

Sizing a Pulverized Coal Combustion Boiler Power Plant and Determining When to Add Carbon Capture Technology to the Plant

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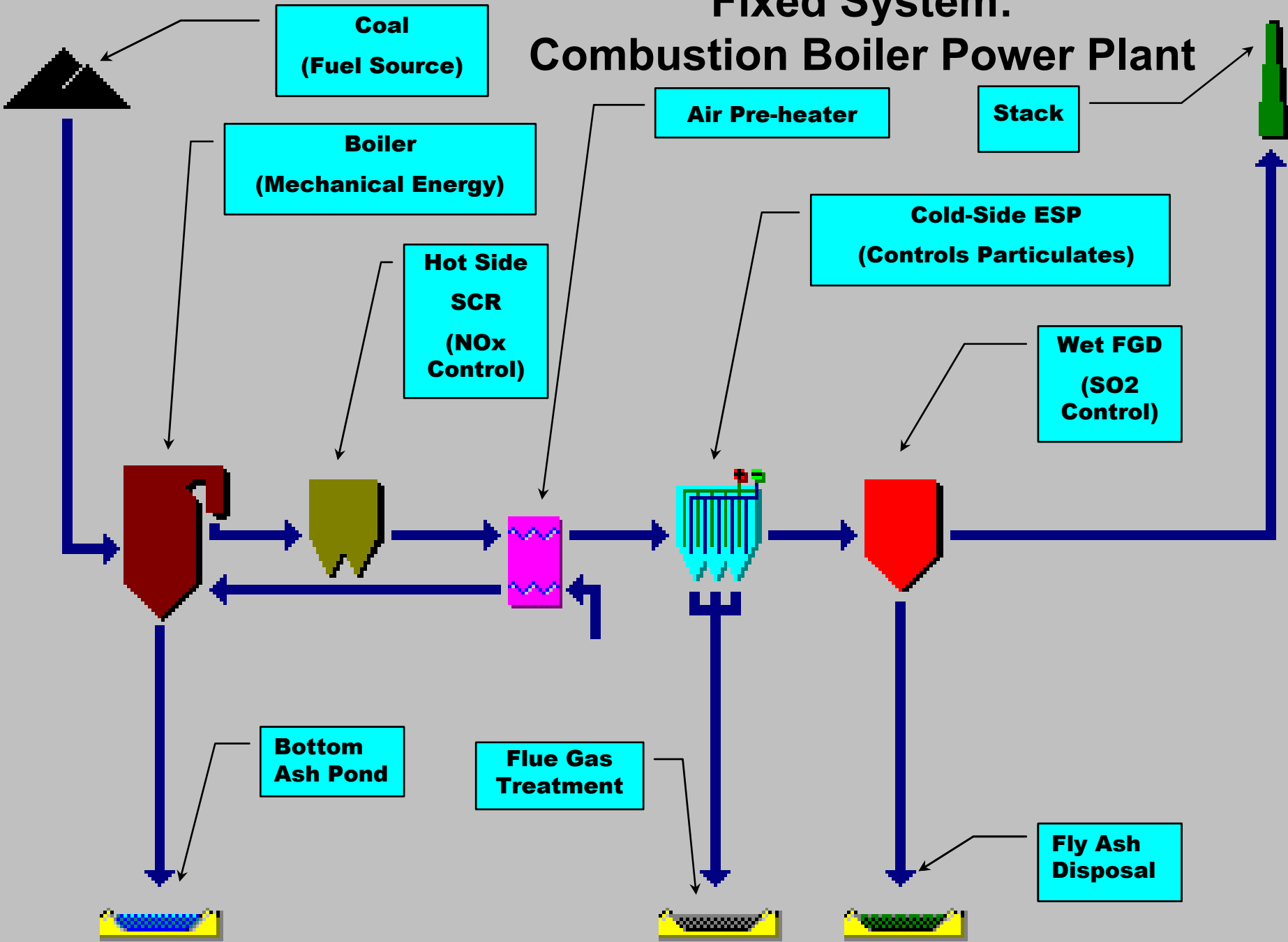
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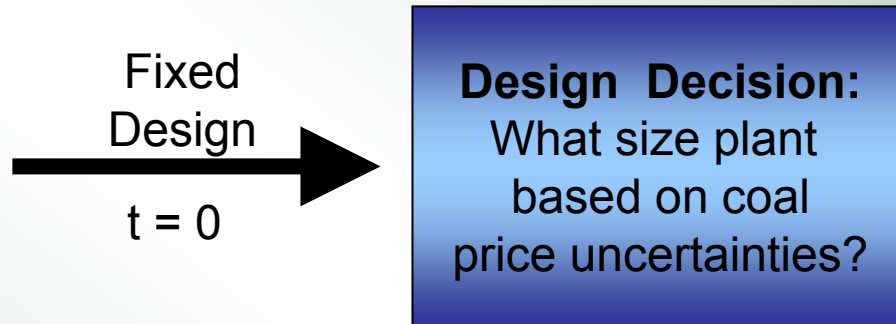


Fixed System: Combustion Boiler Power Plant



Study Process

1. Develop Strategic Plan



1. Determine Fixed Plant Design Size

Calculate Fuel Cost Uncertainties Using Lattice

Lattice Variables:

$$\text{up} = u = e(\sigma * (\Delta t^{.5})) = \underline{1.350} = u$$

$$\text{down} = d = 1/u = \underline{0.741} = d$$

$$\text{probability} = p = 0.5 + 0.5 (v / (\sigma * \Delta t^{0.5})) = \underline{0.678} = p,$$

Where: $\Delta t = 4$ years, $\sigma = 15$ percent, and $v = \text{growth rate } (2.67) * 4$ years.



Outcome Lattice

0 Years	4 Years	8 Years	12 Years	16 Years	20 Years	Step
\$ 35.00	\$ 47.25	\$ 63.77	\$ 86.09	\$116.20	\$156.86	5
	\$ 25.93	\$ 35.00	\$ 47.25	\$ 63.77	\$ 86.09	4
		\$ 19.21	\$ 25.93	\$ 35.00	\$ 47.25	3
			\$ 14.23	\$ 19.21	\$ 25.93	2
				\$ 10.54	\$ 14.23	1
					\$ 7.81	0

Project Mid- point Fuel Costs	8 Years

	High Median
	Low

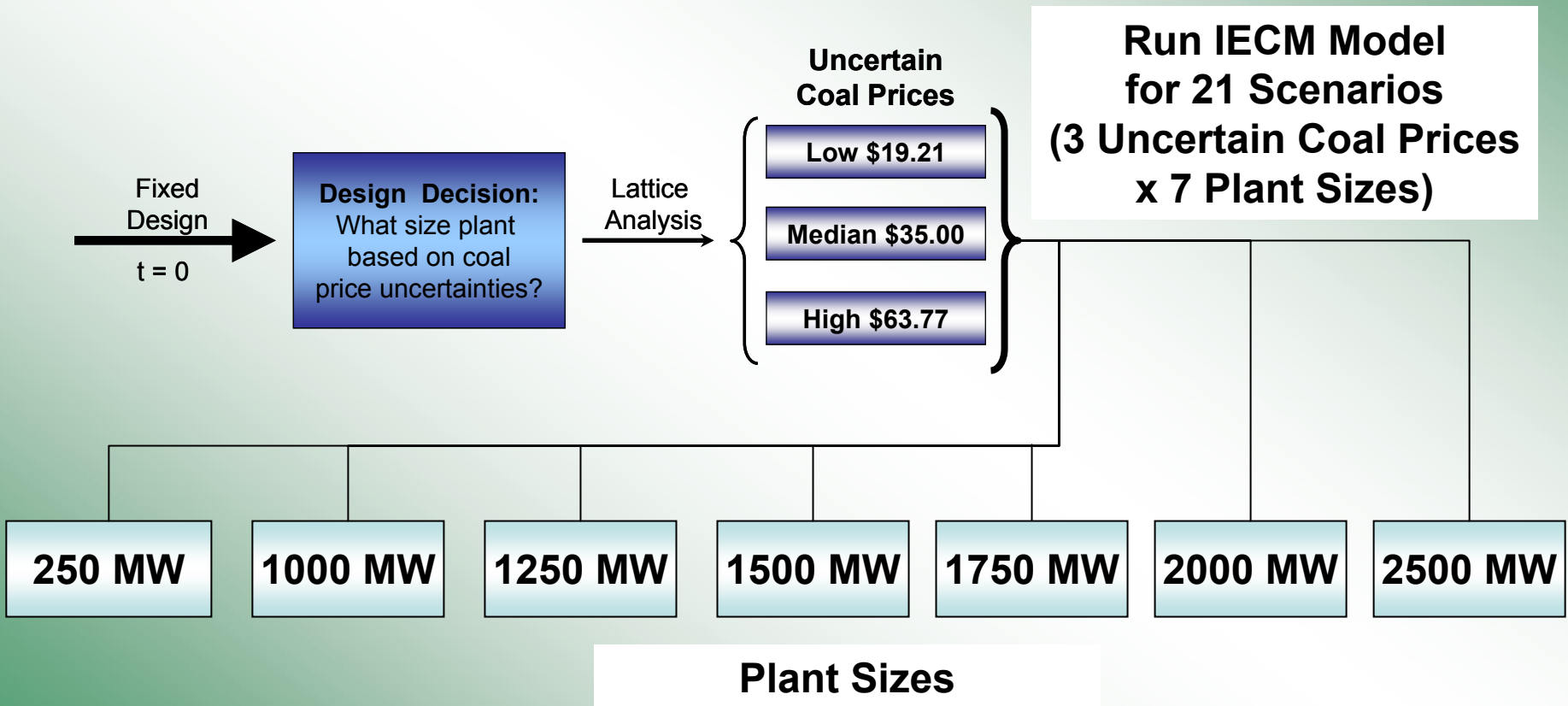
20 Year Lattice Results w/ Probability

Step	Prob	Coal Price/ton
5	0.14	\$156.86
4	0.34	\$ 86.09
3	0.32	\$ 47.25
2	0.16	\$ 25.93
1	0.04	\$ 14.23
0	0.00	\$ 7.81



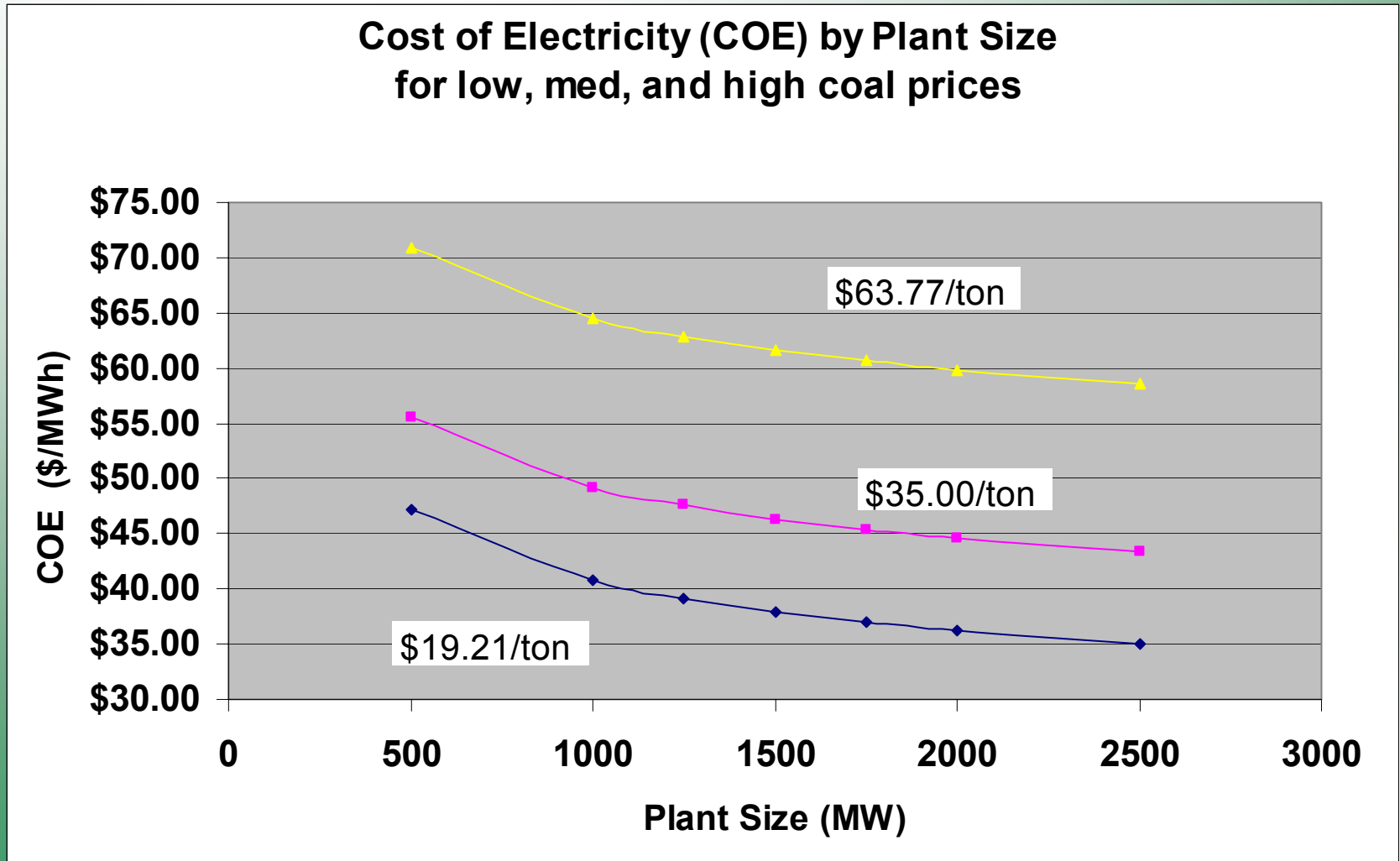
1. Determine Fixed Plant Design Size

Model Fuel Cost and Plant Size Uncertainties



1. Determine Fixed Plant Design Size

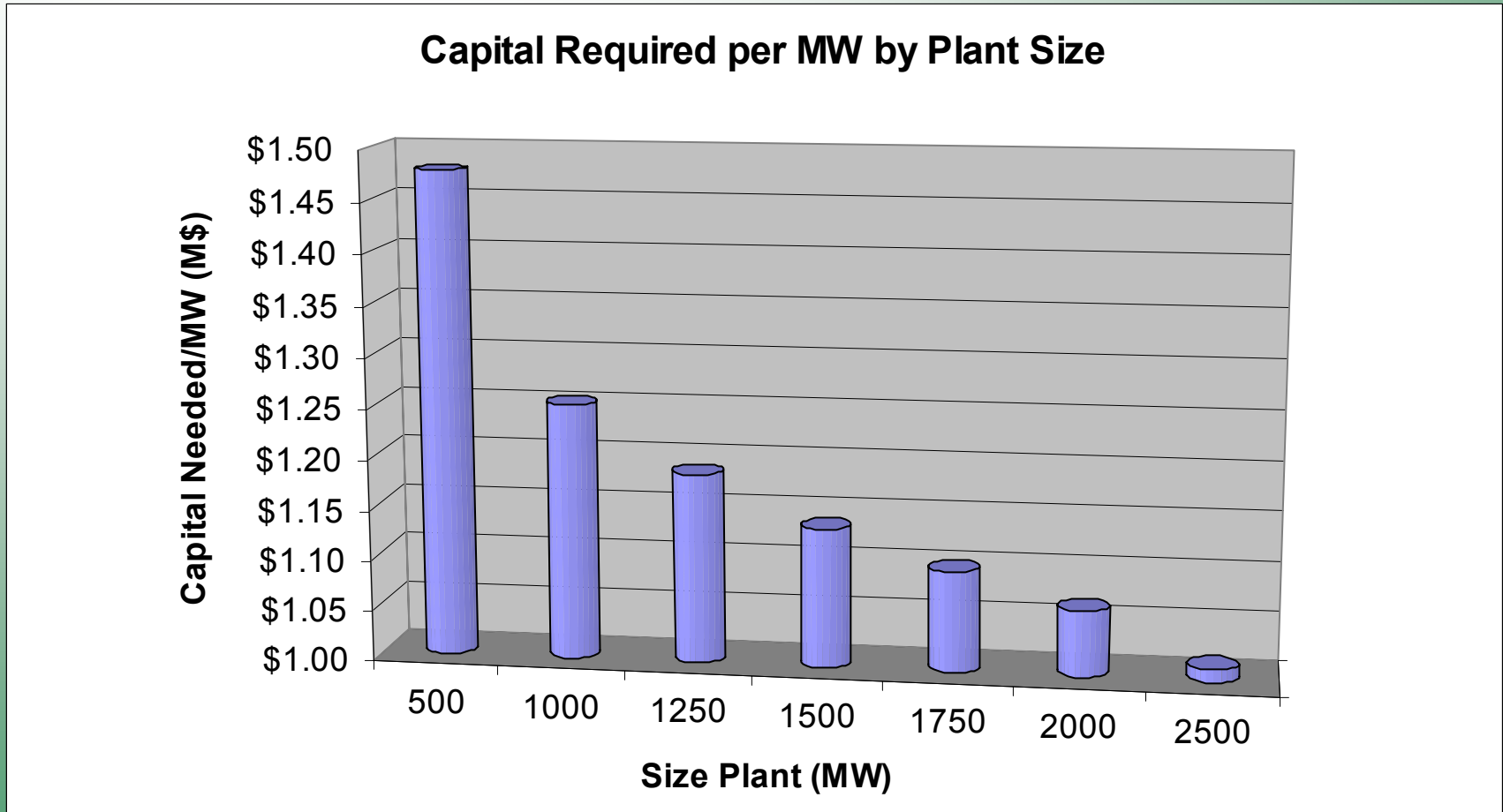
COE Results Show Economies of Scale
Lower COE for Large Plant



1. Determine Fixed Plant Design Size

Capital Requirement Results

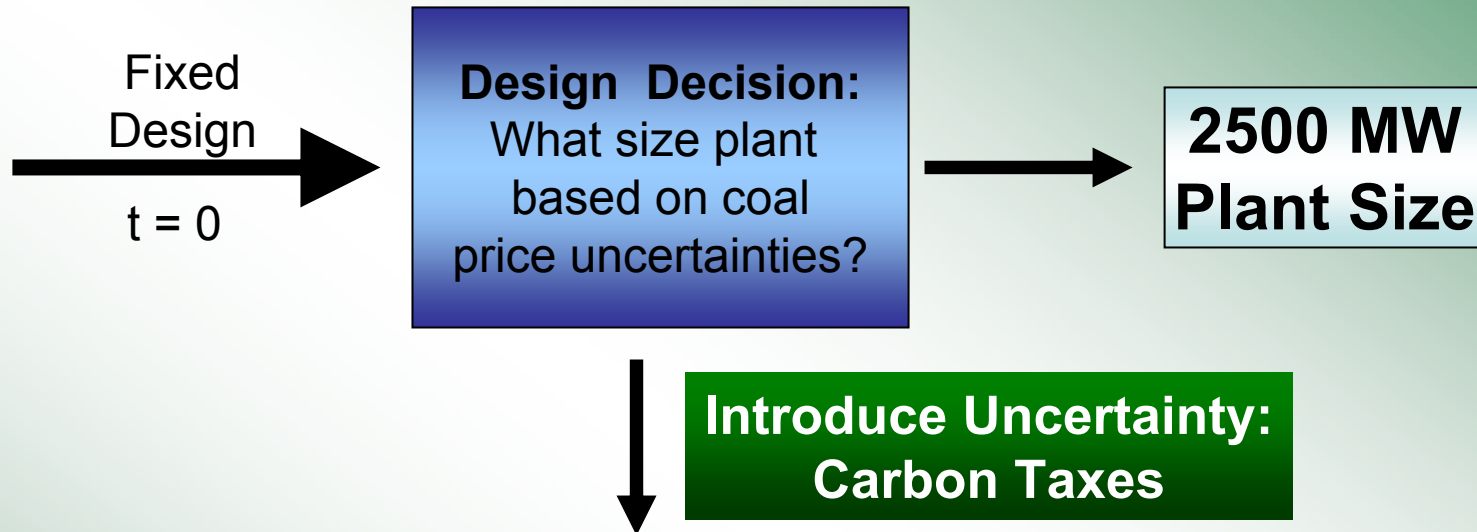
Lower Capital Required for Larger Plant



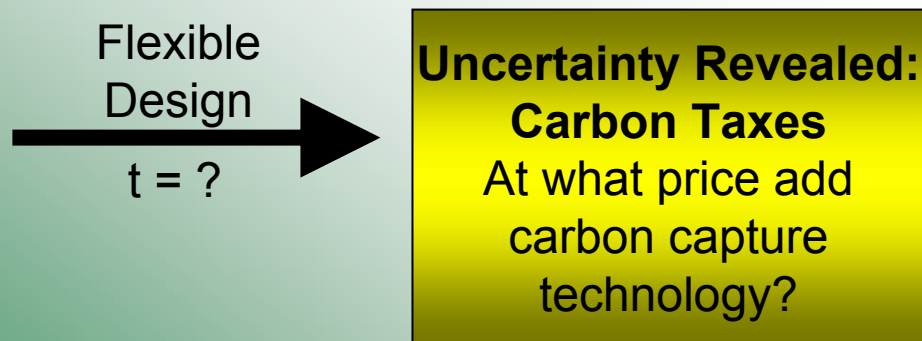
Fixed Plant Size → 2500 MW

Study Process

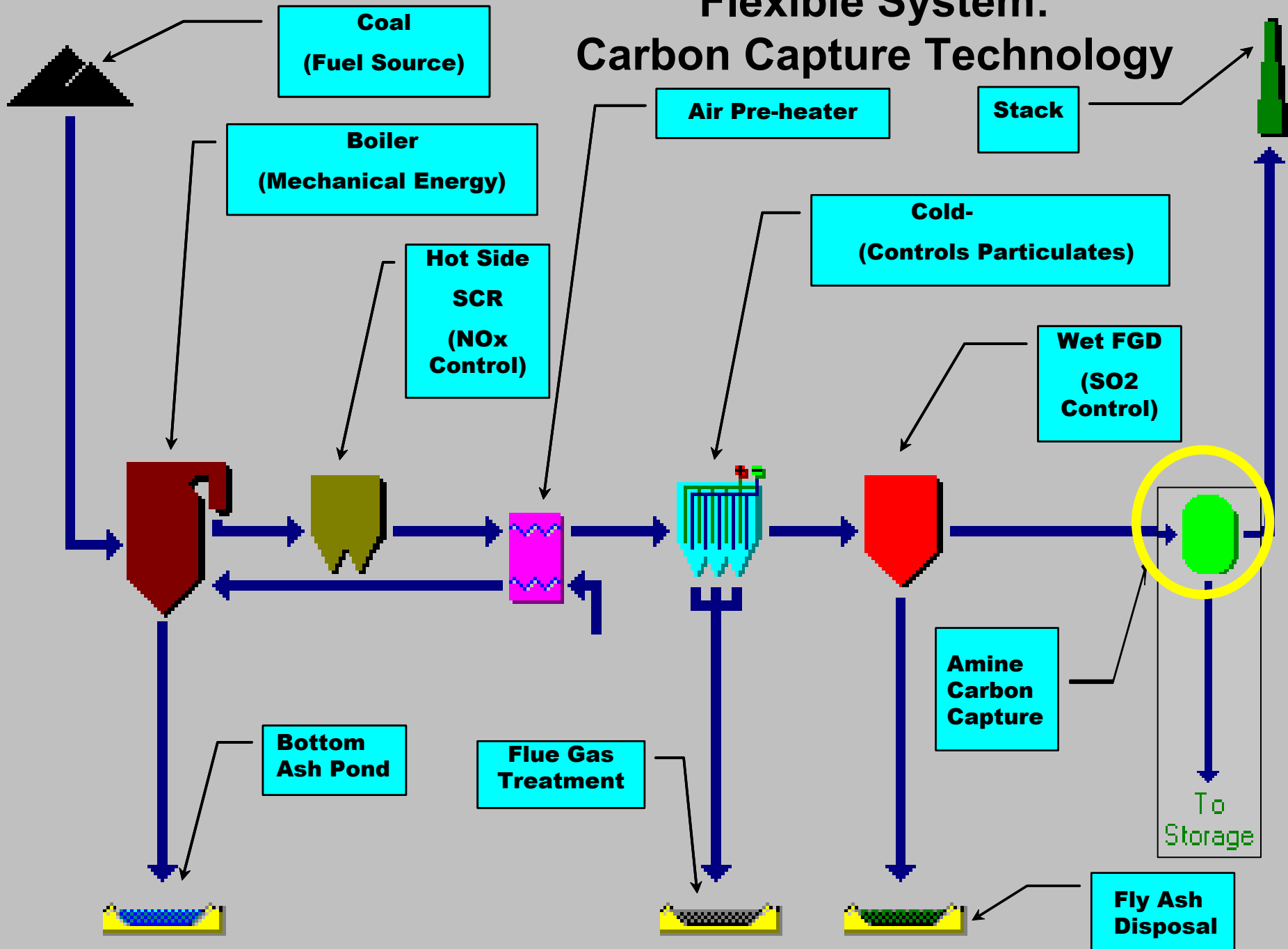
1. Develop Strategic Plan



2. Revise Strategic Plan

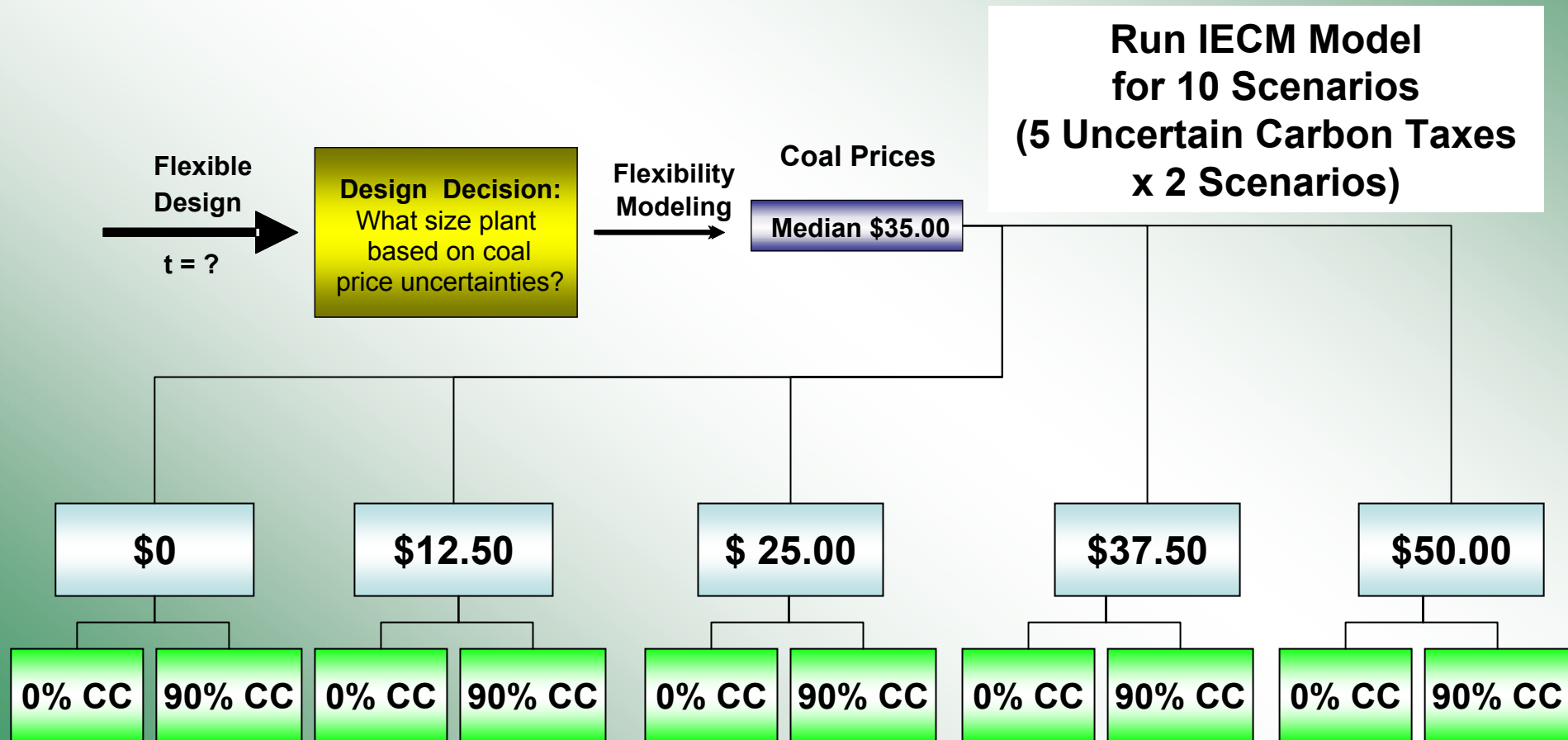


Flexible System: Carbon Capture Technology



2. Determine Flexible Plant Design

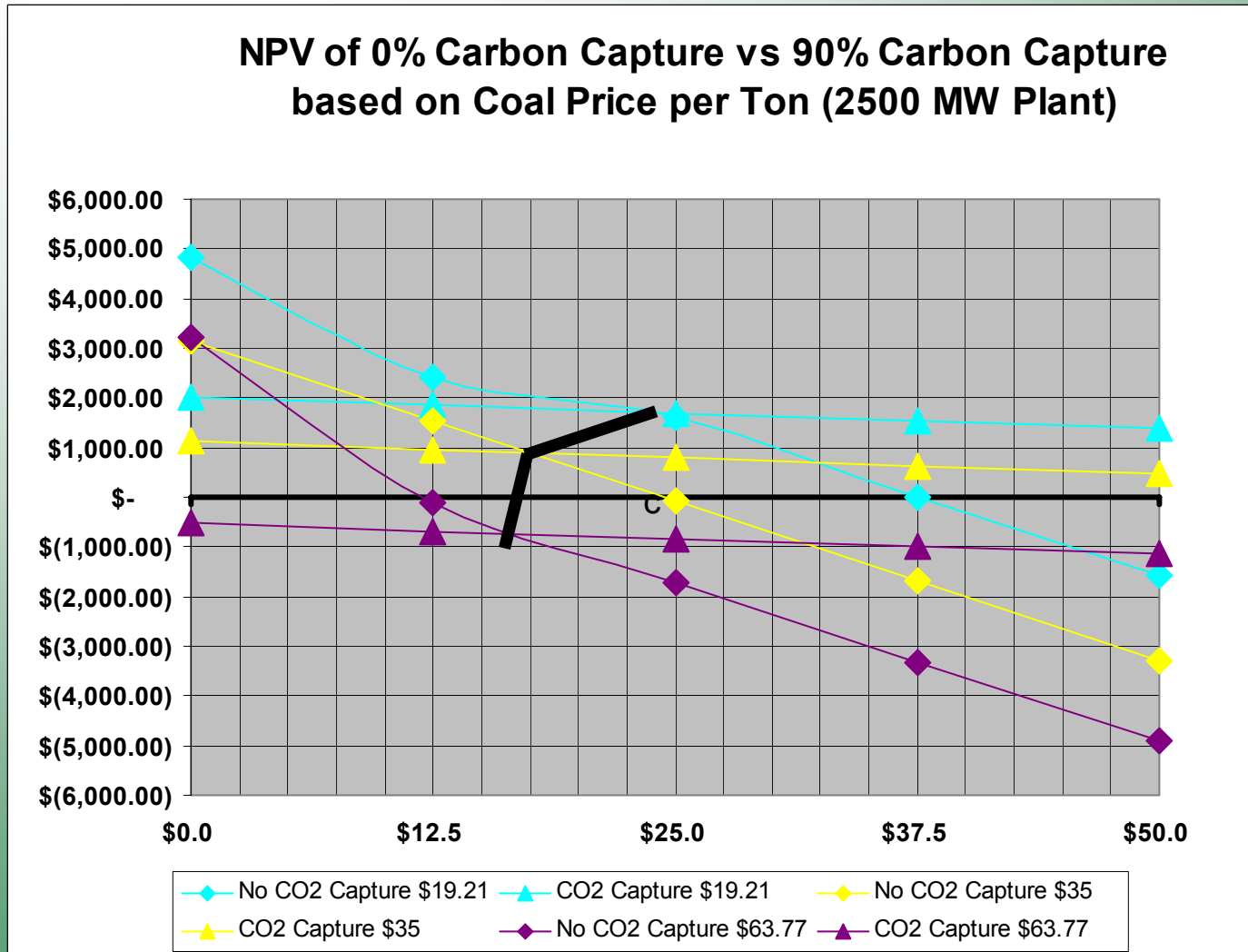
Model Carbon Tax and Carbon Capture Uncertainties



Carbon Taxes with and without Amine System Carbon Capture Scenarios

2. Determine Flexible Plant Design

Model Carbon Tax and Carbon Capture Uncertainties



Findings and Conclusion

Findings

- **The lower the carbon price, the higher carbon tax needed**
- **\$ 25/ton Carbon taxes would incentivize carbon capture technology installation under low, median, and high coal prices**

Conclusion

- **Real Options analysis provides plant owners a way to deal with uncertainties like future coal prices and carbon taxes**