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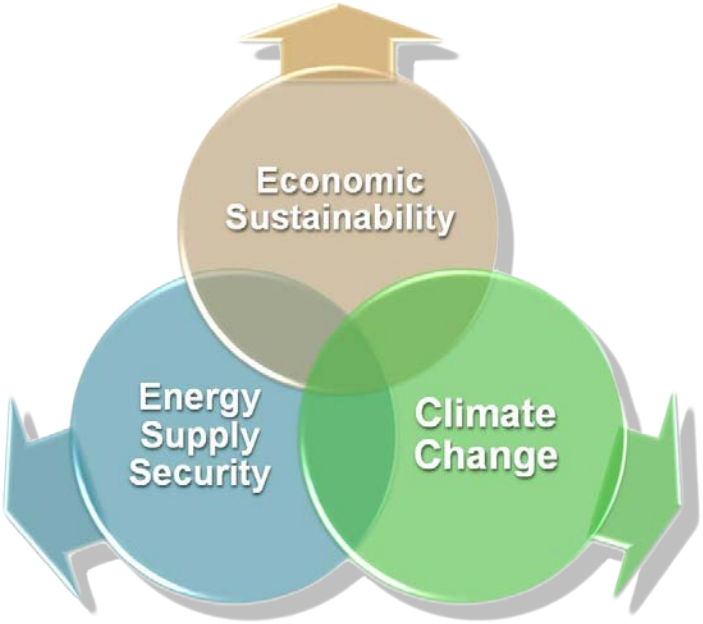

Life Cycle Results from the IGCC LCI&C Study

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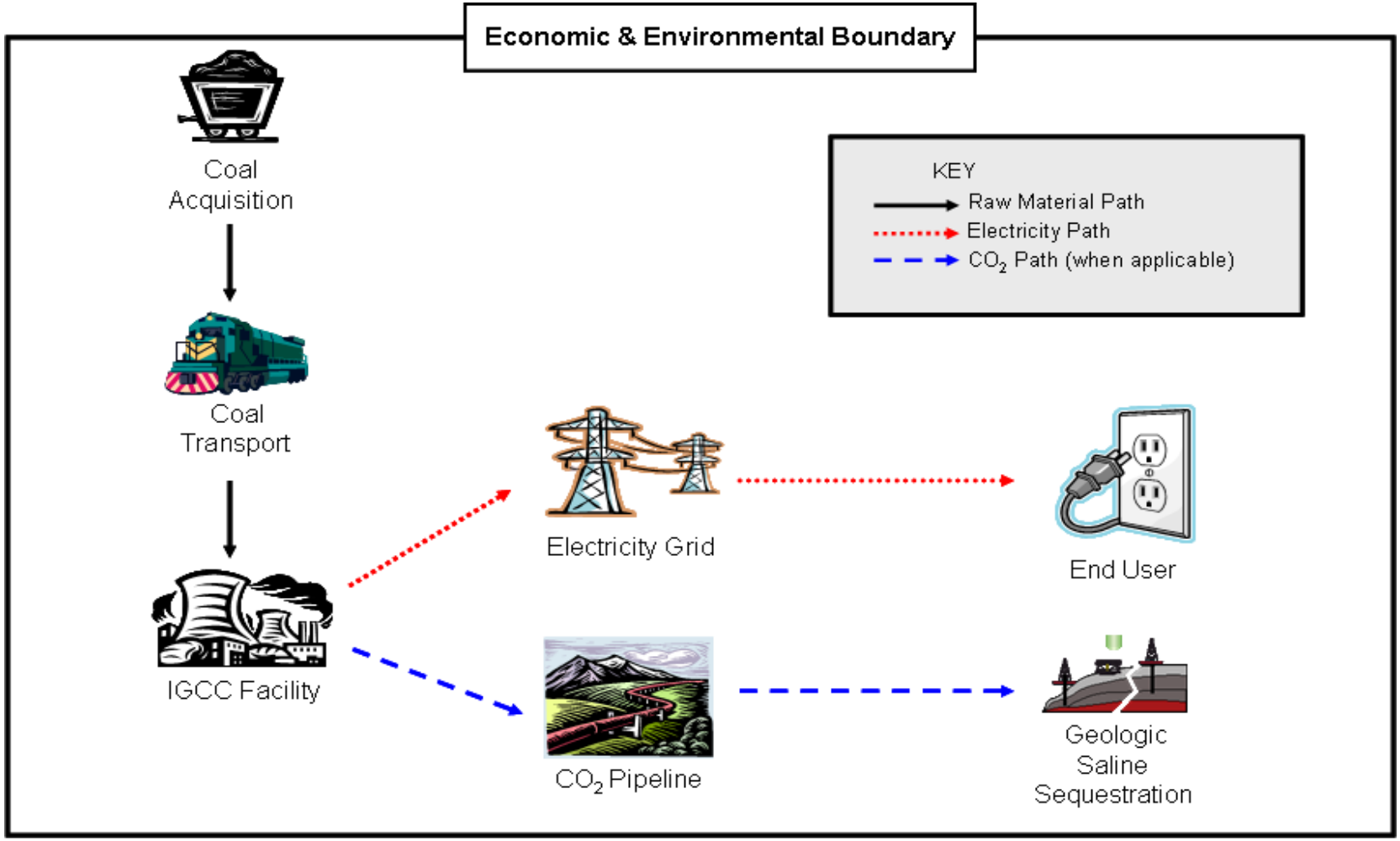
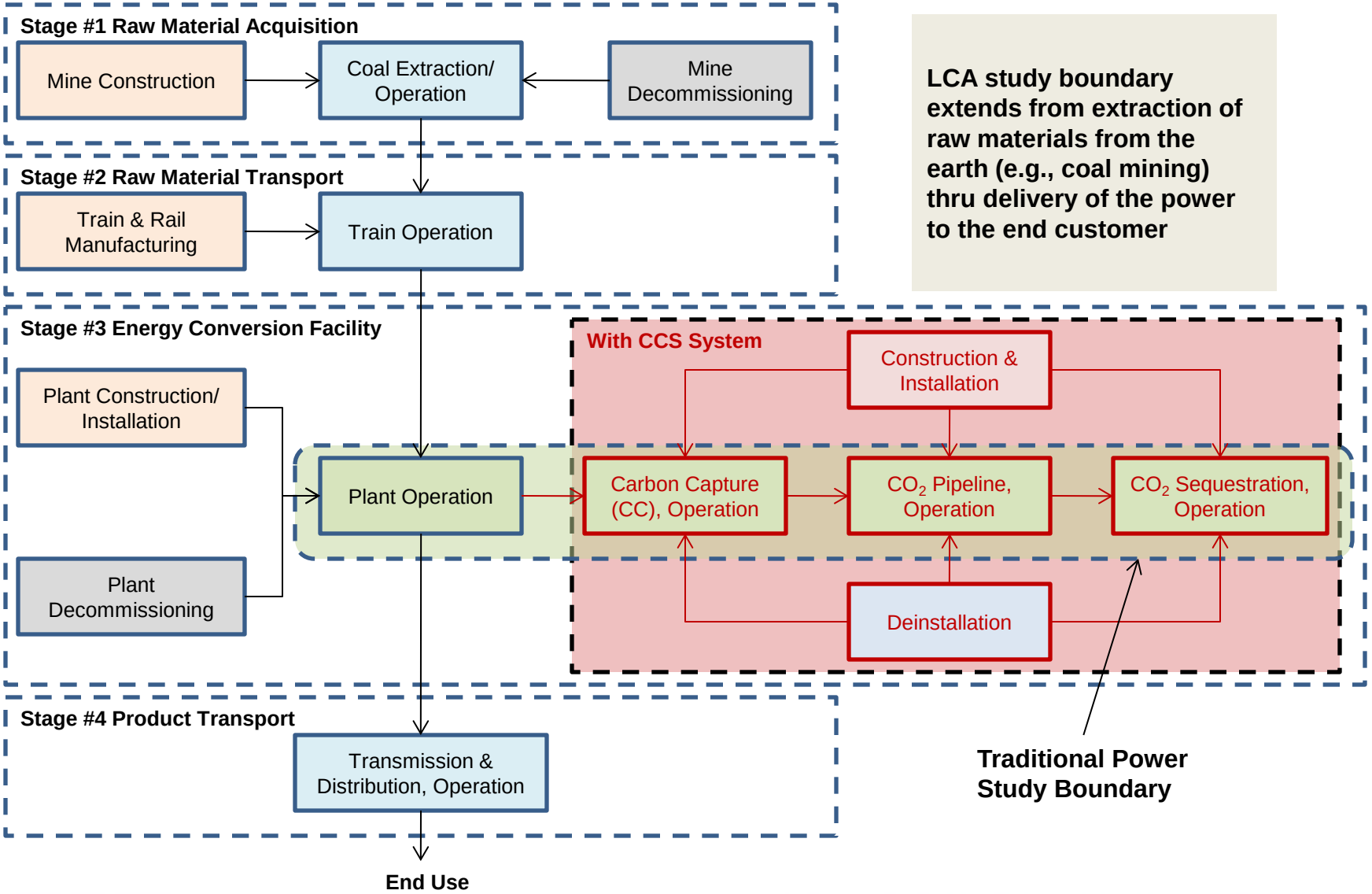
Conceptual Study Boundary

Integrated Gasification Combined Cycle (IGCC)

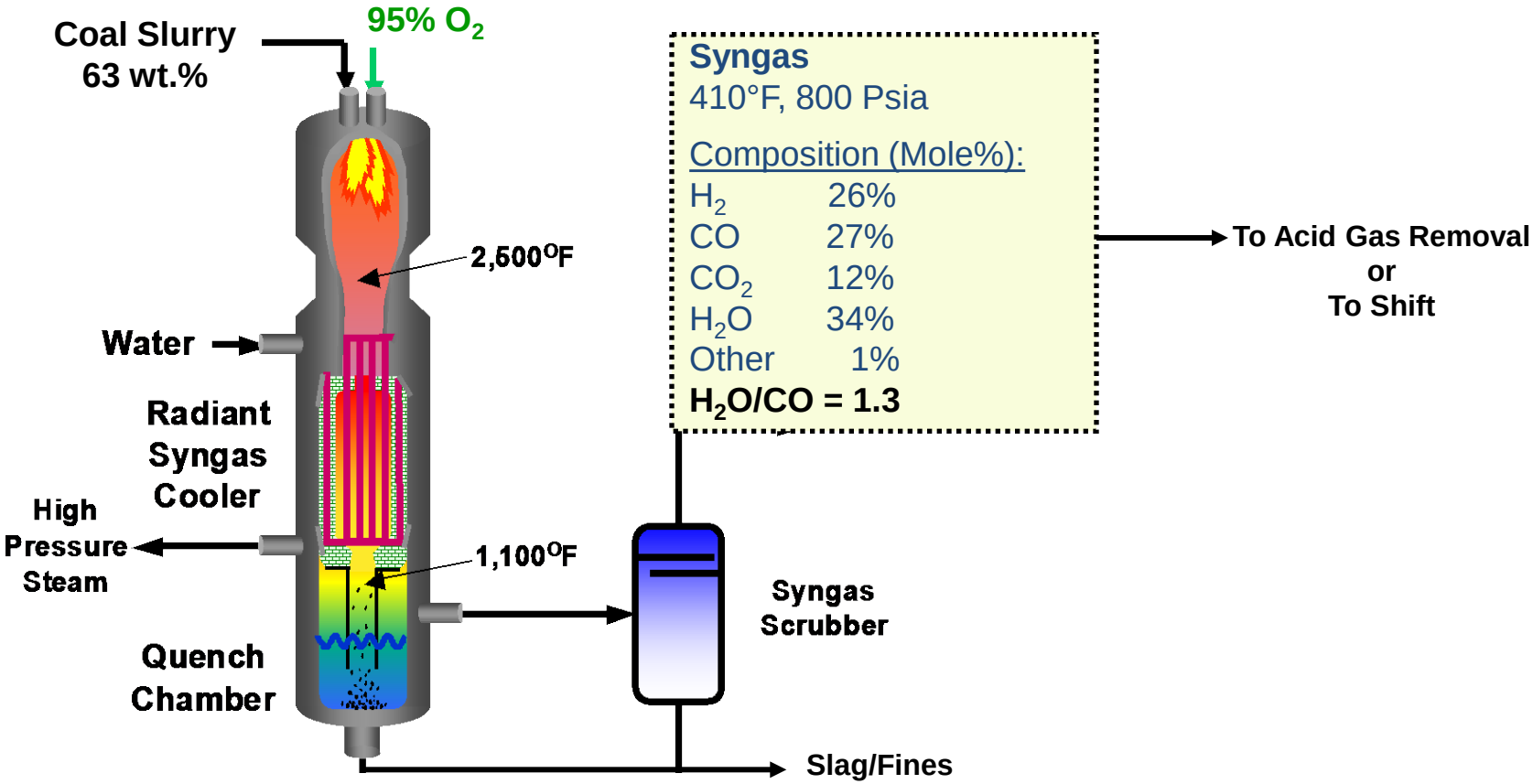


LCA's Expanded Boundary for IGCC



LCA study boundary extends from extraction of raw materials from the earth (e.g., coal mining) thru delivery of the power to the end customer

GE Energy Radiant



Design: Pressurized, single-stage, downward firing, entrained flow, slurry feed, oxygen blown, slagging, radiant and quench cooling

Note: All gasification performance data estimated by the project team to be representative of GE gasifier

Cost and Performance Baseline for Fossil Energy Plants, NETL August 2007

Study Scenarios

Parameters	wo-CCS	w-CCS
Net Power Output (MW)	622	543
Emissions Normalizing Basis (MW)	622	543
Information Source	IGCC LCI&C	IGCC LCI&C

Key Modeling Assumptions

Parameters	IGCC
Study Boundary Assumptions	
Temporal Bounday (Years)	30
Cost Boundary	Overnight
LC Stage #1: Raw Material Acquisition	
Extraction Location	Southern Illinois
Feedstock	Ill. #6 Coal
Extraction Method	Underground
C&O Costs	In Delivery Price
LC Stage #2: Raw Material Transport	
One-way transport Distance (Miles)	1170
Rail Spur Length (Miles)	25
Main Rail/Pipeline Length (Miles)	Pre-Existing
Unit Train Infrastructure C&O Costs	In Delivery Price

Key Modeling Assumptions (Cont.)

Parameters	Ex. PC
LC Stage #3: Energy Conversion Facility	
Location	Southern Mississippi
Net Output (MW)	622
Net Output w-CCS (MW)	543
Trunk line Constructed Length (Miles)	50
Capacity Factor	80%
CCS CO_2 Capture Percentage	90%
CO_2 Pipeline Pressure (psia)	2215
CO_2 Pipeline Length (Miles)	100
CO_2 Loss Rate	1% / 100 yrs
LC Stage #4: Product Transport	
Transmission Line Loss	7%
Transmission Grid Construction	Pre-Existing

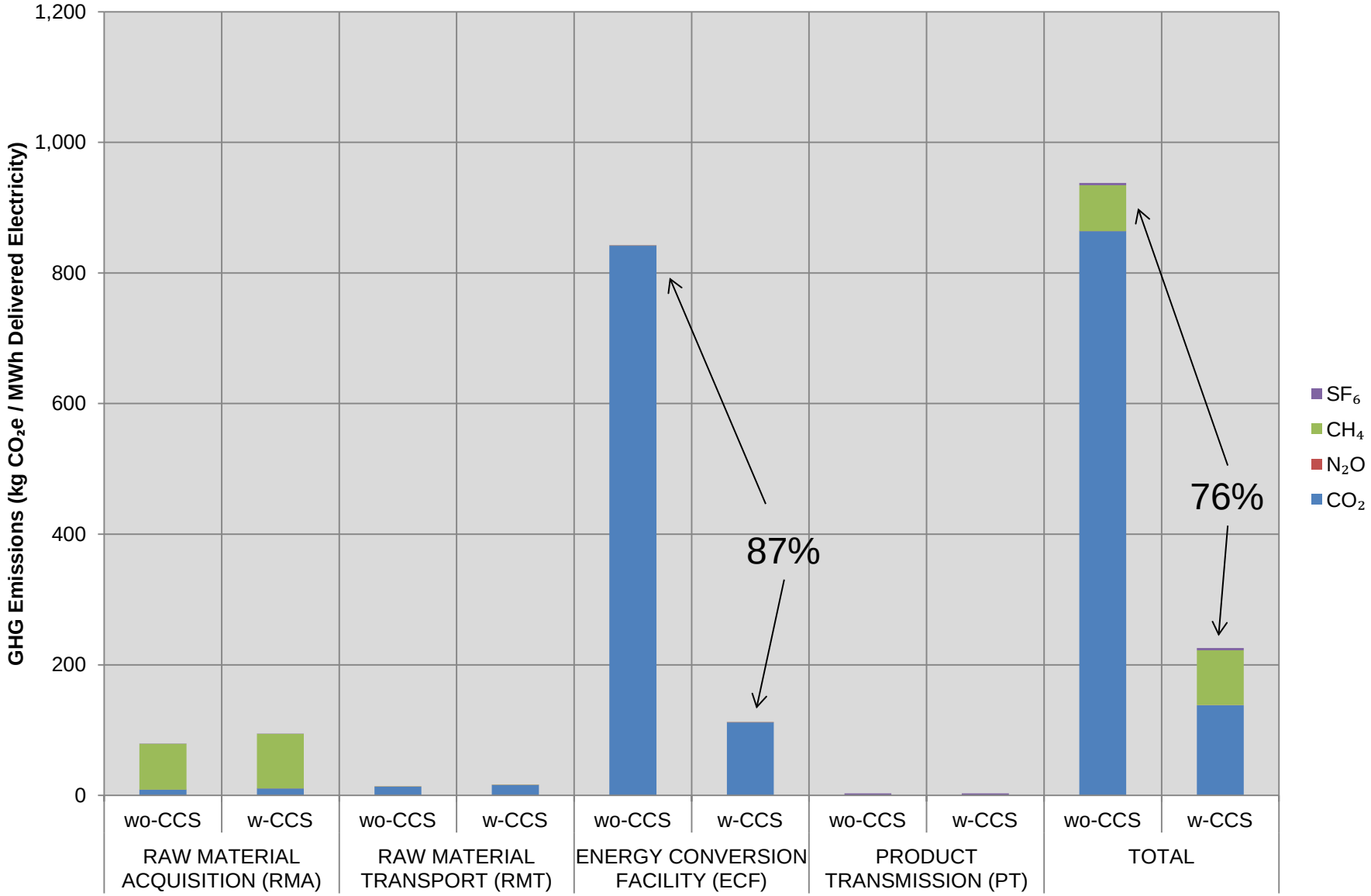
Life Cycle Cost Parameters

Property	Value	Units
Reference Year Dollars	December 2006/ January 2007	Year
Assumed Start-Up Year	2010	Year
Real After-Tax Discount Rate	10.0	Percent
After-Tax Nominal Discount Rate	12.09	Percent
Assumed Study Period	30	Years
MACRS Depreciation Schedule Length	Variable	Years
Inflation Rate	1.87	Percent
State Taxes	6.0	Percent
Federal Taxes	34.0	Percent
Total Tax Rate	38.0	Percent
Fixed Charge Rate Calculation Factors		
Capital Charge Factor	0.1773	--
Levelization Factor	1.426885	--
Start Up Year (2010) Feedstock & Utility Prices	**$2006 Dollars**	**Units**
Natural Gas	6.76	$/MMBtu
Coal	1.51	$/MMBtu
Process Water	0.00049 (0.0019)	$/L ($/gal)

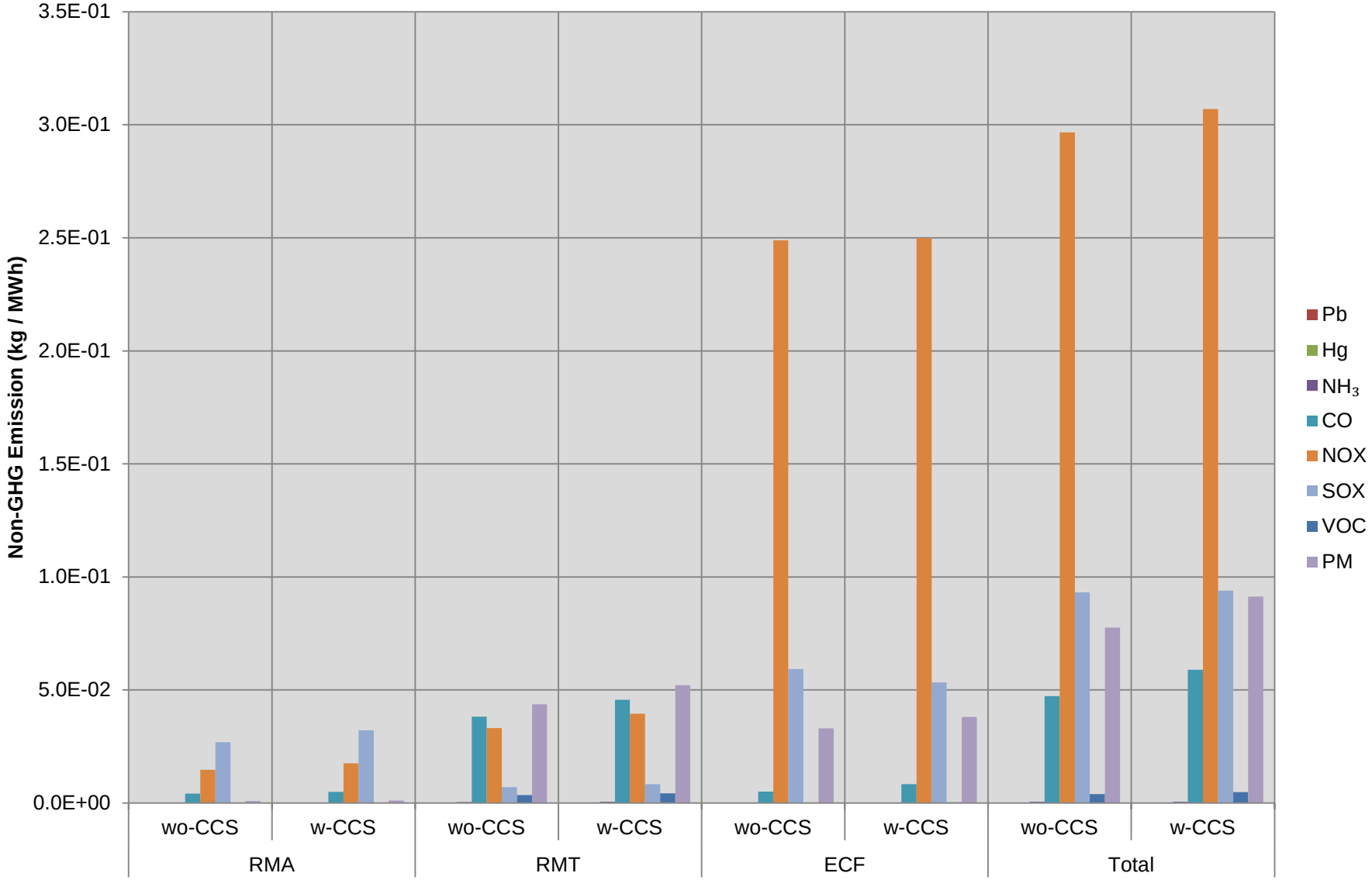
Emissions Performance

- **GHG Emissions** (2007 IPCC CO_2e Values, 100 Year basis)
  - Carbon Dioxide (CO_2)
  - Methane (CH_4)
  - Nitrous Oxide (N_2O)
  - Sulfur Hexafluoride (SF_6)
- **Water Usage**
  - Withdrawal
  - Consumption
- **Non-GHG Emissions**
  - Criteria Air Pollutants
    - Carbon Monoxide (CO)
    - Nitrogen Oxides (NOX)
    - Sulfur Oxides (SOX)
    - Volatile Organic Compounds (VOC)
    - Particulate Matter (PM)
    - Lead (Pb)
  - Species of Interest
    - Ammonia (NH_3)
    - Mercury (Hg)

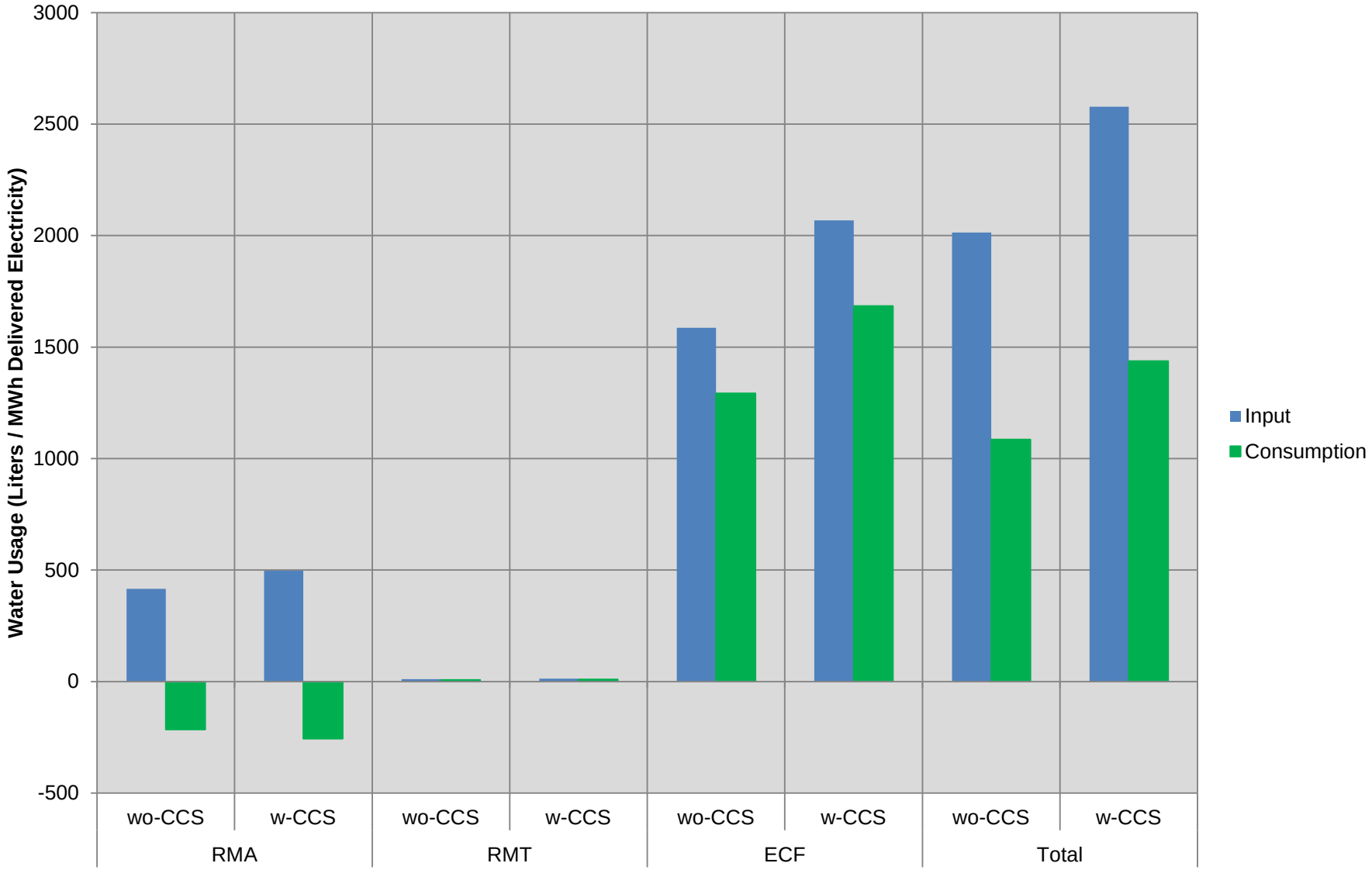
GHG Emissions



Non-GHG Air Emissions



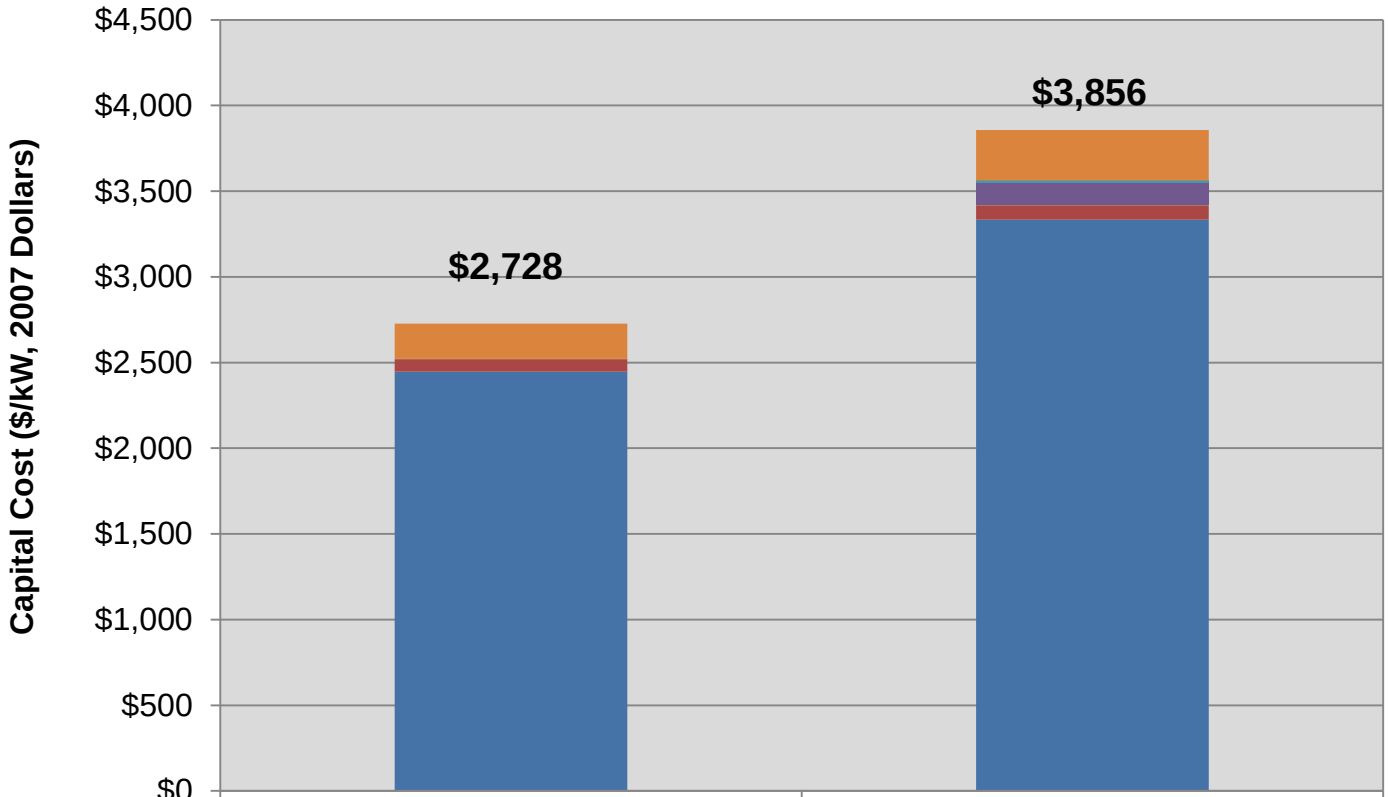
Water Usage


Water Usage (Liters / MWh Delivered Electricity)
3000
2500
2000
1500
1000
500
0
-500
wo-CCS
w-CCS
wo-CCS
w-CCS
wo-CCS
w-CCS
wo-CCS
w-CCS
RMA
RMT
ECF
Total
Input
Consumption

LCA Inventory Results Recap

Emission Type	Species	RMA		RMT		ECF		PT		TOTAL	
		wo-CCS	w-CCS	wo-CCS	w-CCS	wo-CCS	w-CCS	wo-CCS	w-CCS	wo-CCS	w-CCS
GHG (kg CO_2e / MWh)	CO_2	8.82	10.53	13.29	15.87	841.88	111.61	0.00	0	863.99	138.01
	N_2O	0.04	0.05	0.10	0.11	0.01	0.01	0.00	0	0.14	0.18
	CH_4	70.08	83.70	0.17	0.21	0.11	0.13	0.00	0	70.37	84.04
	SF_6	4.0E-02	4.7E-02	7.1E-07	8.5E-07	8.2E-03	9.2E-03	3.27	3	3.32	3.32
	Total	78.98	94.33	13.56	16.20	842.01	111.76	3.27	3.27	937.81	225.56
Non-GHG (kg / MWh)	Pb	2.4E-07	2.8E-07	8.7E-08	1.0E-07	1.3E-05	1.6E-05			1.3E-05	1.7E-05
	Hg	1.6E-07	2.0E-07	7.8E-09	9.4E-09	2.6E-06	3.0E-06			2.8E-06	3.2E-06
	NH_3	1.9E-05	2.3E-05	4.8E-04	5.7E-04	2.2E-06	3.5E-06			5.0E-04	5.9E-04
	CO	4.1E-03	5.0E-03	3.8E-02	4.6E-02	5.0E-03	8.3E-03			4.7E-02	5.9E-02
	NO_X	1.5E-02	1.8E-02	3.3E-02	4.0E-02	2.5E-01	2.5E-01			3.0E-01	3.1E-01
	SO_X	2.7E-02	3.2E-02	7.0E-03	8.4E-03	5.9E-02	5.3E-02			9.3E-02	9.4E-02
	VOC	1.3E-04	1.6E-04	3.6E-03	4.3E-03	2.6E-04	3.7E-04			4.0E-03	4.8E-03
	PM	8.8E-04	1.0E-03	4.4E-02	5.2E-02	3.3E-02	3.8E-02			7.8E-02	9.1E-02
Water Usage (Liter / MWh)	Input	416.3	497.2	10.4	12.5	1587.0	2068.6			2013.7	2578.2
	Consumption	-214.7	-256.5	7.7	9.2	1292.4	1684.5			1085.4	1437.2

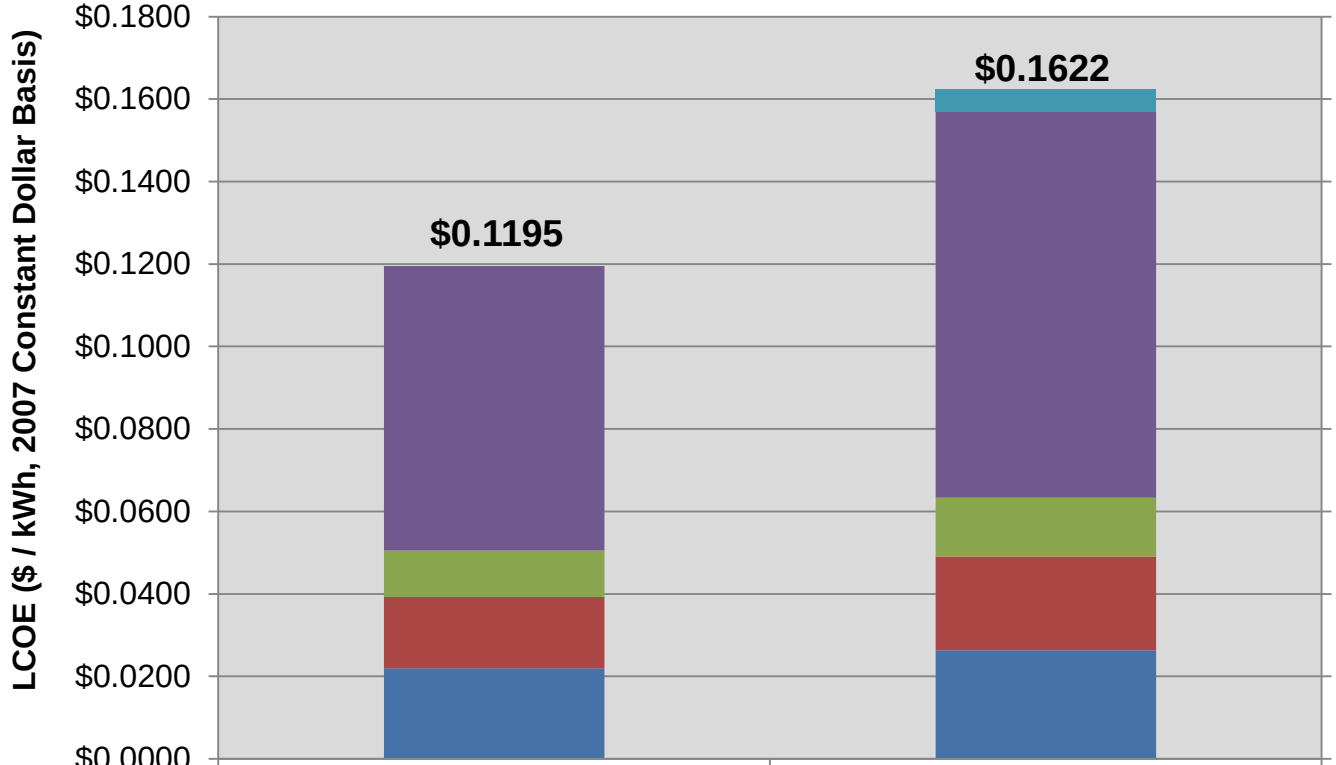
Capital Costs



	wo-CCS	w-CCS
Decommissioning	$206	$295
Sequestration Site	$0	$14
CO2 Pipeline	$0	$127
Switchyard	$2	$2
Trunkline	$73	$84
Capital Costs	$2,446	$3,334
Total LC Plant Cost	$2,728	$3,856

LCOE

2007 $'s



	wo-CCS	w-CCS
CO2 T, S & M	$0.0000	$0.0053
Capital Costs	$0.0690	$0.0936
Variable O&M Costs	$0.0112	$0.0143
Labor Costs	$0.0173	$0.0227
Utility + Feedstock Costs	$0.0220	$0.0263
Total LC LCOE	$0.1195	$0.1622

Key Findings

- **GHG Emissions**
  - Coal-bed methane – 89% of RMA GHG Emission
  - CO_2
    - 98% of Transport GHG
    - 99% of ECF GHG
  - A 90% CCS equates to 76% reduction in LC GHG
- **Non-GHG Emissions**
  - NOx – Dominant RMA emission
  - RMT - PM from fugitive dust, CO and Nox
  - NOx - Largest emission component from the ECF and the total LC

Key Findings (Cont.)

- **Water Usage**
  - RMA - net production at mine
    - Due to stormwater and mine runoff
  - RMT- Minimal usage
  - ECF - Primary user
    - 79% to 80% of input
  - The Total water input is ~30% larger than the ECF input
  - Total Consumption is lower than ECF consumption
    - Due to the offset seen from the RMA stage

Key Findings (Cont.)

- **Capital Costs**
  - Capital Equipment costs are the largest component
    - 86 – 90% of overall Capital Cost
  - CCS – Increases CC 41%
- **LCOE**
  - Capital costs – 57% of the LCOE
  - Utility costs – +19% with CCS
  - Labor and Variable O&M – +31% and +28% change with CCS, respectively
  - LCOE – +36% with CCS

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