

Post-Combustion Capture

Carbon Capture and Storage: Key Issues and Challenges

The Edison Foundation

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MIT

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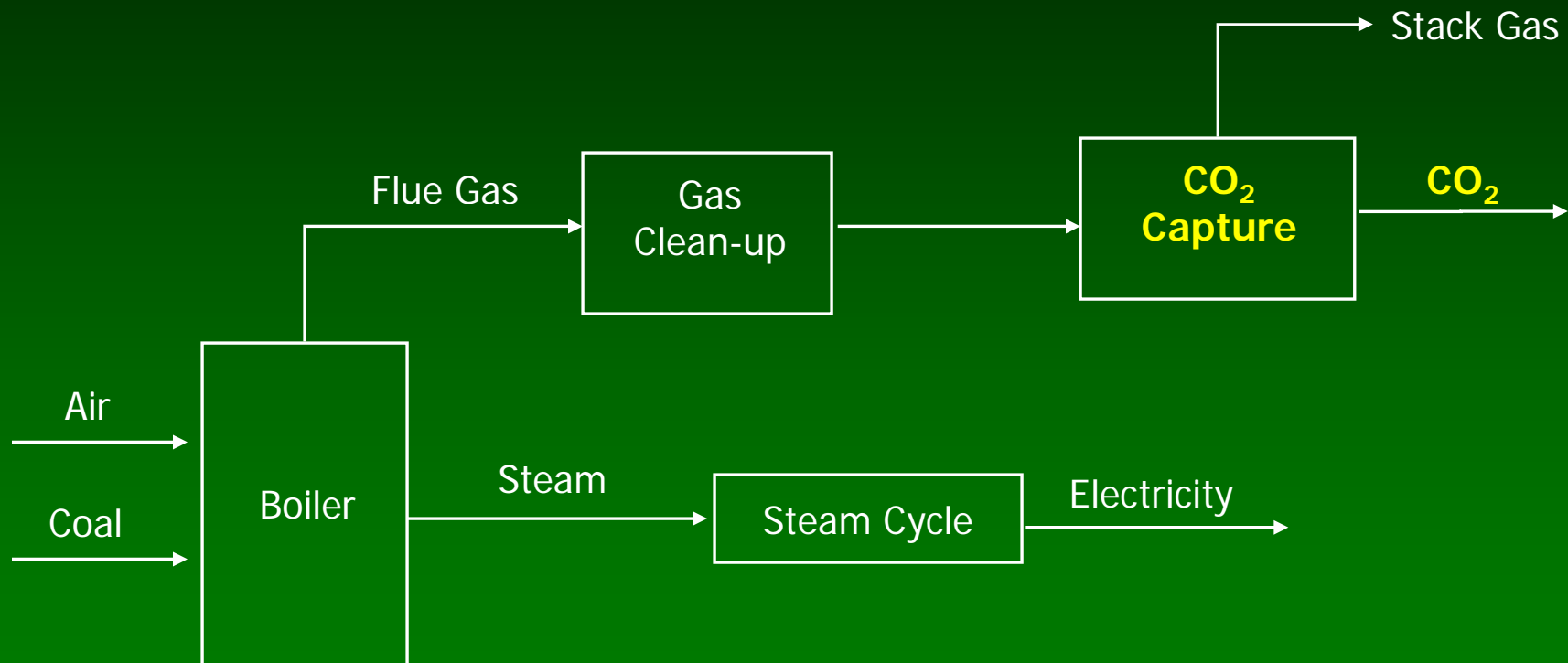
Outline

- Motivation
- Post-Combustion Capture Primer
- Ways Forward
 - Improved Solvents
 - Beyond Solvents

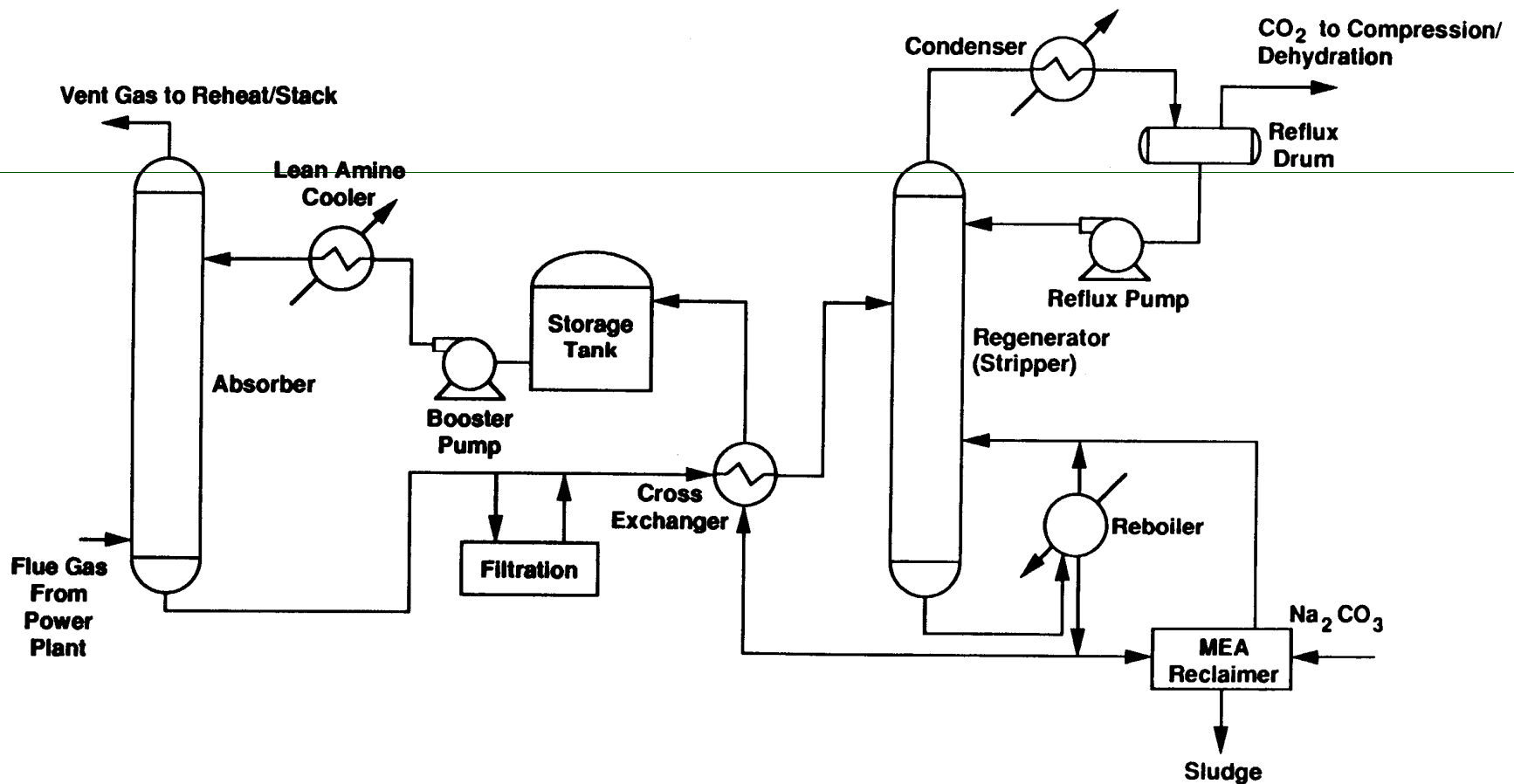
Post-Combustion Capture: More than an Afterthought

- Compatible with existing coal infrastructure
 - No change in basic combustion technology
 - Offers good retrofit opportunities
- Leading candidate today for gas-fired power plants
- Slow progress of IGCC
- Offers flexibility – e.g., can operate without capture as a peaking unit

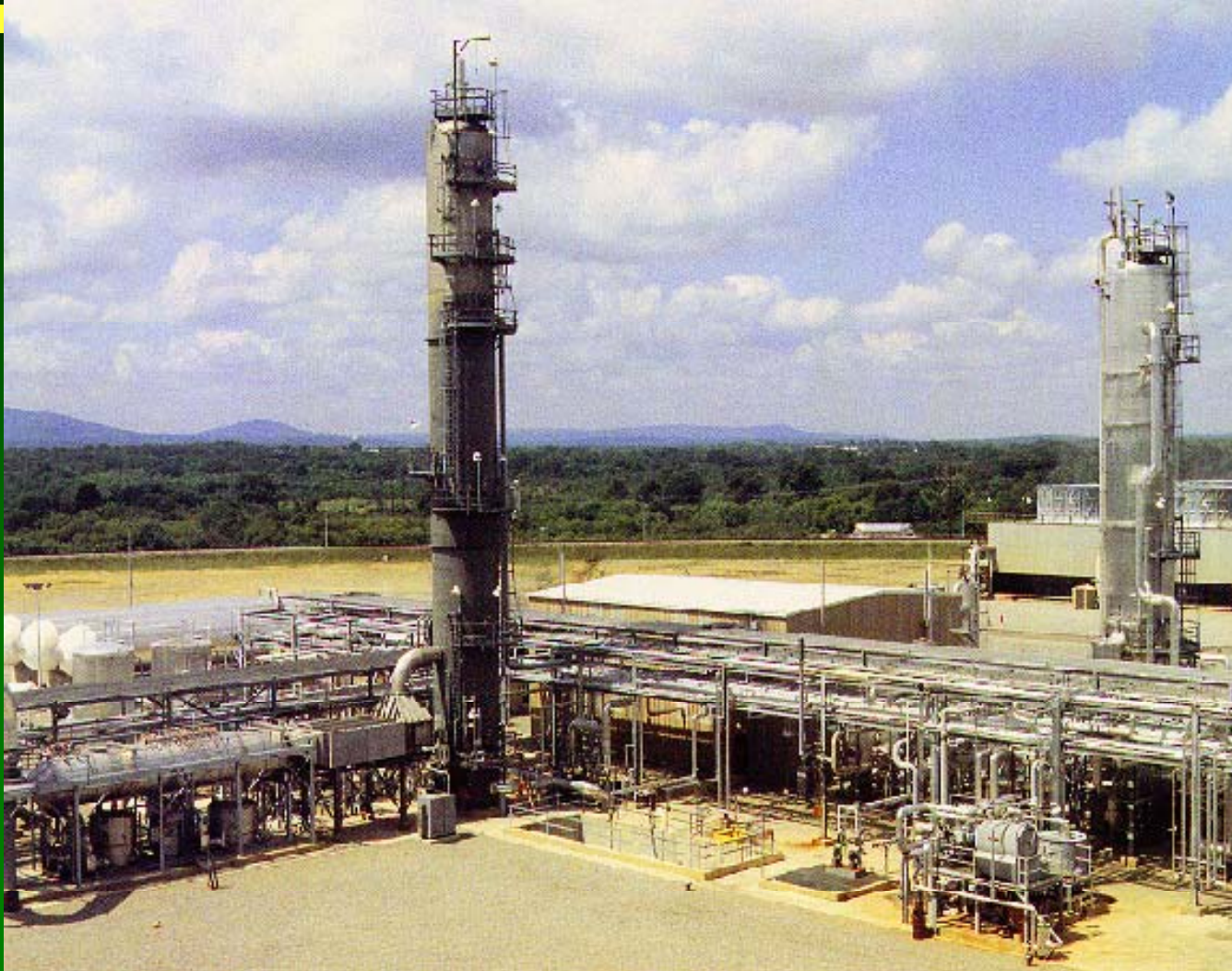
Post-Combustion Capture



Schematic of Amine Process for CO₂ Capture



CO₂ Capture at a Power Plant



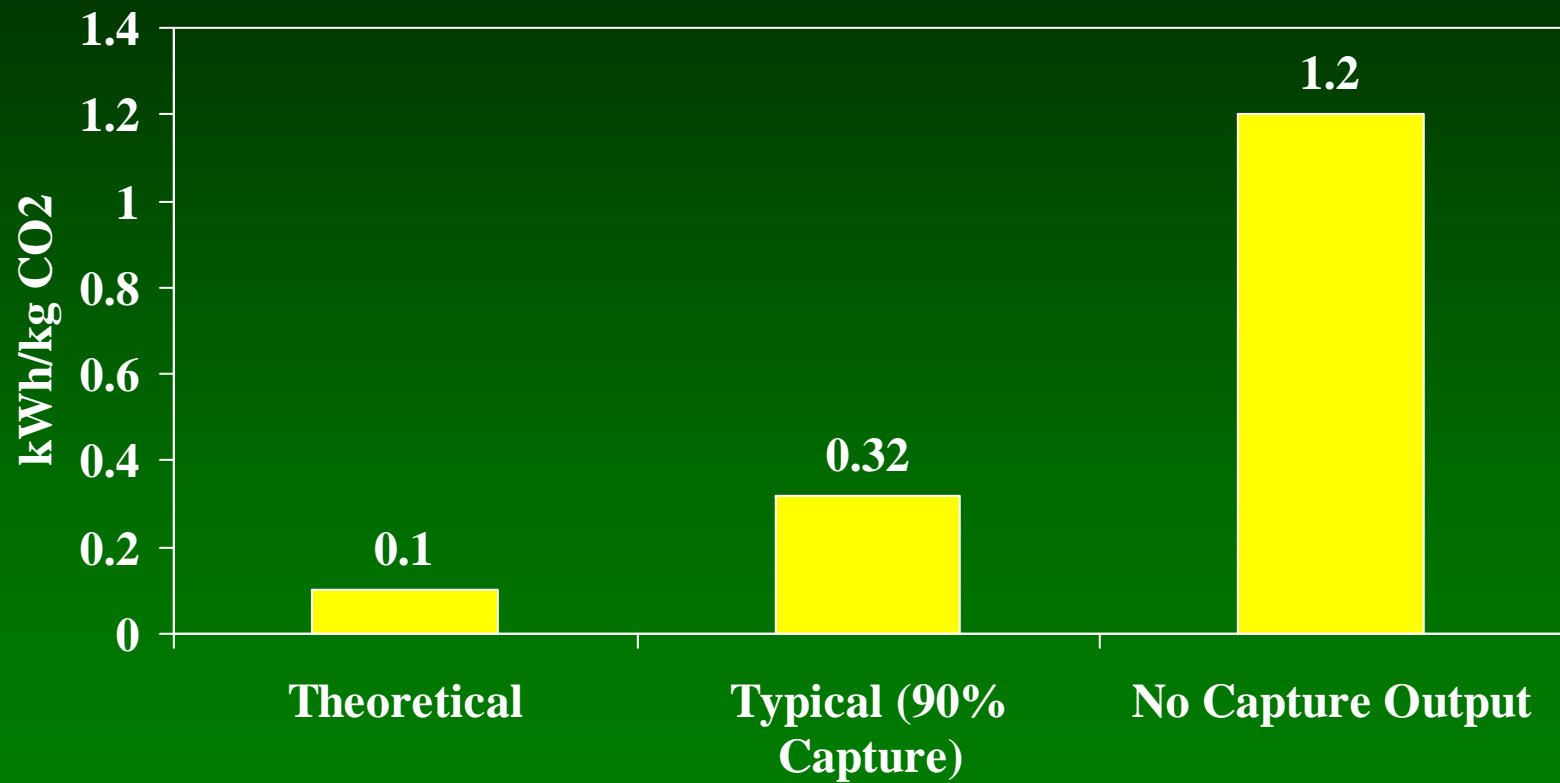
Source: ABB Lummus

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Capture and Compression Capital Costs

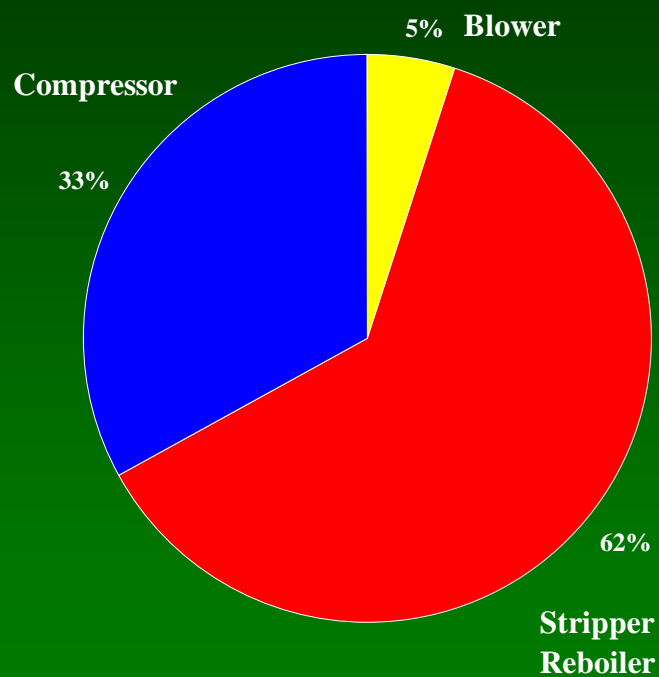
Power Plant	Capture Technology	Capital Investment	Power Output	\$/kW
SCPC	Post-Combustion	+23%	-24%	+62%

Separation Energy

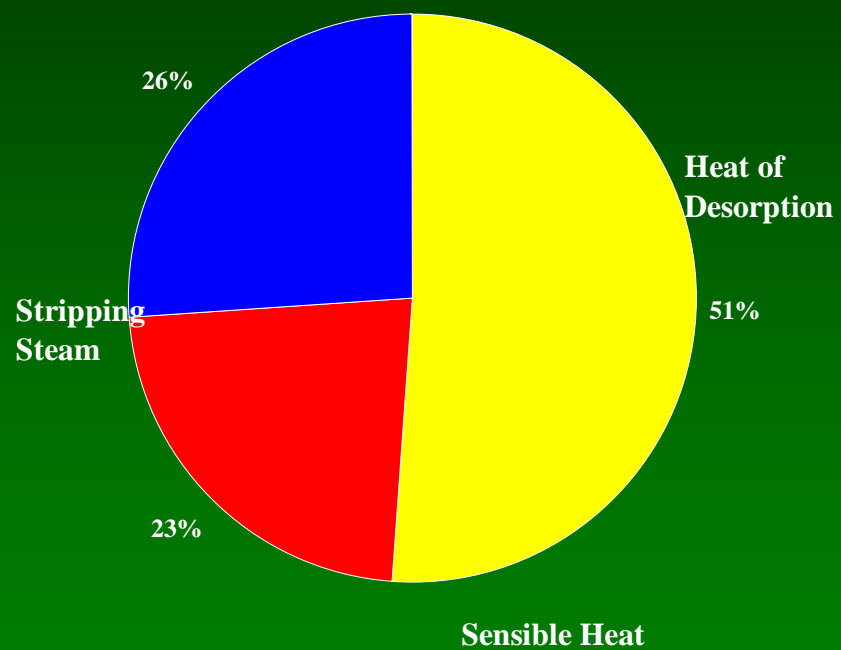


Energy Breakdown

Capture Energy



Stripper Reboiler



Comparing Solvents

- Regeneration Energy
- Solvent Reactivity
- Solvent Characteristics
 - Cost
 - Degradation
 - Volatility
 - Capacity

Improved Solvent Example: Ammonia

	Amine	Ammonia
Regeneration Energy		X
Reactivity	X	
Solvent Characteristics		
Cost		X
Degradation		X
Volatility	X	
Capacity		X

Thoughts on Improved Solvents

- Modest improvements (i.e., 10-20%) highly likely
- Large improvements (>50%) will be very difficult

Beyond Solvents: Stimulus-Responsive Sorbents

- **Definition:** materials that undergo dramatic changes in ordering (resulting in a large change in capacity for solutes like CO₂) with small changes in energy input
- **Example:** water hydrates (problem is restricted range of operating conditions)
- **Other Materials:** liquid crystals, ionic liquids, metal organic frameworks
- **Stimuli:** electric fields, magnetic fields, light irradiation (solvents use temperature and/or pressure)

Stimulus-Responsive Sorbents: Status

- Relatively little work on-going
- Very early stages of R&D, so commercial products many years away
- Success not guaranteed – challenges include finding materials that can operate in the harsh flue gas environment and at the scale required
- Opportunity – this is a very large, mostly unexplored solution space

Summary

- Best policy for CCS is a balanced portfolio that includes post-, pre-, and oxy- combustion
- Post-combustion capture has some nice features (e.g., compatible with existing marketplace)
- Current focus for post-combustion is improved solvents – will probably lead to modest improvements but probably not a game-changer
- Need to expand research into new areas like Stimulus-Responsive Sorbents

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