exchangers
  - ➢ Control system
  - ➢ Reactors
  - ➢ Gas cost for LFG and SG
- **High Impact:**
  - ➢ Gas Revenue
  - ➢ Gas cost for CH4




## 7. Conclusions

- Each gas source is financially viable over 15 years
  - ➢ Plant will be paid off in 1-5 years, depending on gas source
- LFG/BG most viable due to cheap gas cost and high $CH_4$ concentration
  - ➢ However, LFG degrades quickly and BG concentrations can vary significantly

## 8. References


- Landfill gas: https://www.fortistar.com/fortistar-announces-construction-project-that-will-capture-enough-landfill-methane-to-produce-5-1-million-gas-gallon-equivalents/
- Sour gas: https://samcotech.com/samco-innovations/platform-oil-gas-recovery/sour-acid-gas/
- Natural gas: https://www.forbes.com/sites/ucenergy/2018/02/20/fracking-has-its-costs-and-benefits-the-trick-is-balancing-them/?sh=78e7355119b4