

# Evaluation of Potential Cost Reductions from Improved CO<sub>2</sub> Capture Systems

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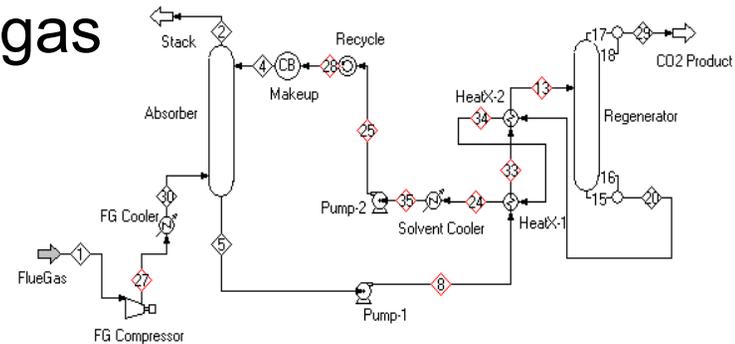
# Motivation

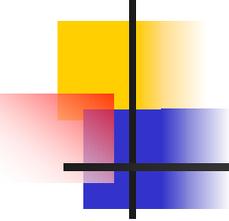
## ■ Amine-based CO<sub>2</sub> capture

- 👍 Effective for power plant flue gas
- 👍 Proven technology
- 👍 Commercially available
- 👎 Energy-intensive process
- 👎 Expensive

## ■ Major R&D efforts worldwide

- To improve the performance and to reduce costs
- Sorbent properties, column design, heat integration issues

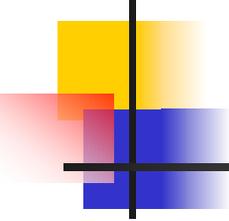




# Objectives

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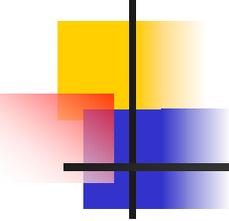
- To identify some of the key parameters that govern the performance and cost of the amine-based CO<sub>2</sub> capture technology
- To understand what experts in this field believe about possible improvements in these parameters (Expert Elicitation)
- To estimate the potential for *future* cost reductions that may result from these process improvements



# Methodology

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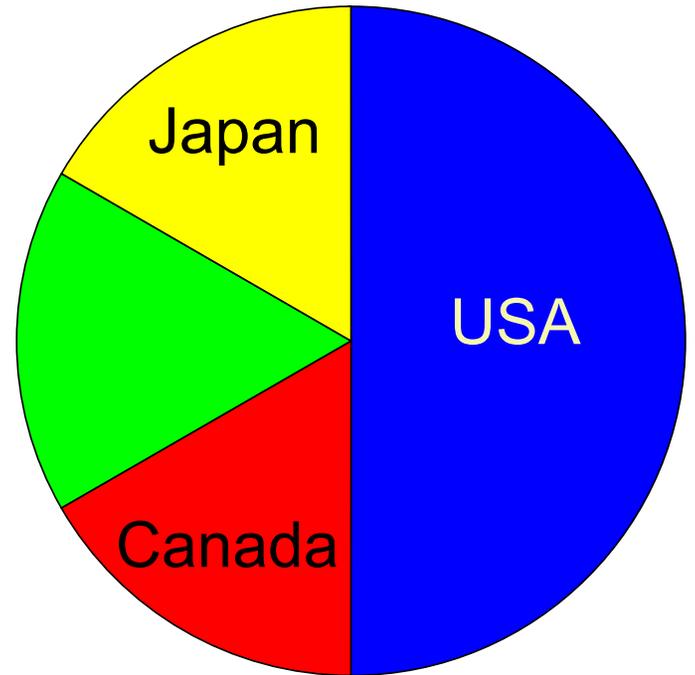
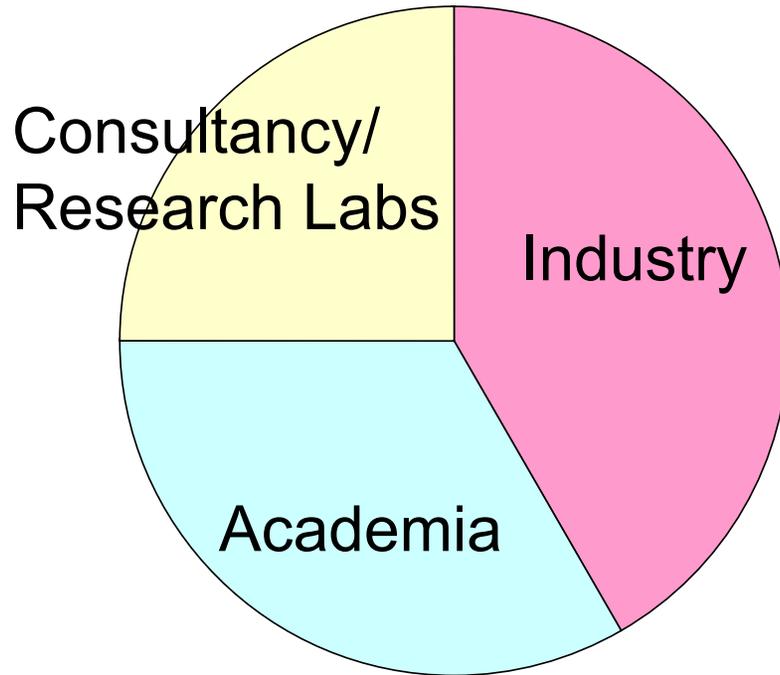
- Formulated detailed questionnaire for experts
- Follow-up interviews (in person or by telephone) and iteration
- Review of compiled responses
- Data analysis and interpretation
- Used responses in IECM-CS model to estimate performance and costs

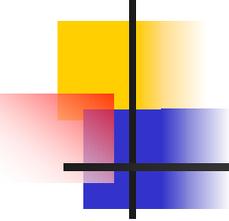


# Experts' Affiliations

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N = 12



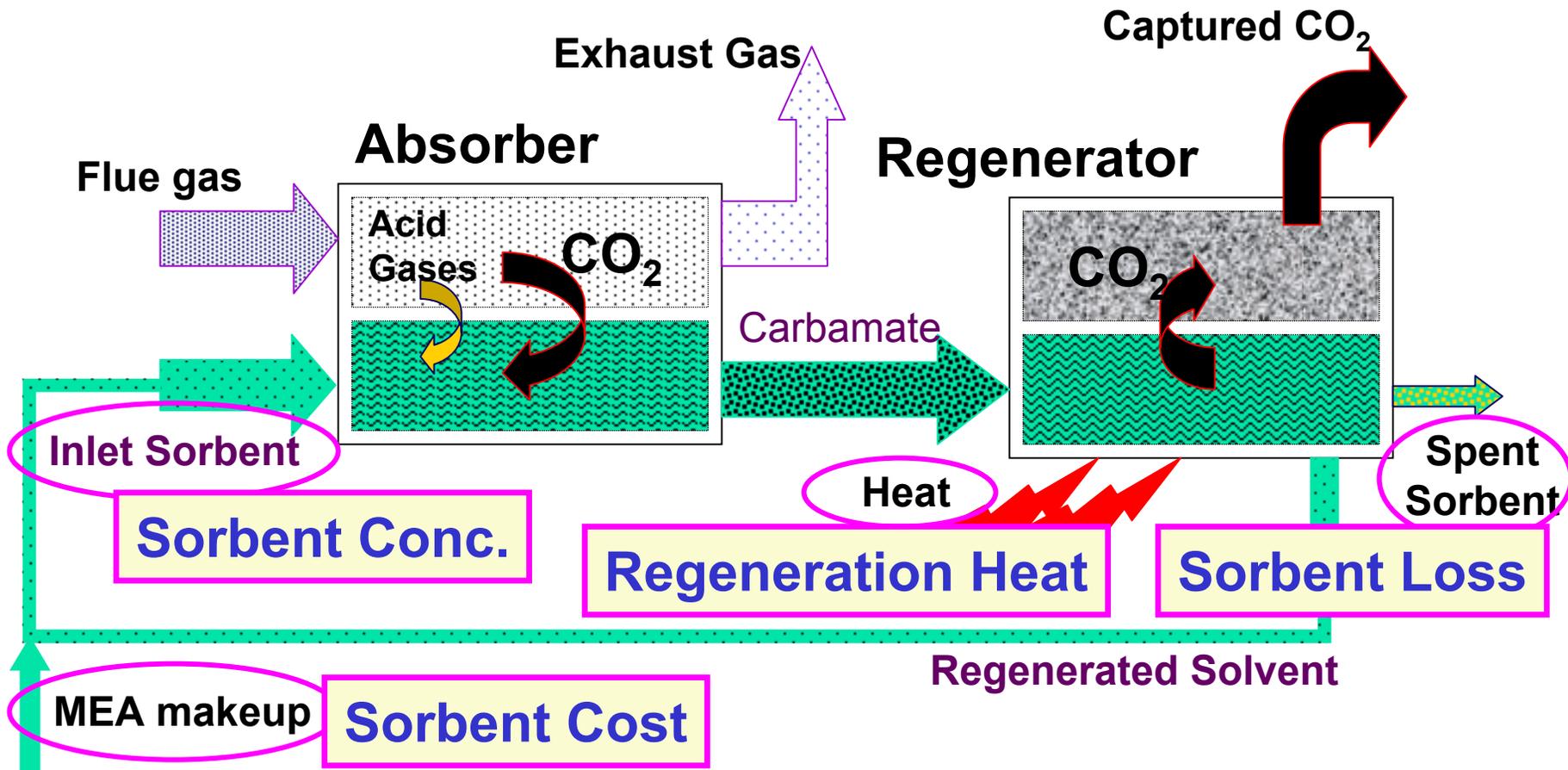


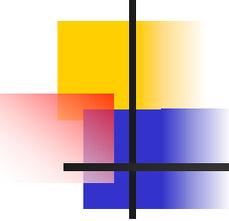
# Questionnaire

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- Parameters analyzed
  - Selected based on insights from a detailed process simulation model

# Amine System for CO<sub>2</sub> Capture





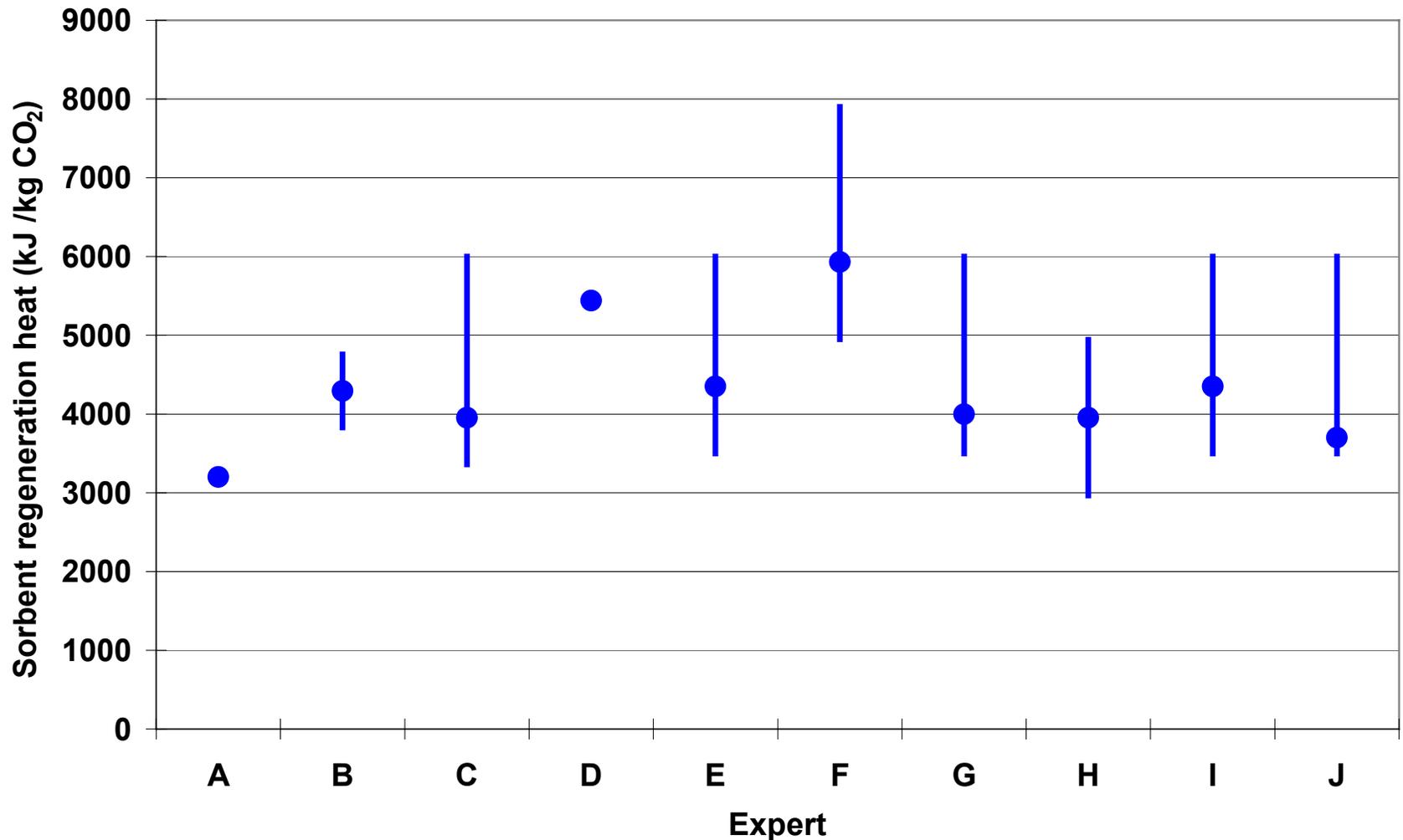
# Questionnaire

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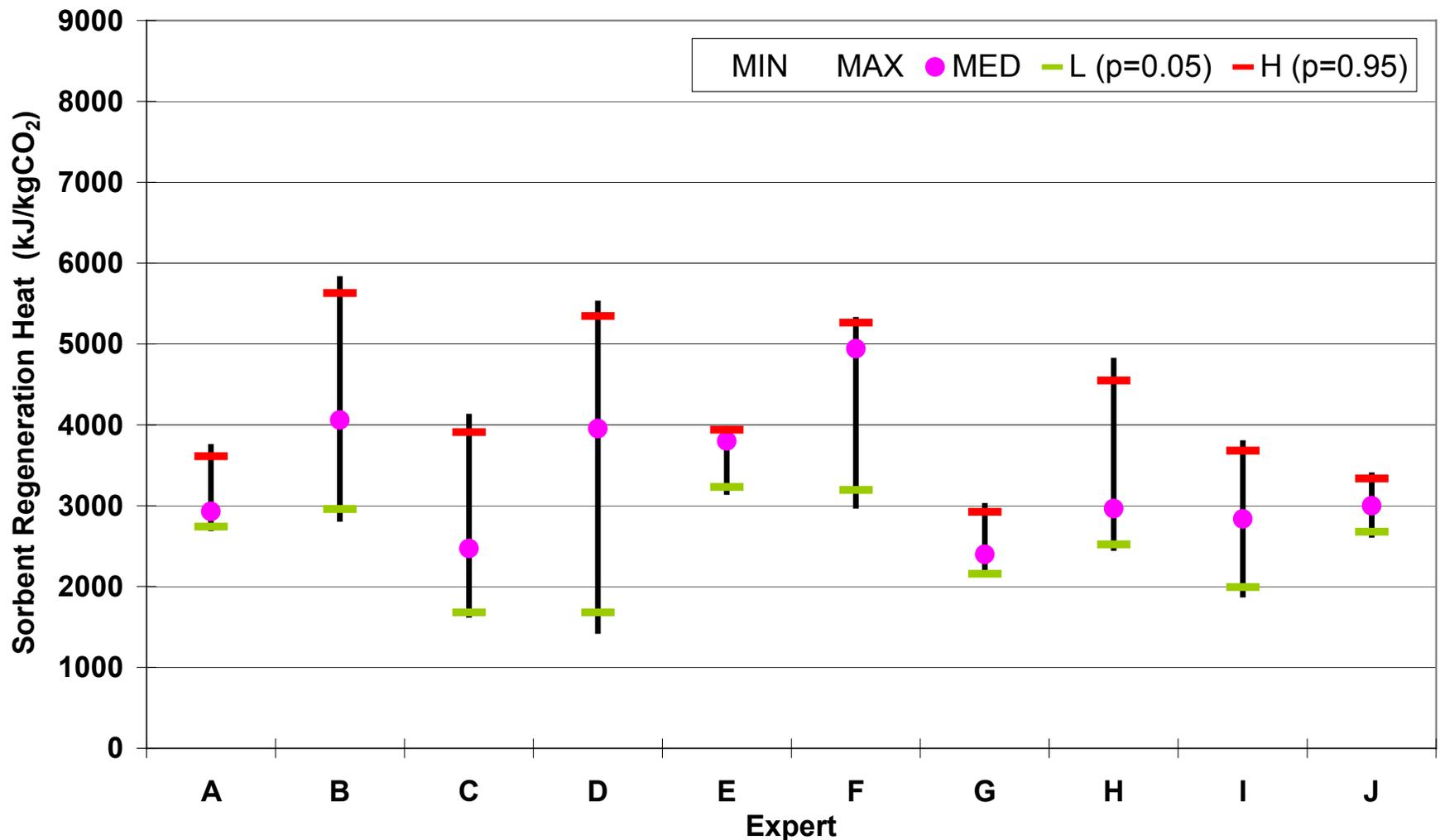
- Parameters analyzed
  - Sorbent concentration
  - Sorbent regeneration heat requirement
  - Sorbent losses
  - Sorbent cost
- Information requested
  - Parameter values for current systems (baseline)
  - Detailed probabilistic judgments about the parameter values for a future (year 2015) system
  - Research priorities

# Summary of responses

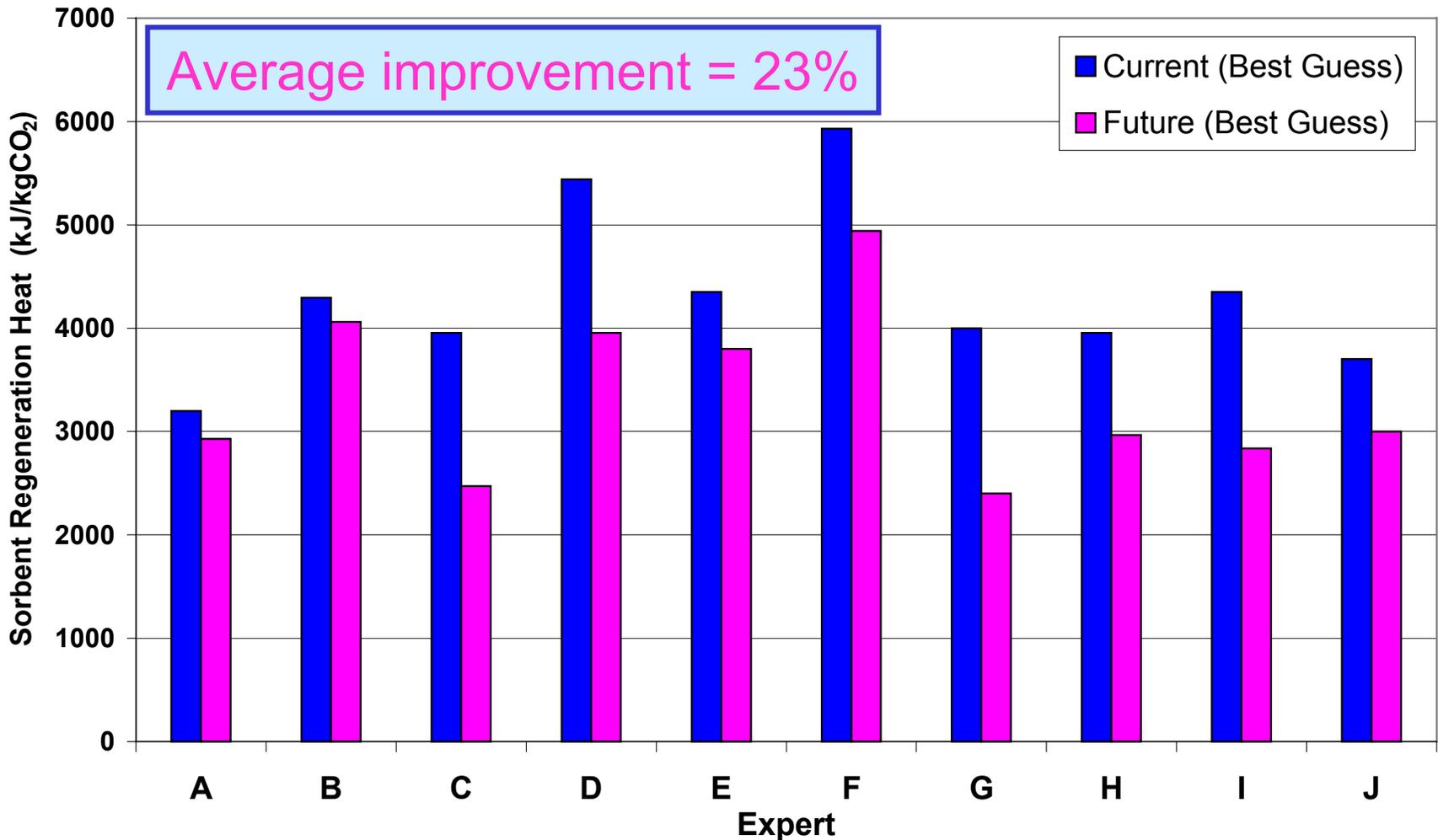
## Sorbent Regeneration Heat: Current Baseline



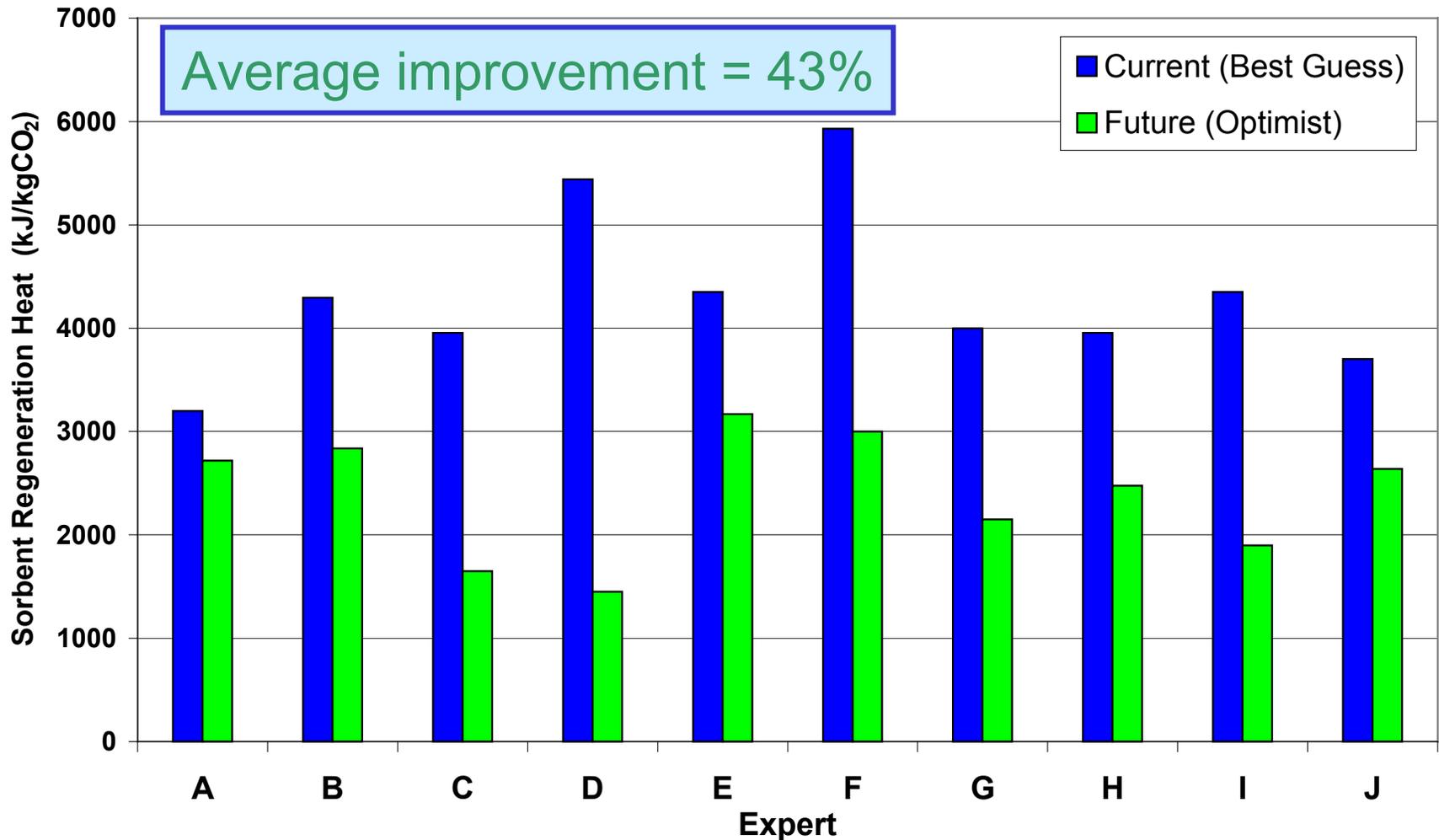
# Summary of responses: Sorbent Regeneration Heat: Future projections



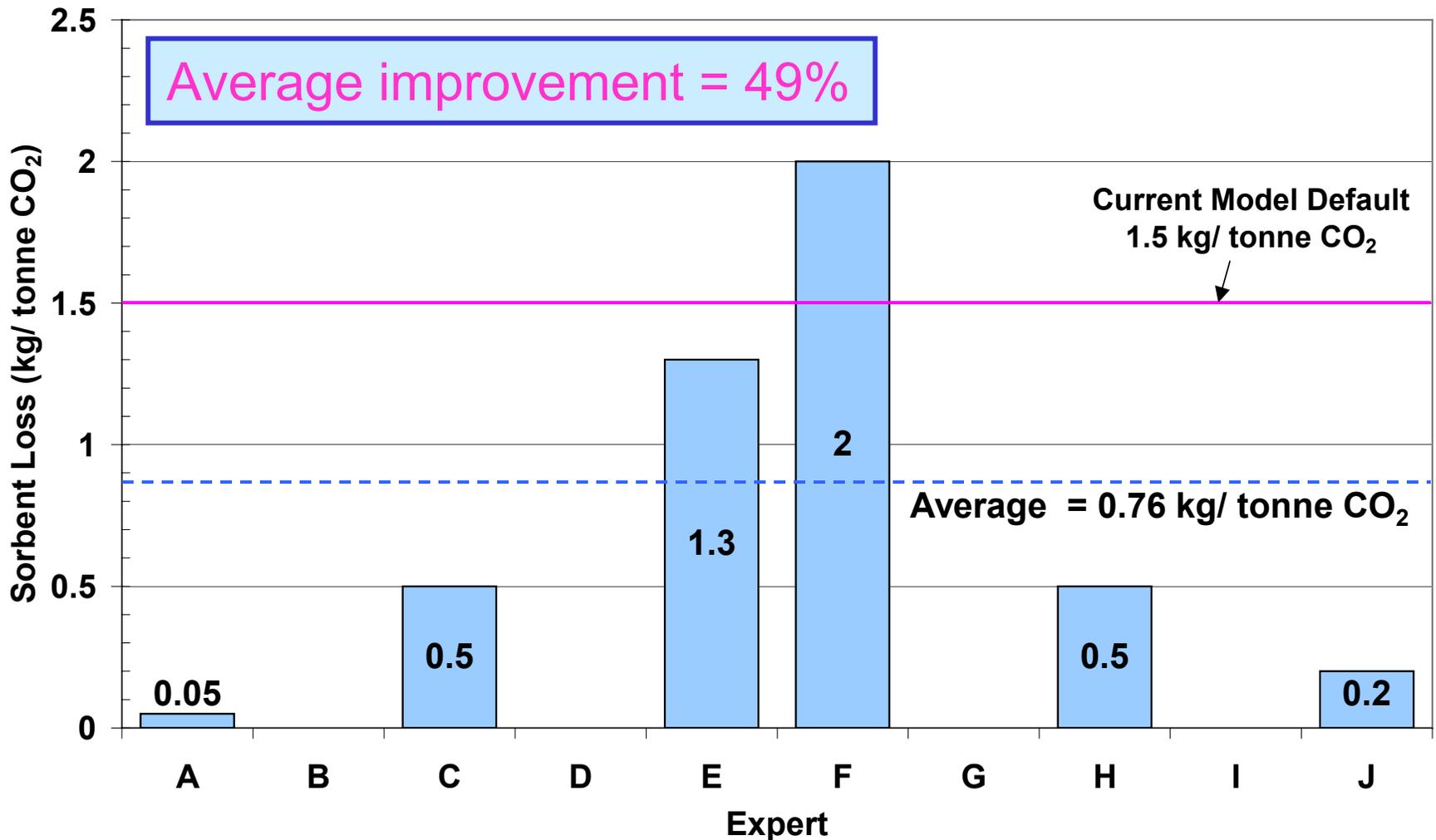
# Sorbent Regeneration Heat: Baseline vs. “Best Guess” Projections



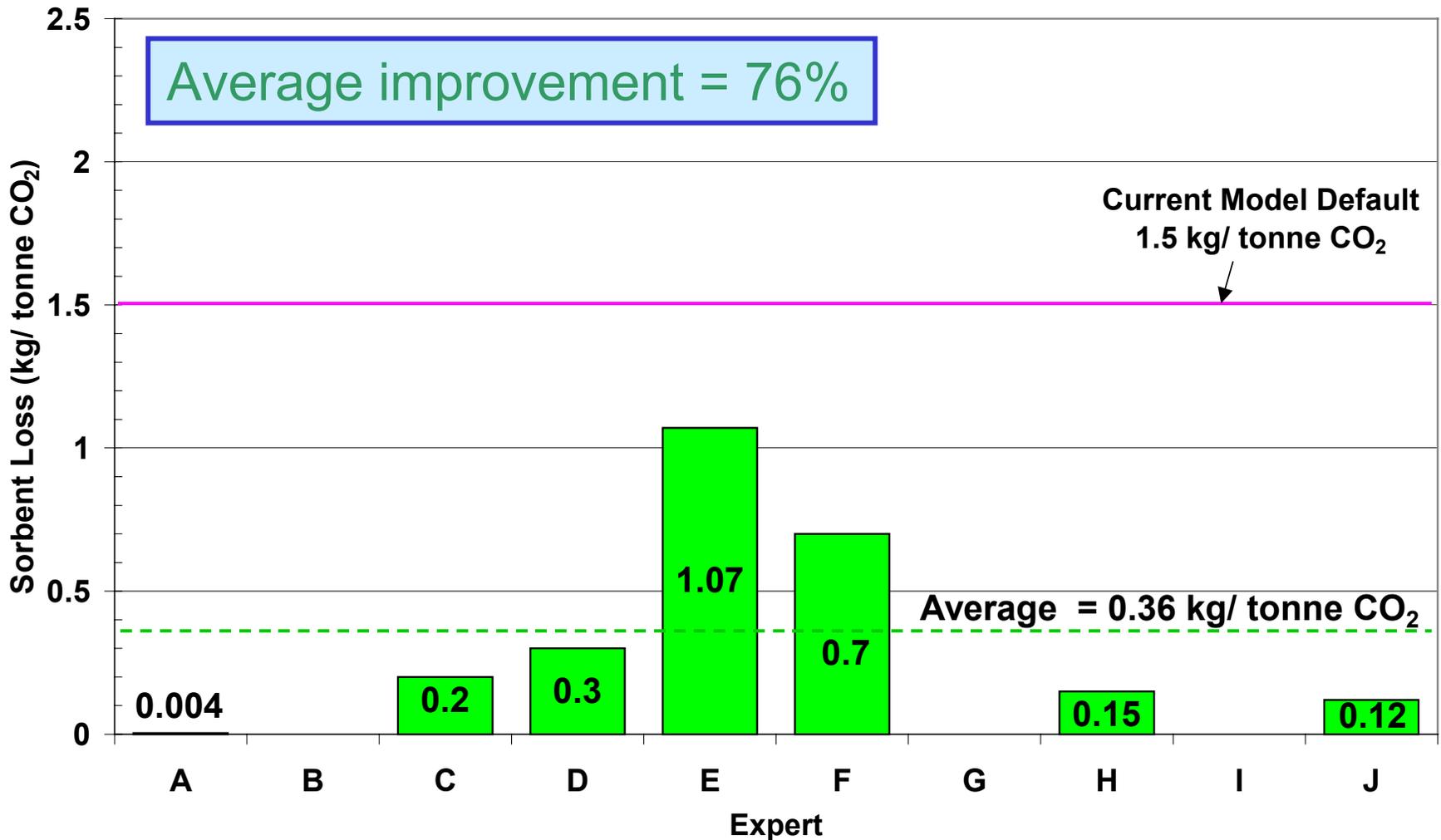
# Sorbent Regeneration Heat: Baseline vs. Most Optimistic Projections



# Expected Improvement in Sorbent Loss: “Best Guess”

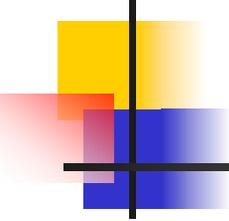


# Expected Improvement in Sorbent Loss: “Most Optimistic”



# Expected Future Improvement : Relative to the Current Baseline

Parameter	Average Improvement Based on	
	Best Guess Values	Optimistic Values
Sorbent Conc. (wt%)	28%	81%
Regeneration Heat (kJ/ kgCO <sub>2</sub> )	23%	43%
Sorbent Loss (kg/ tonne CO <sub>2</sub> )	49%	76%
Sorbent Cost (\$/ tonne sorbent)	(48%)	3%



# How would these improvements affect future costs?

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- Use expert judgment values in the IECM-CS modeling framework

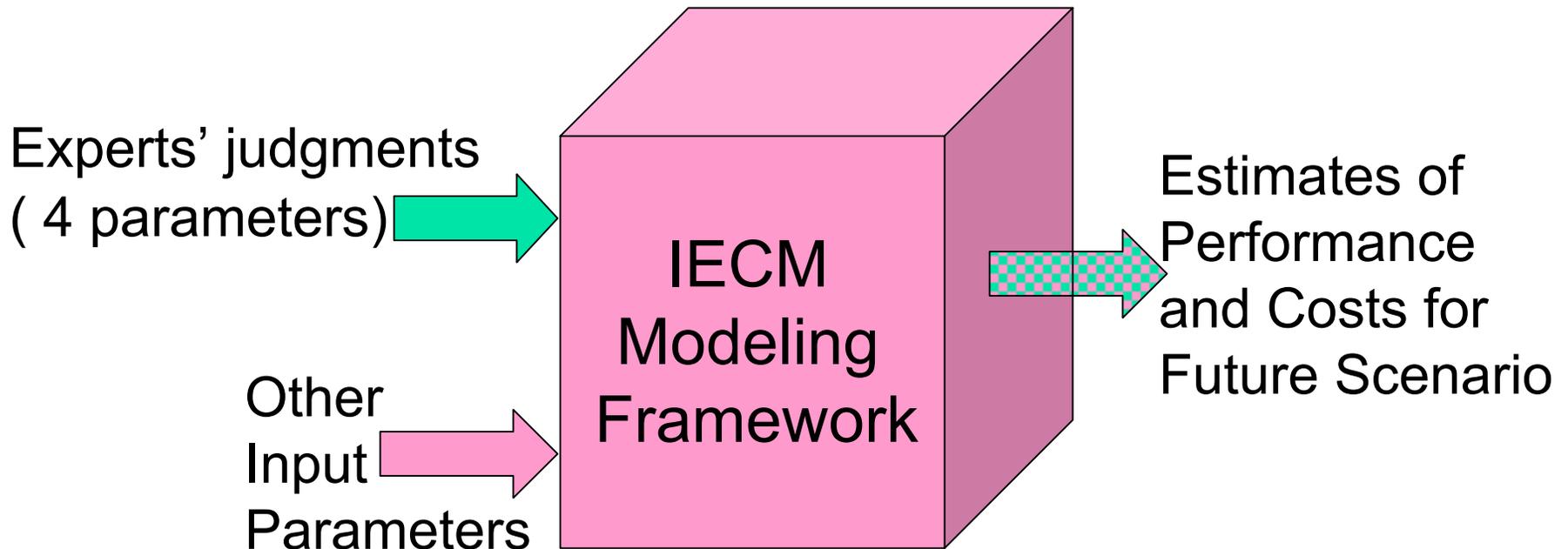
# Evaluation Method: IECM-CS Model

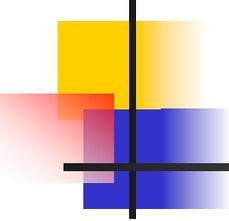
The screenshot displays the IECM Interface software window, which is divided into three main sections: **Configure Plant**, **Set Parameters**, and **Get Results**. The **Configure Plant** section is currently active and contains the following settings:

- Combustion Controls**
  - Furnace Type: Tangential
  - NOx Control: Low NOx Burners
- Post-Combustion Controls**
  - NOx Control: Hot-Side SCR
  - Particulates: Cold-Side ESP
  - SO2 Control: Wet FGD
  - SO2/NOx: None
  - CO2 Control: Absorption - MEA
- By-Product Management**
  - Recovery: None
  - Fly Ash Disposal: mixed w/ Landfill
  - CO2 Storage: Depleted Oil Wells

To the right of the configuration panels is the **Plant Diagram**, which illustrates the process flow. It shows a sequence of components: a furnace (red), a particulate control device (green), a nitrogen oxide control device (pink), a sulfur dioxide control device (blue), another furnace (red), and a CO2 capture unit (green). Arrows indicate the flow of materials between these units. The diagram also shows the final destinations for by-products: fly ash is sent to a landfill, and CO2 is stored in depleted oil wells.

# How would these improvements affect future costs?

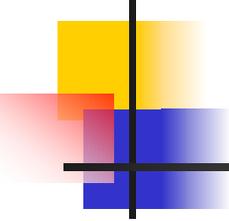




# Estimated Future Cost Reduction in Amine-based CO<sub>2</sub> Capture

(Relative to the Current Baseline)

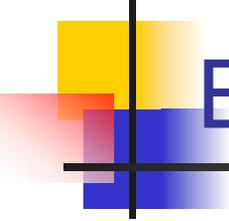
<b>Cost Reduction in</b>	<b>Based on Average Improvement in 4 parameters</b>	
	<b>Best Guess</b>	<b>Optimistic</b>
Capital Cost (\$/kW)	6%	16%
Incremental COE (\$/MWh)	18%	35%
Avoidance Cost (\$/ tonne CO <sub>2</sub> av.)	18%	36%



# What did we learn?

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- There is “**Good News**”:  
Significant improvements in the performance and costs of amine-based CO<sub>2</sub> capture are expected over the next 15 years
- **Further cost reductions** are possible:  
Only 4 parameters were considered here. There are many other parameters that will affect future performance and cost; e.g.,
  - Heat integration design
  - Capital and operating cost parameters
  - Learning curve for total system cost



# Experts' Consensus on R&D Priorities

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1. To develop sorbents with lower regeneration energy requirement
2. To develop less expensive technologies for CO<sub>2</sub> storage/ disposal
3. To improve heat integration within the power plants (to reduce the energy penalty due to steam extraction for sorbent regeneration)
4. To develop more efficient power plants (lower heat rate)

# My Sincere Thanks to All the Experts



*Grazie*

Bedankt

有難う

Gracias

*Vielen*  
Dank

*Merci*

*Díky*



*Köszönettel*

תודה



**THANK YOU!**

*Obrigado!*



谢谢

Спасибо

Teşekkürler

شكراً

Ευχαριστώ πολύ

ขอบคุณ