SUSTAINABLE ENERGY SOLUTIONS

Cryogenic Carbon Capture
An ARPA-E Project

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Sustainable Energy Solutions

NETL Conference
July 11, 2013

About SES

- Founded in 2008
- About 20 employees
- Based in Orem, Utah
- Funding from Arpa-e, DOI, Dong Energy, State of Wyoming, CCEMC

SUSTAINABLE ENERGY SOLUTIONS

Anatomy of an Energy Solution

- Energy efficient
- Environmentally benign
- Bolt-on technology
- Scalable to 99%+ capture
- Stabilizes Grid
- Enables intermittent and alternative systems
- Minimal water consumption

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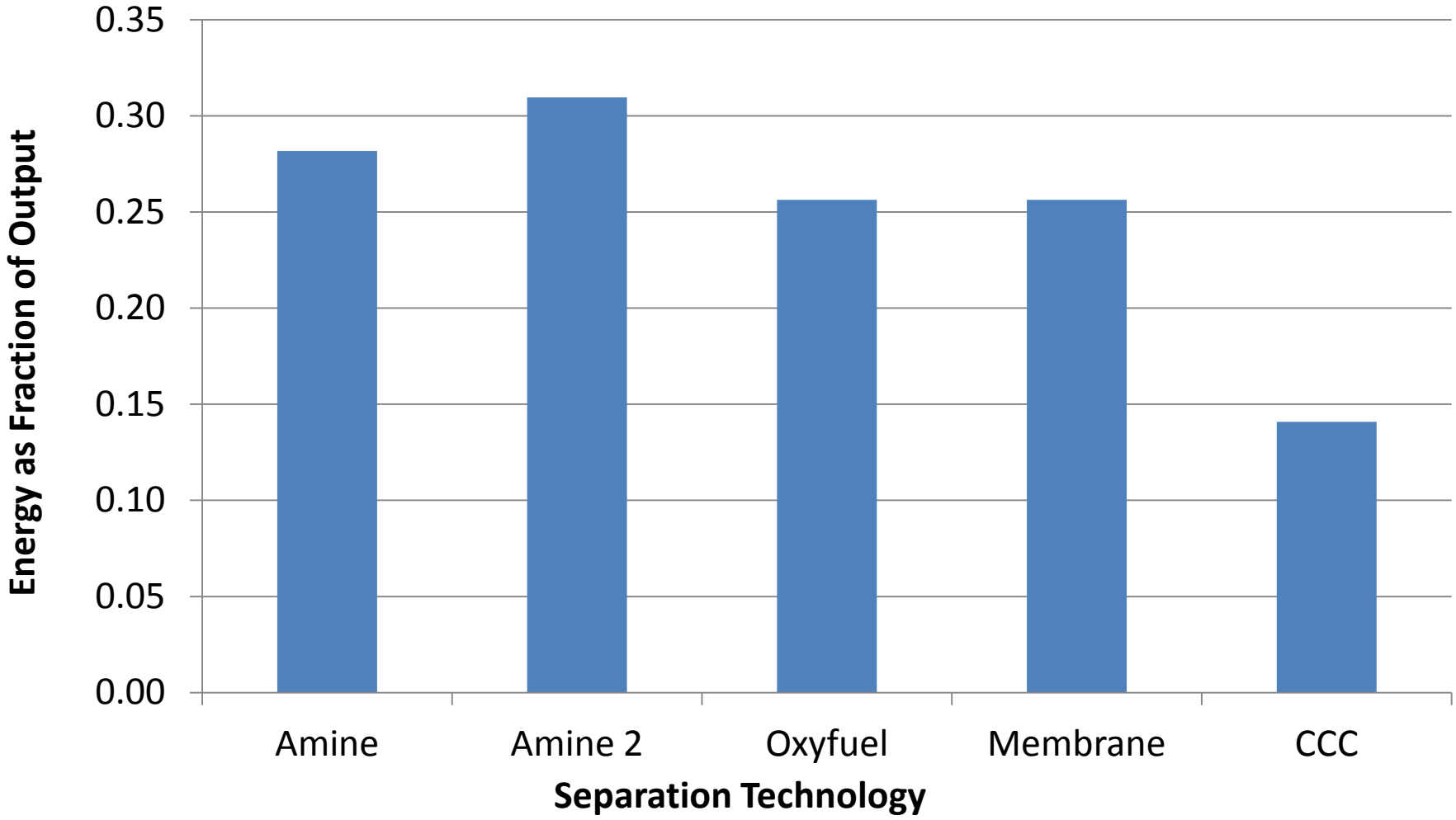
CCS Energy Demand



Data from DOE reports 2007/1281, 2010/1291, and Baxter et al, 2010

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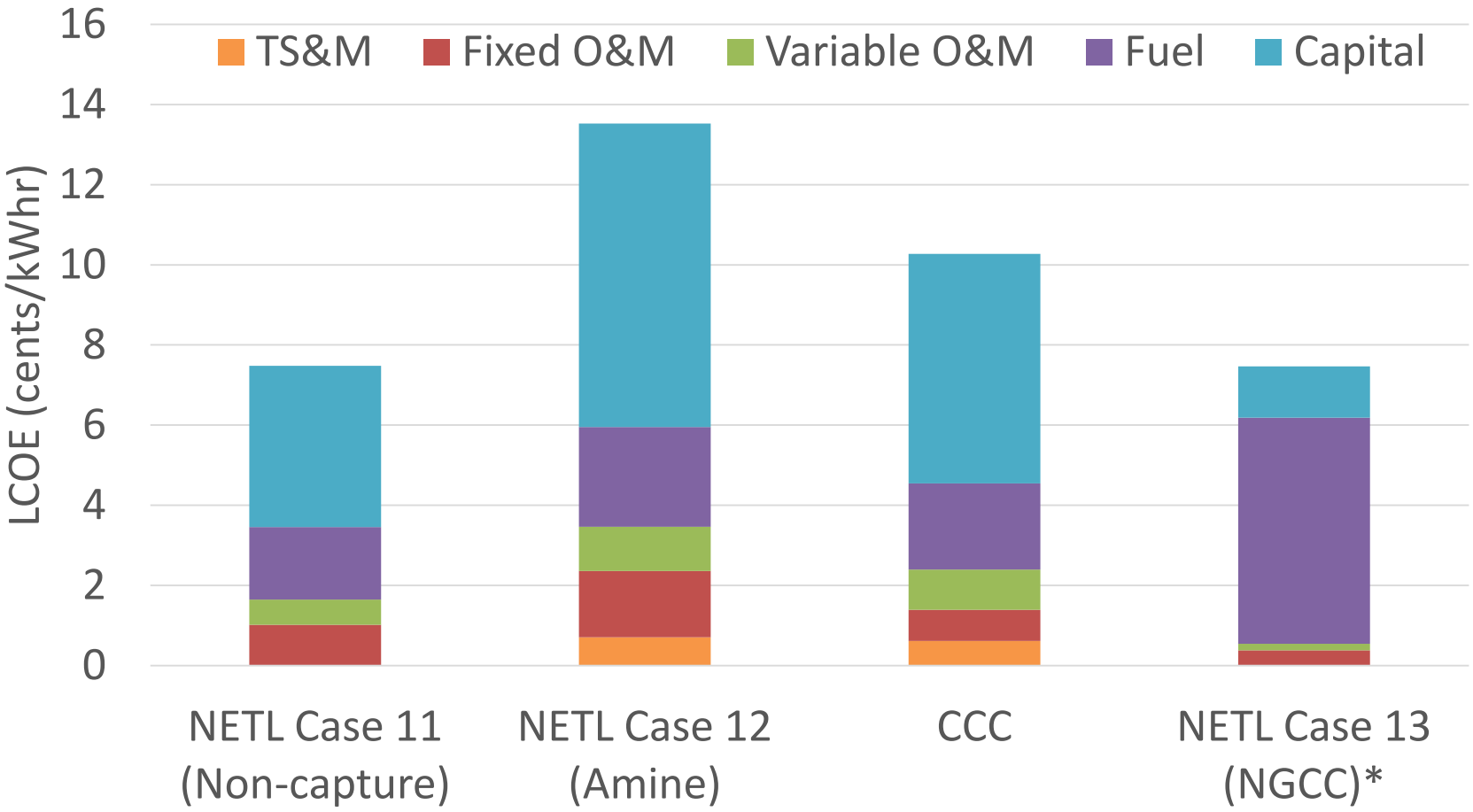
Greenfield Installations



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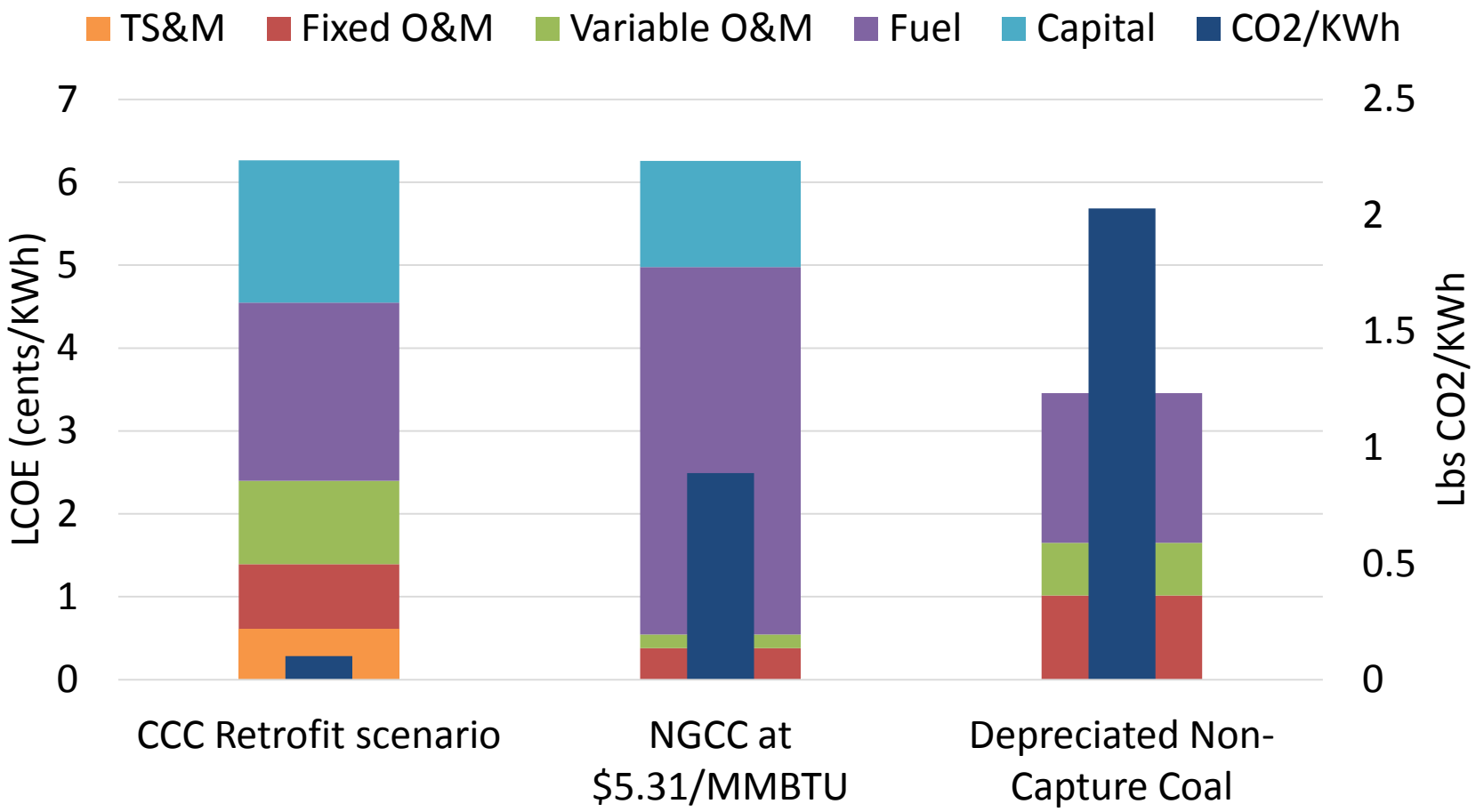
Retrofit Installations



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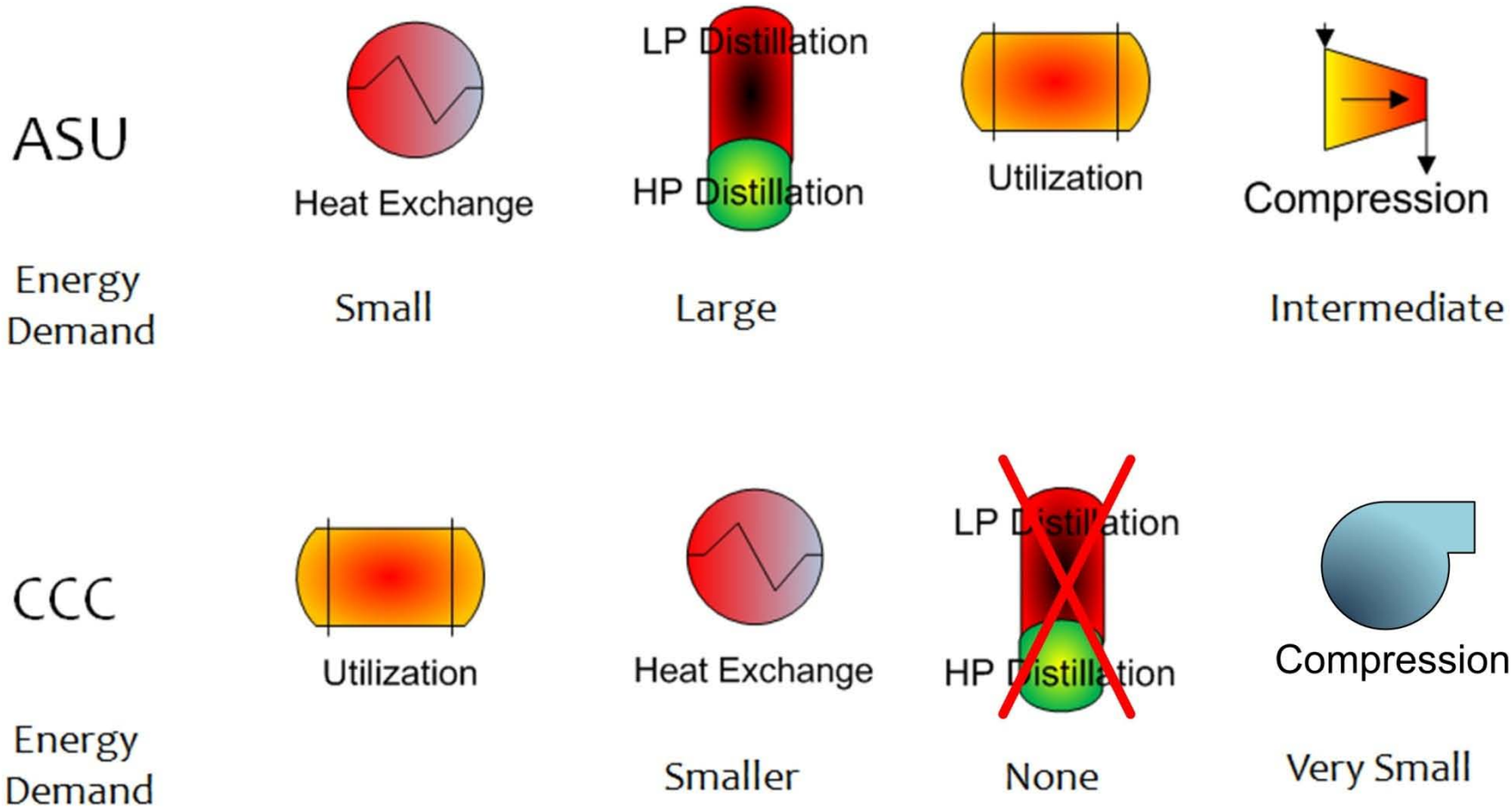
ASU Comparison



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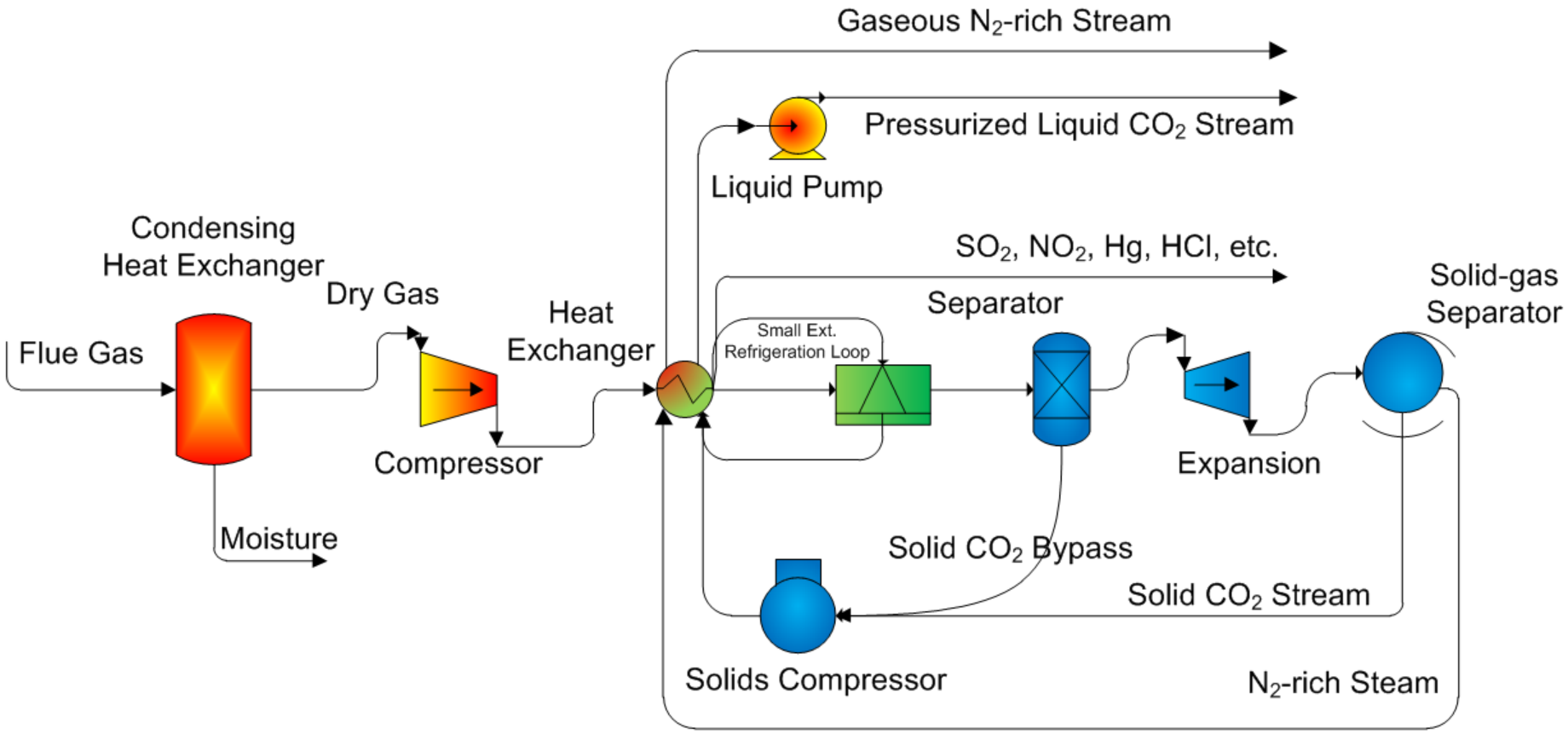
CCC Process – Compressed Flue Gas



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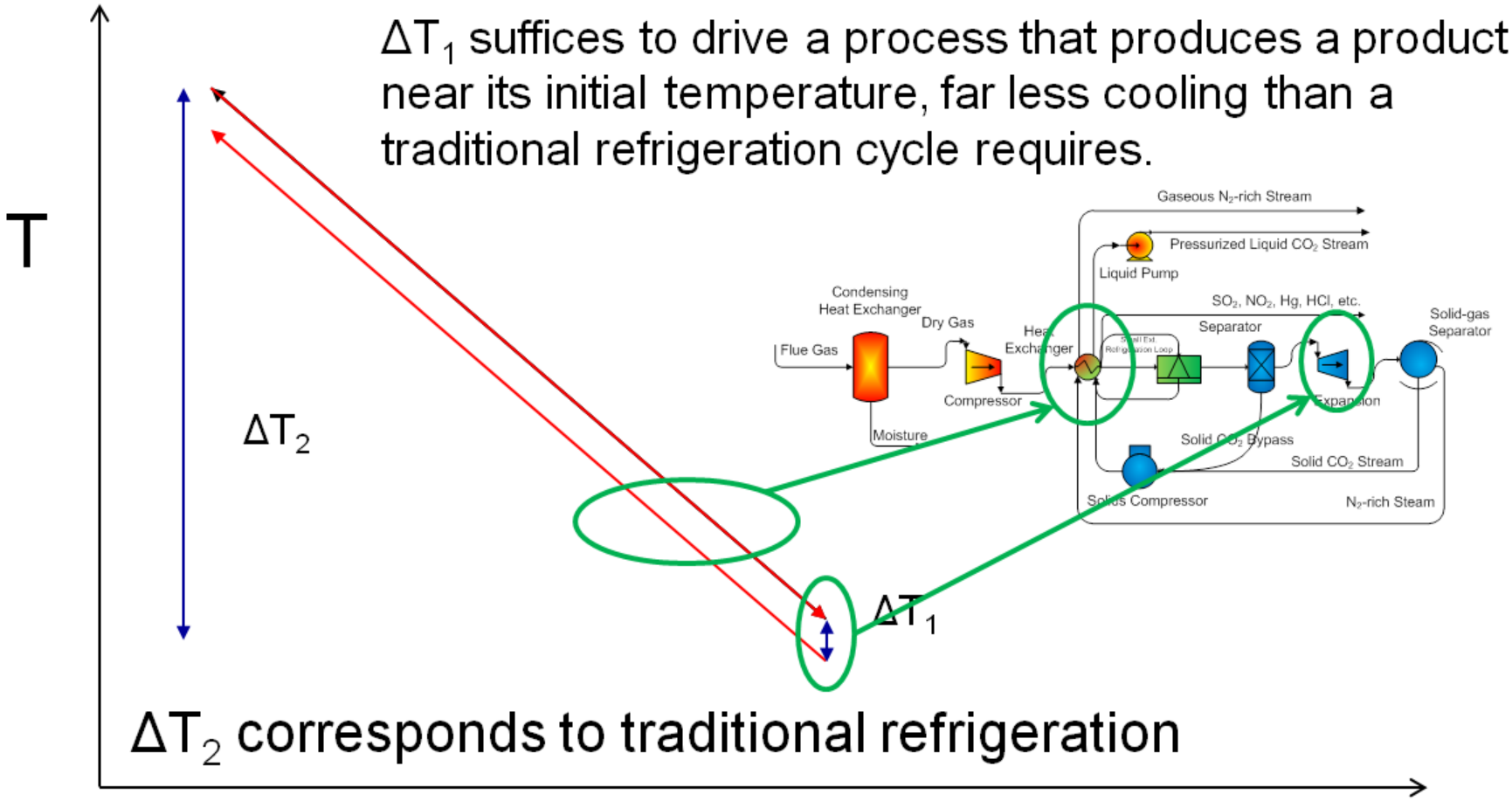
Basic Principles

ΔT_1 suffices to drive a process that produces a product near its initial temperature, far less cooling than a traditional refrigeration cycle requires.



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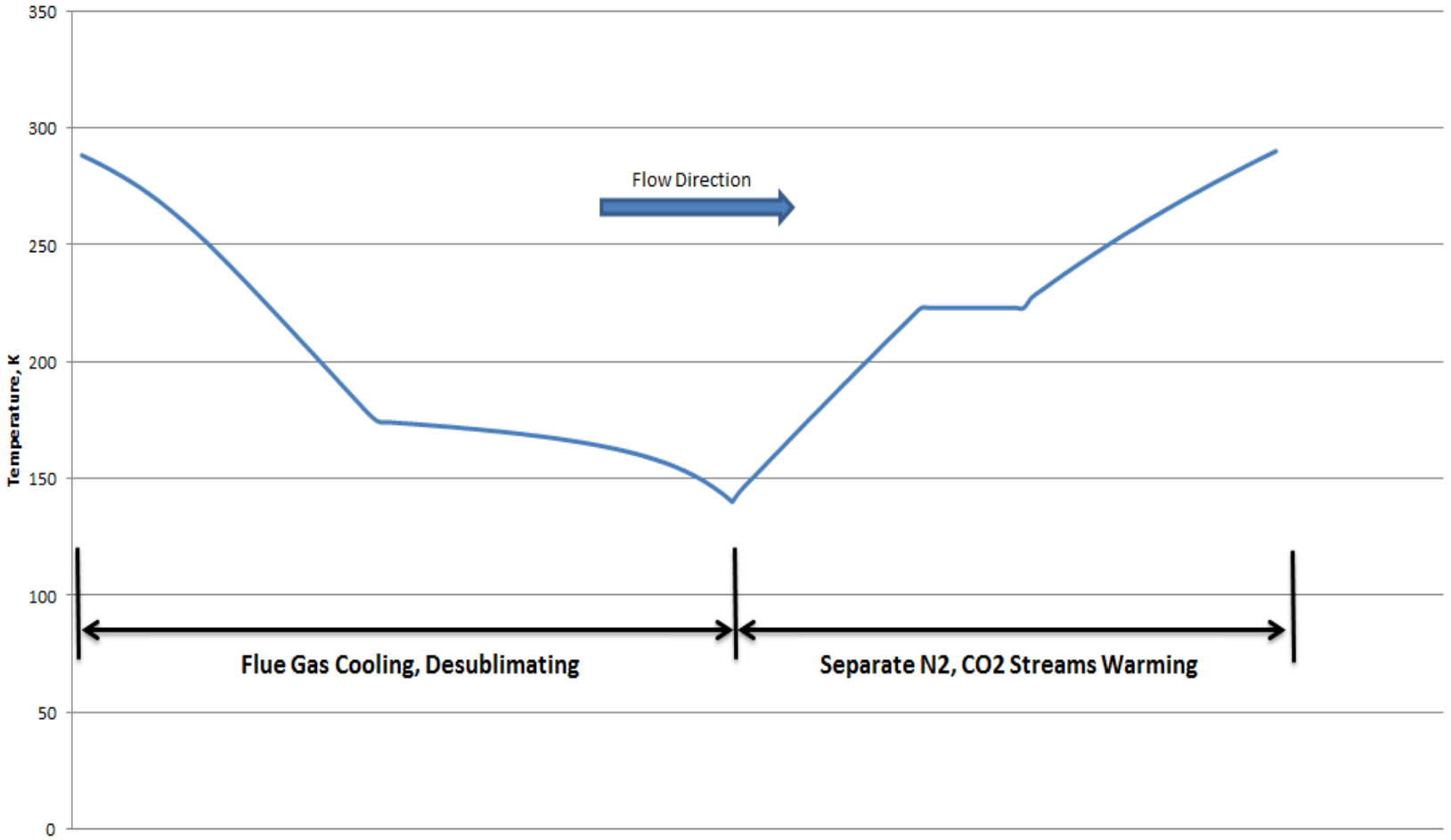
Actual Gas Temperature Profiles



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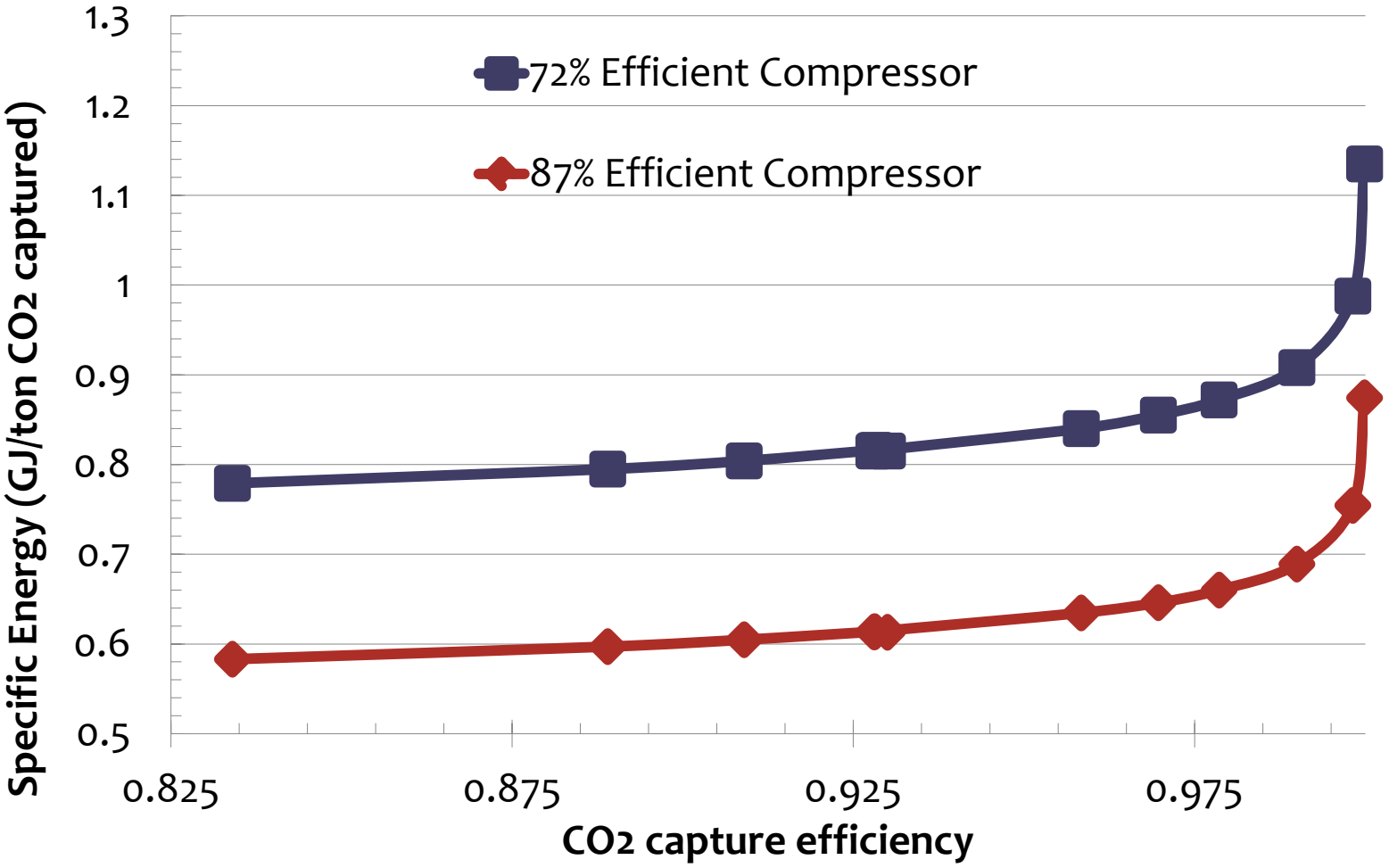
Energy Efficiency



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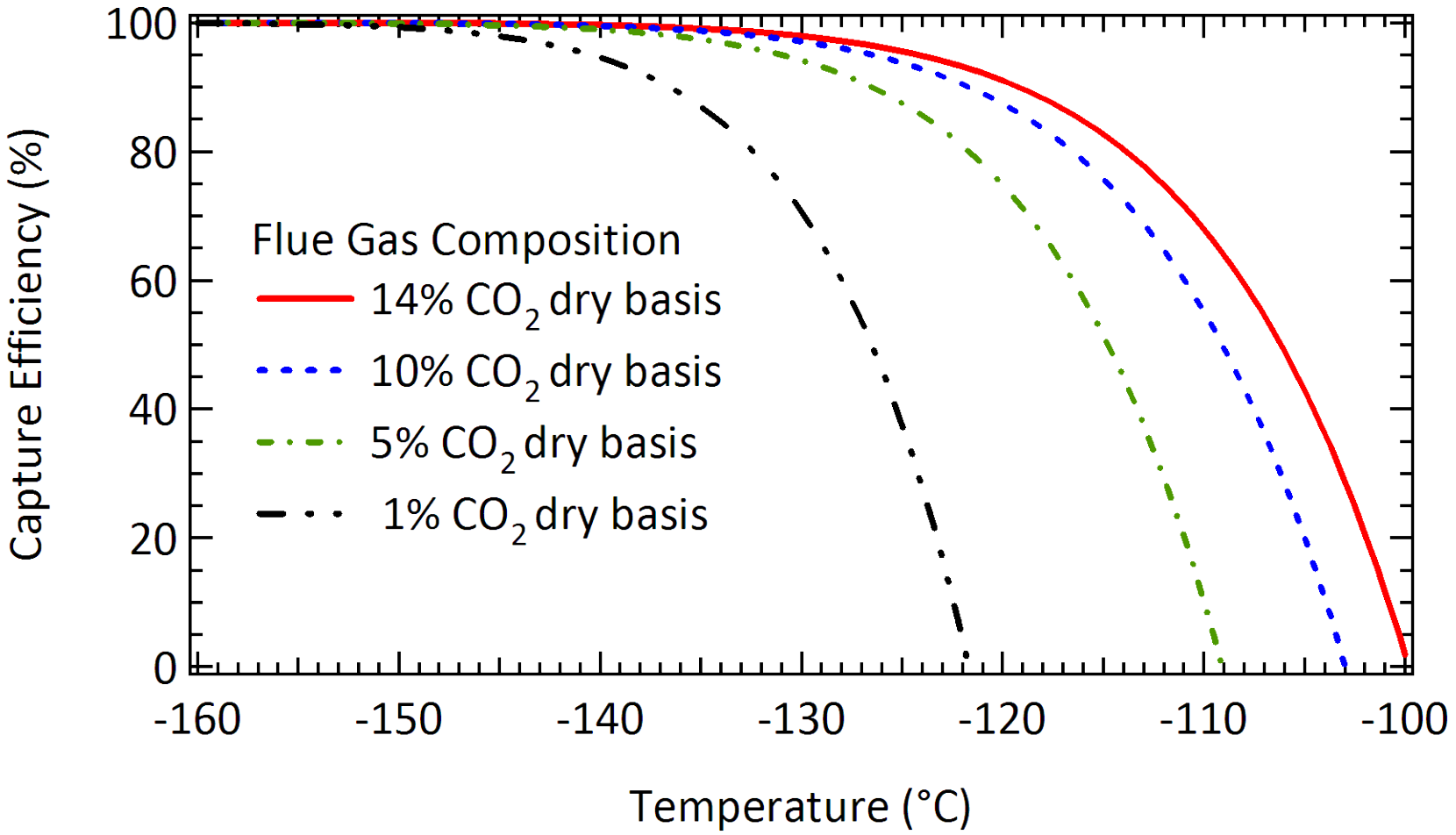
Capture Efficiency at 1 atm



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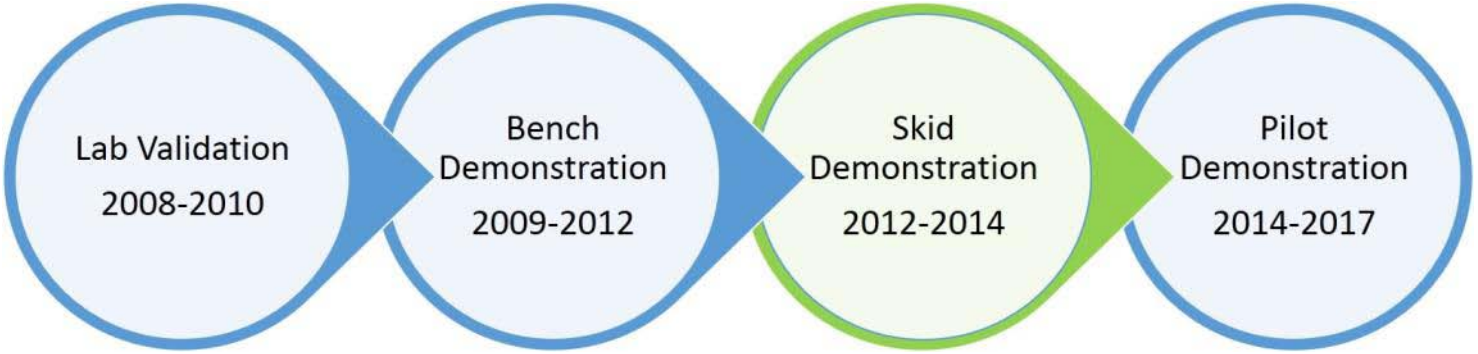
Technology Development



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Desublimating Heat Exchanger

- Continuous desublimation of CO_2
- ECL Skid can process 100 scfm of flue gas
  - 1 ton per day CO2

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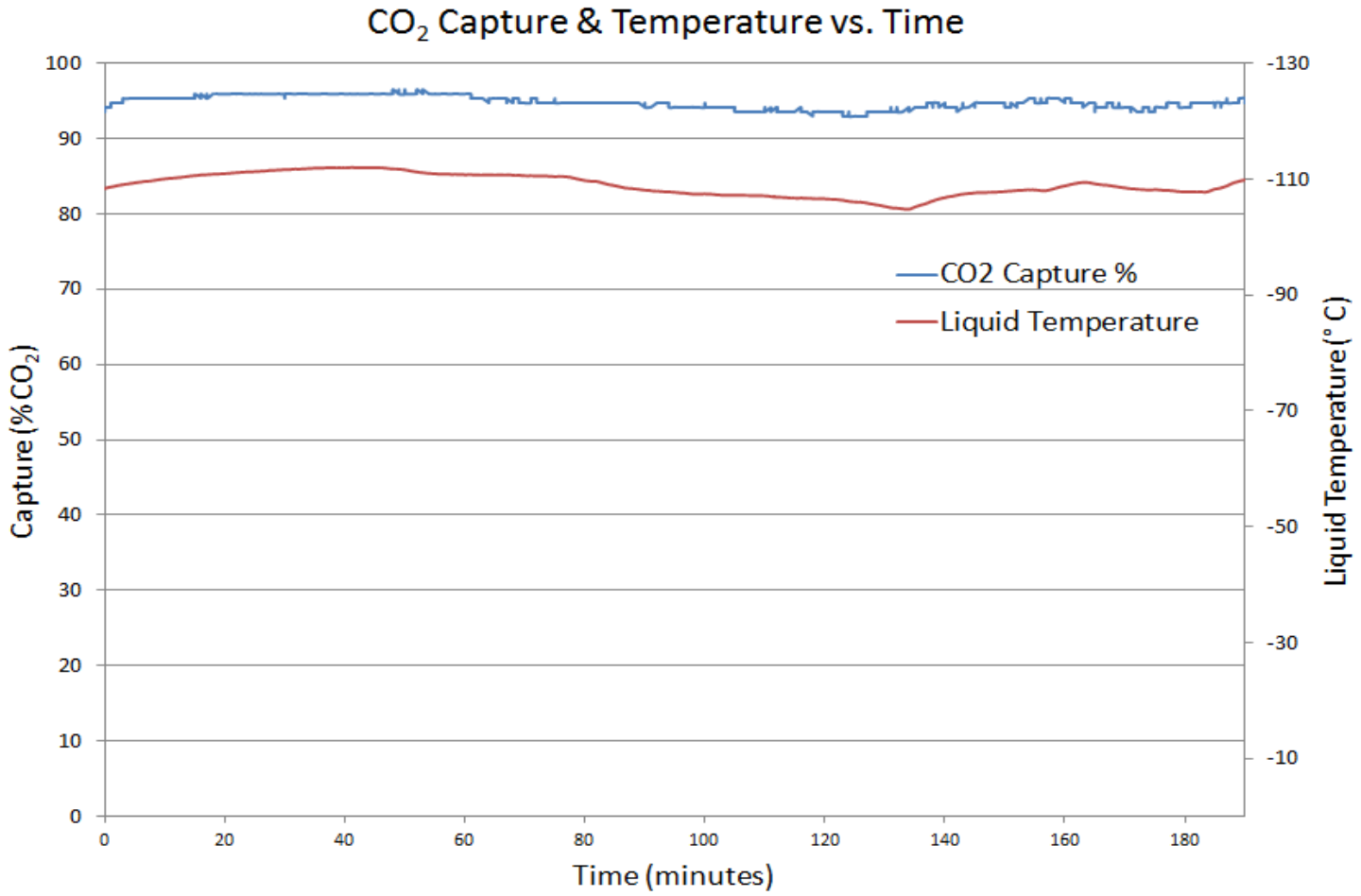
CO_2 Capture



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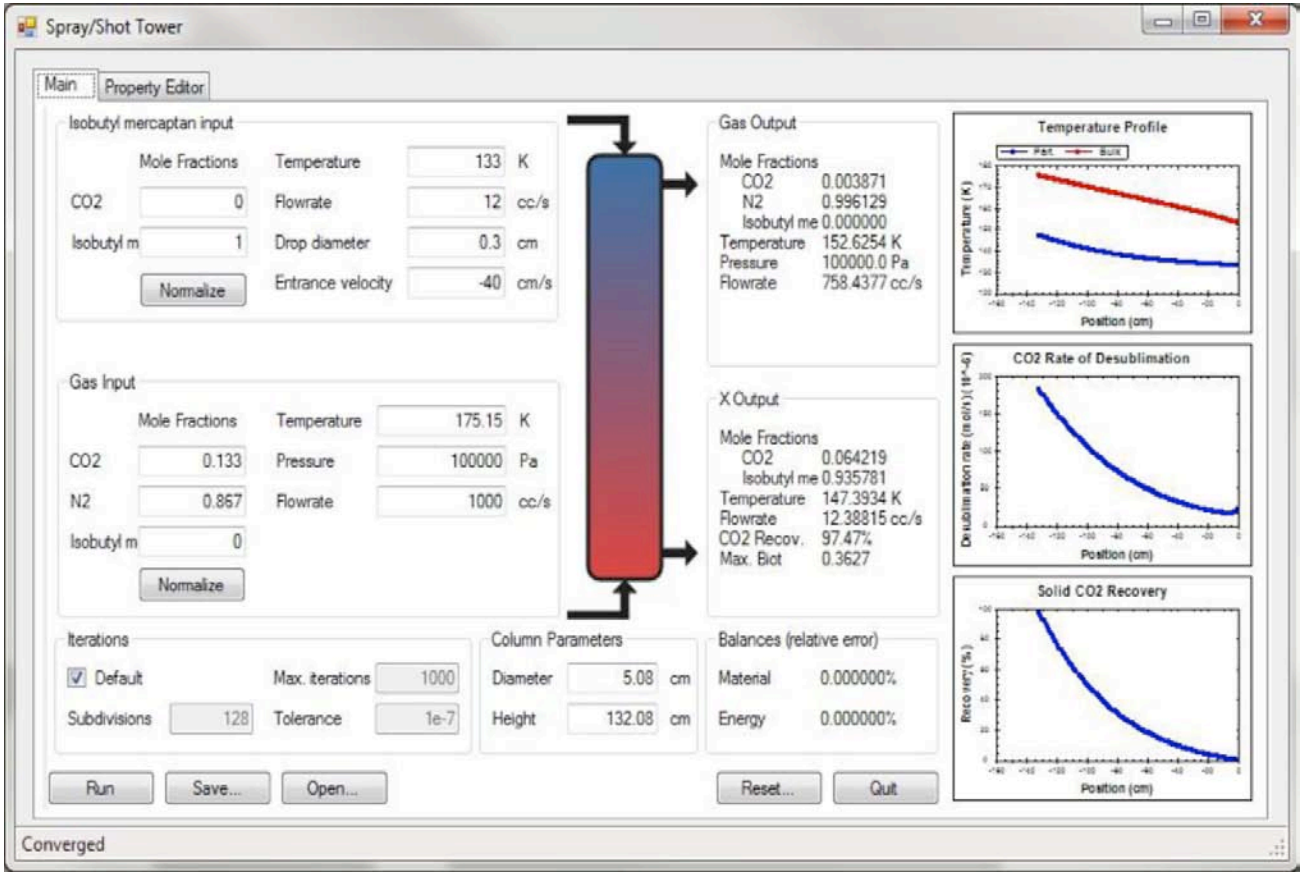
Spray Tower



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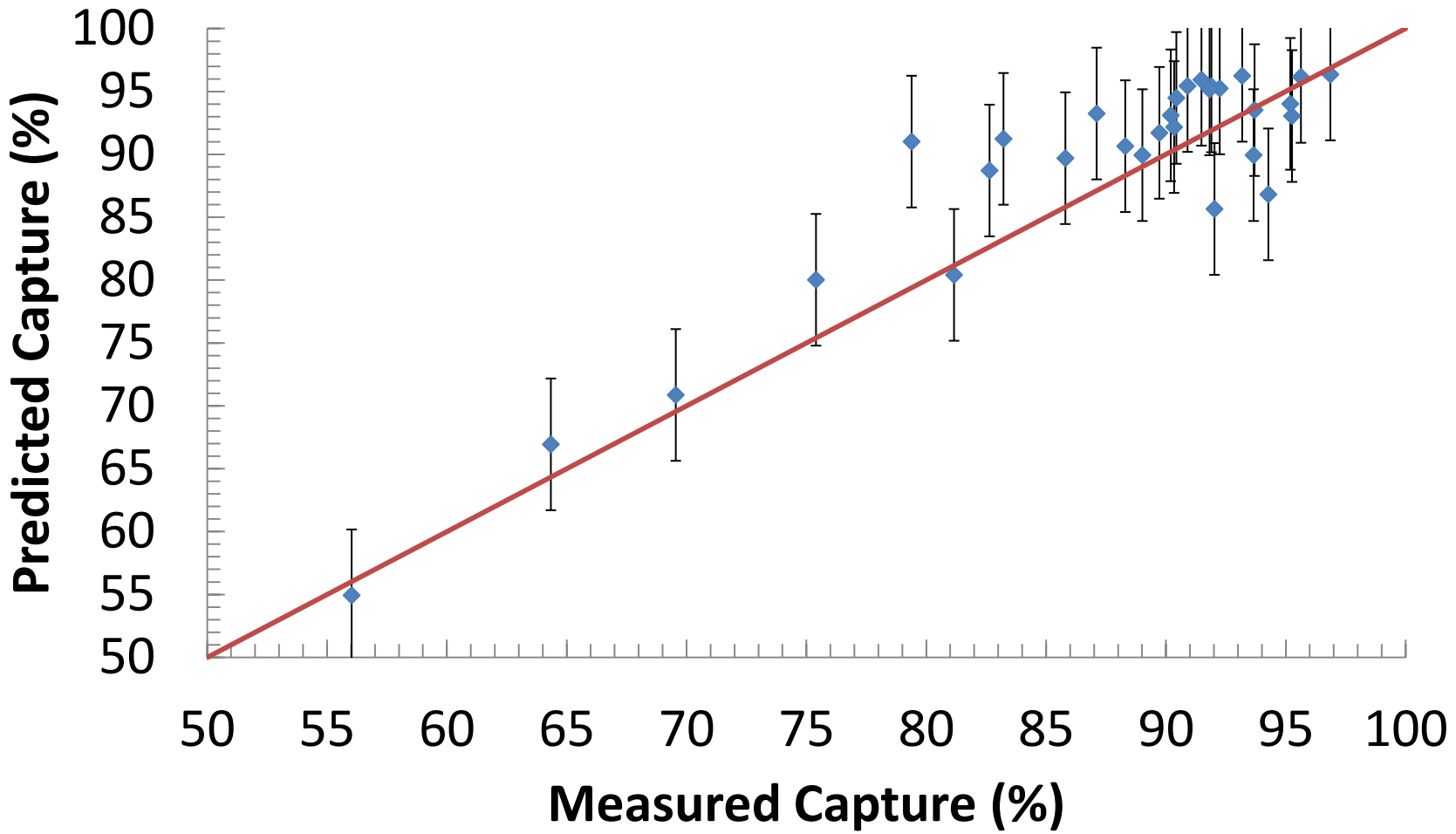
Detailed Analyses



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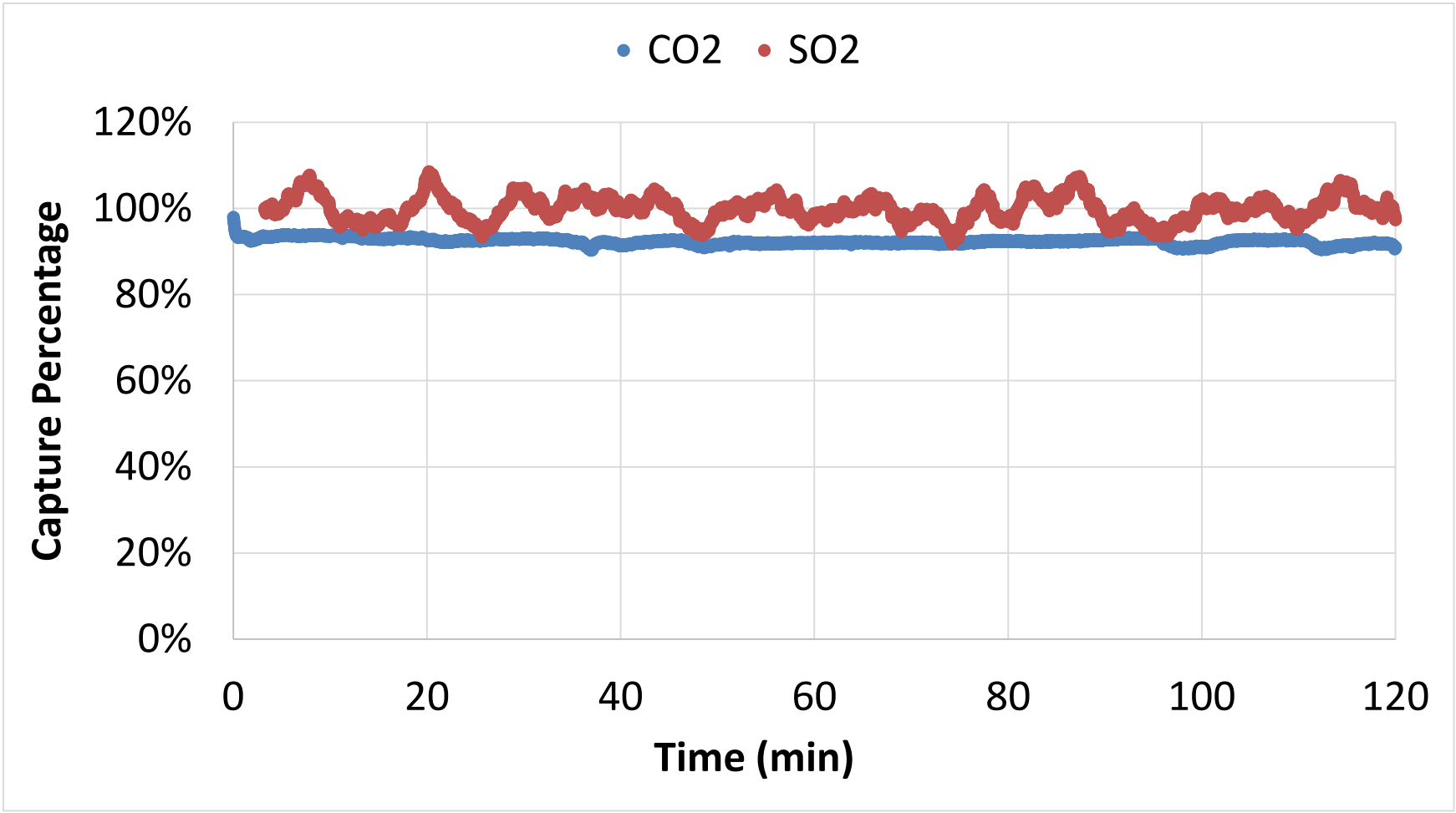
Multipollutant Capture



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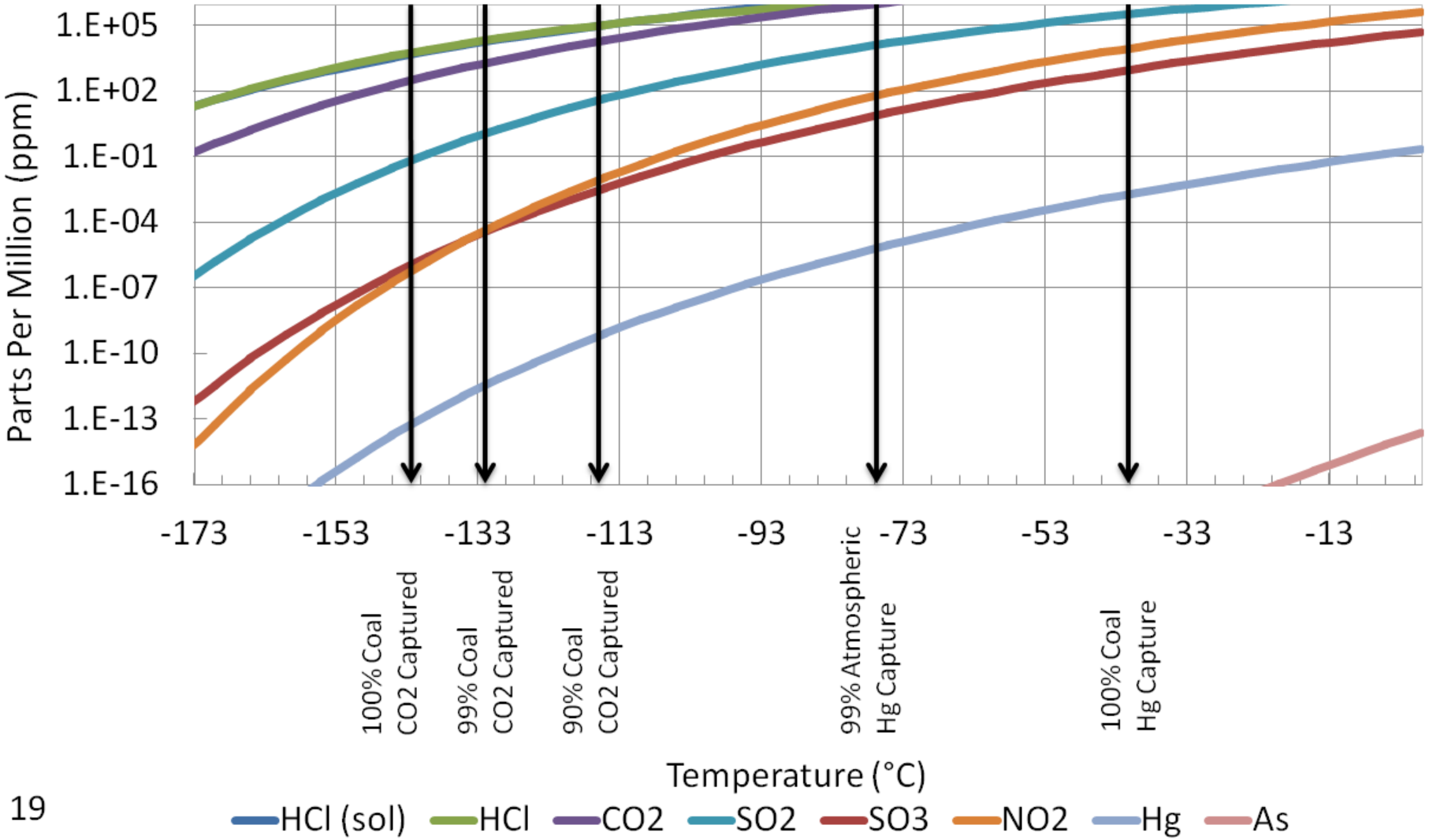
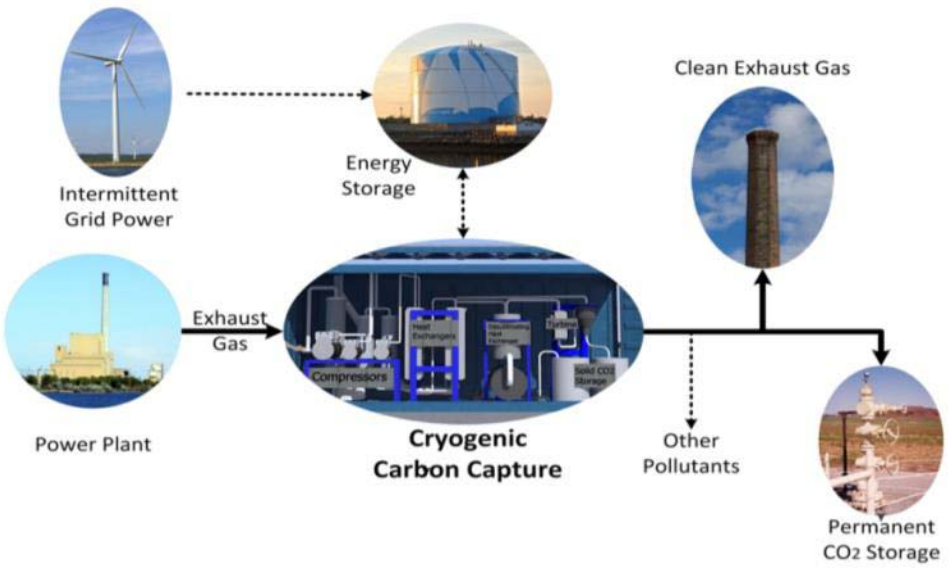
Thermodynamic Pollutant Levels



Energy Storage Grid Integration

- Core technology is CCC
- The ECL variant of CCC allows for energy storage to drive the CCC process
- Energy will be stored as a cryogenic liquid
  - 100's of MW capacity
- Rapid response time
- Roundtrip efficiency is greater than 90%



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Demonstration Cost and footprint

	ECL Skid	CFG Skid	Proposed Pilot
Flowrate (scfm)	100	25	2000-6000
kW Equivalent	60	15	1000-3000
Footprint	40' x 8'	20' x 8'	40' x 40'
Equipment Cost	$2 M	$1.2 M	$31 M

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Conclusions

CCC advantages

- Energy consumption (<50% NETL case 12)
- Cost increase (<50% NETL case 12)
- Efficient at high capture
- Bolt-on, common-platform technology
- Multi-pollutant capabilities meeting NSPS criteria for most pollutants (Hg, SO_2, SO_3, NO_2, PM_{xx}, HCl)
- Water conservation
- Energy storage is very promising!

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Acknowledgements

- DOE/Arpa-e, DOI, Dong Energy, State of Wyoming, CCEMC
- American Air Liquide (Dave Hasse, Dave Edwards), GE Global Research (Vitali Lissianski)
- Sustainable Energy Solutions
  - Larry Baxter (BYU), Chris Bence, Dave Frankman, Andrew Baxter, Stephanie Burt, Chris Hoeger, Allyson Frankman, Aaron Sayre, Eric Mansfield, Skyler Chamberlain
- BYU
  - Mark Jensen, Brad Nielson, Brad Meldrum, Ruochen Wu, Farhad Fazlollahi

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