SOFC Stack Performance Goals

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Fuel Cells '97

Morgantown, West Virginia

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Objective

- **To Understand:**
  - What performance is required for a SOFC to compete
  - How stack performance affects the Cost of Electricity (COE)
  - What are reasonable research goals

Stack Parameters Affecting COE

- **Area-Specific Resistance**
  - Stack cost
  - Optimum power density/electrical efficiency
- **Excess Air Ratio**
  - BOP costs
  - Parasitic power

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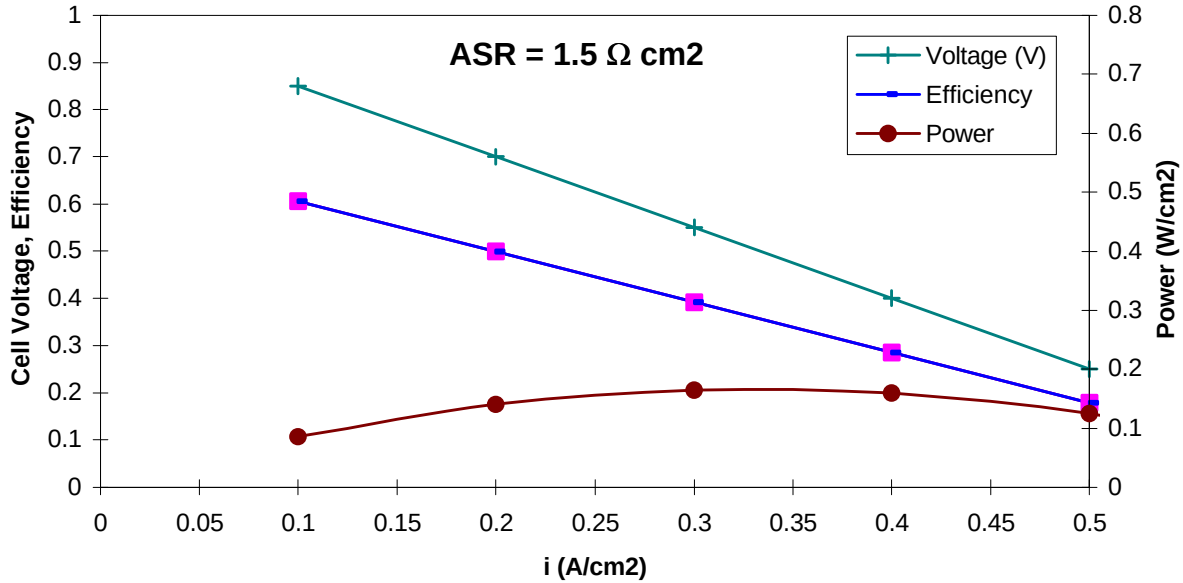
Area-Specific Resistance Determines Optimum Power Density, Stack Cost, BOP Cost, and Electrical Efficiency



Base Case:

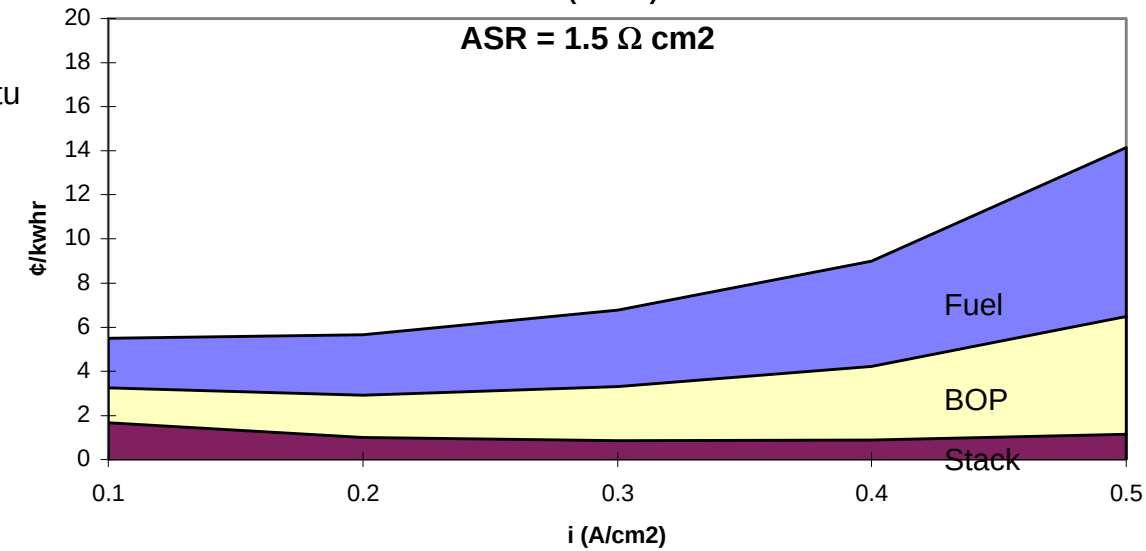
Efficiency: 50%

Stack Cost: $500/m2

BOP: $667/kW

CRF: 0.25/yr

Gas Cost: $4.00/MMBtu



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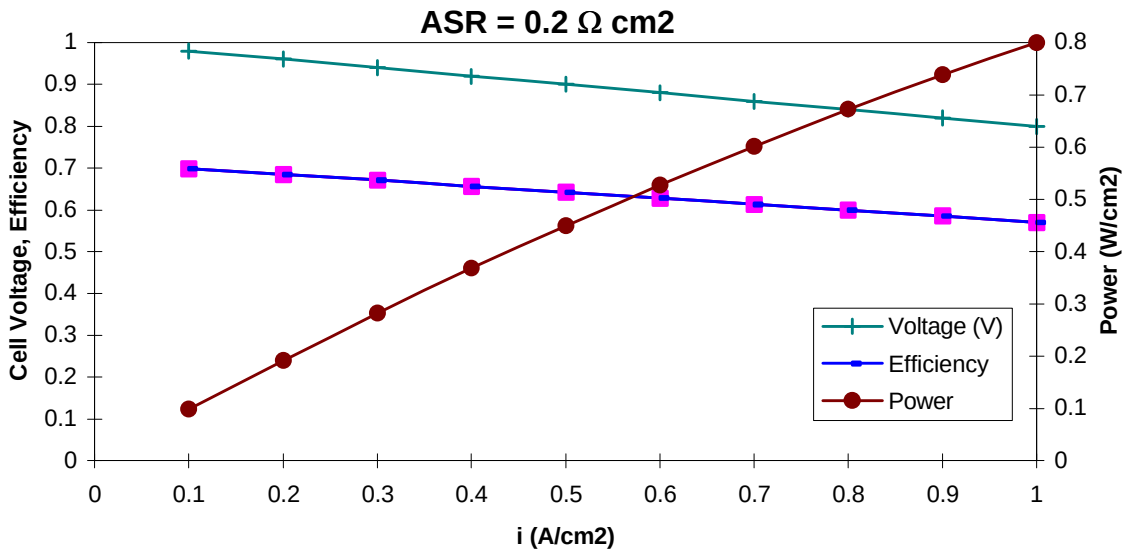

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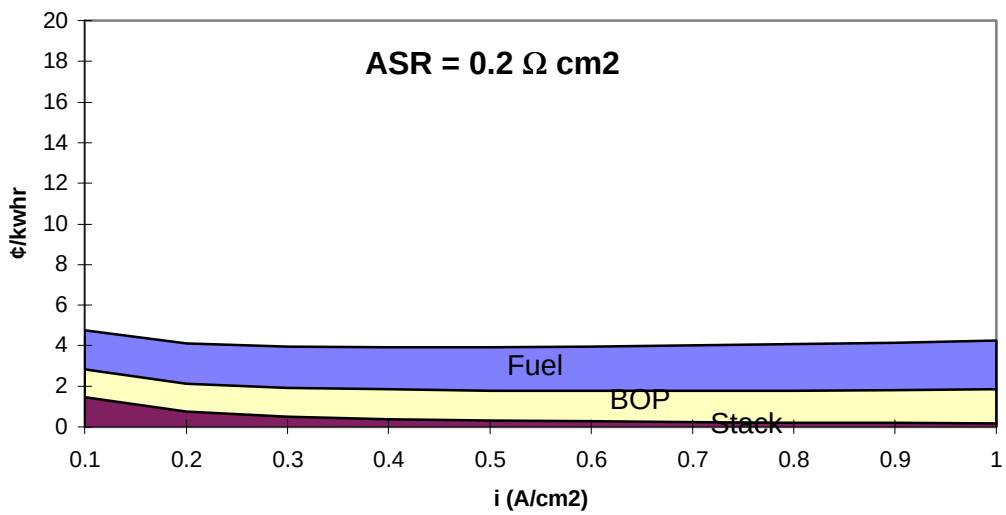

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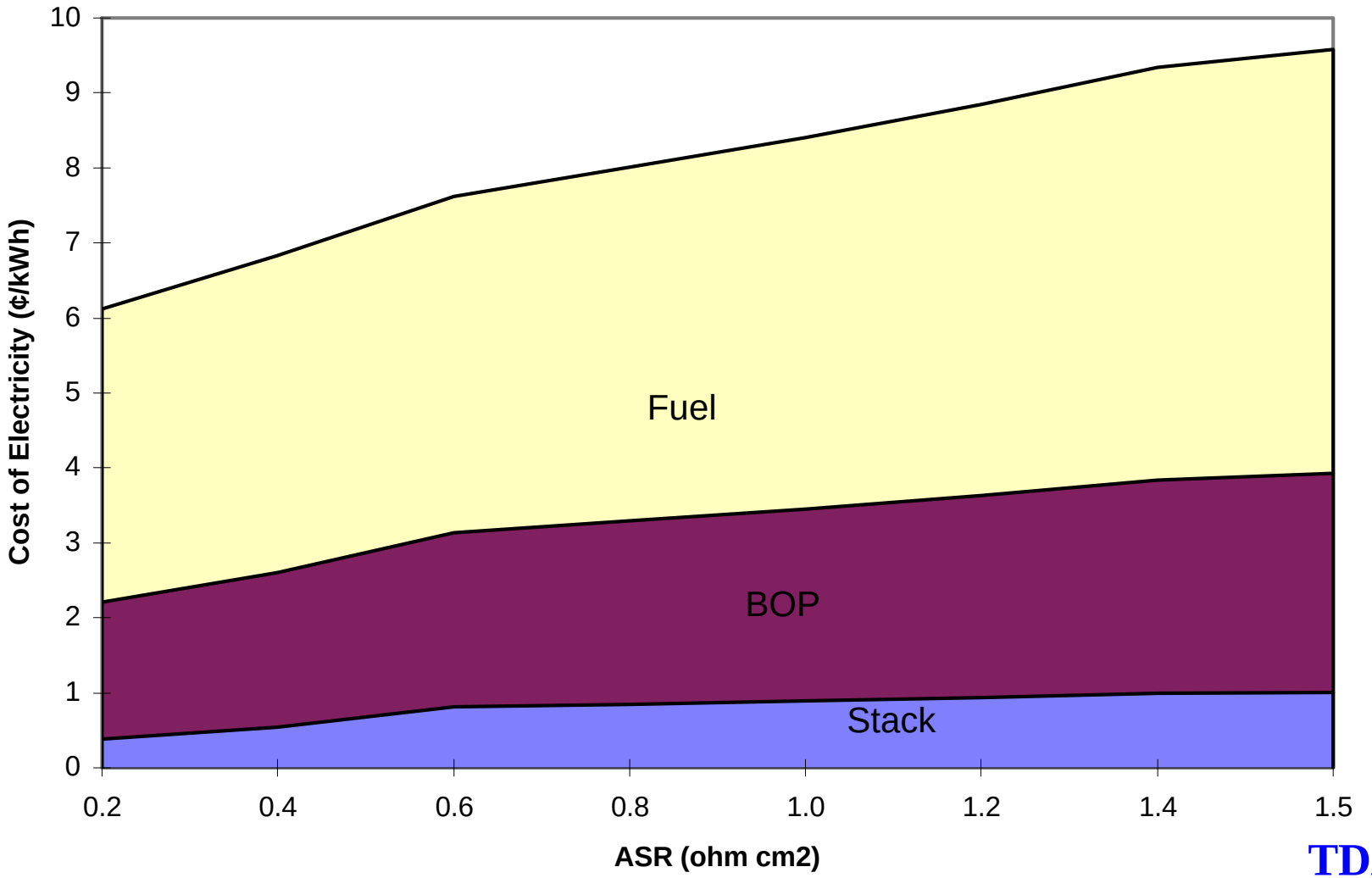
COE As a Function of Area-Specific Resistance



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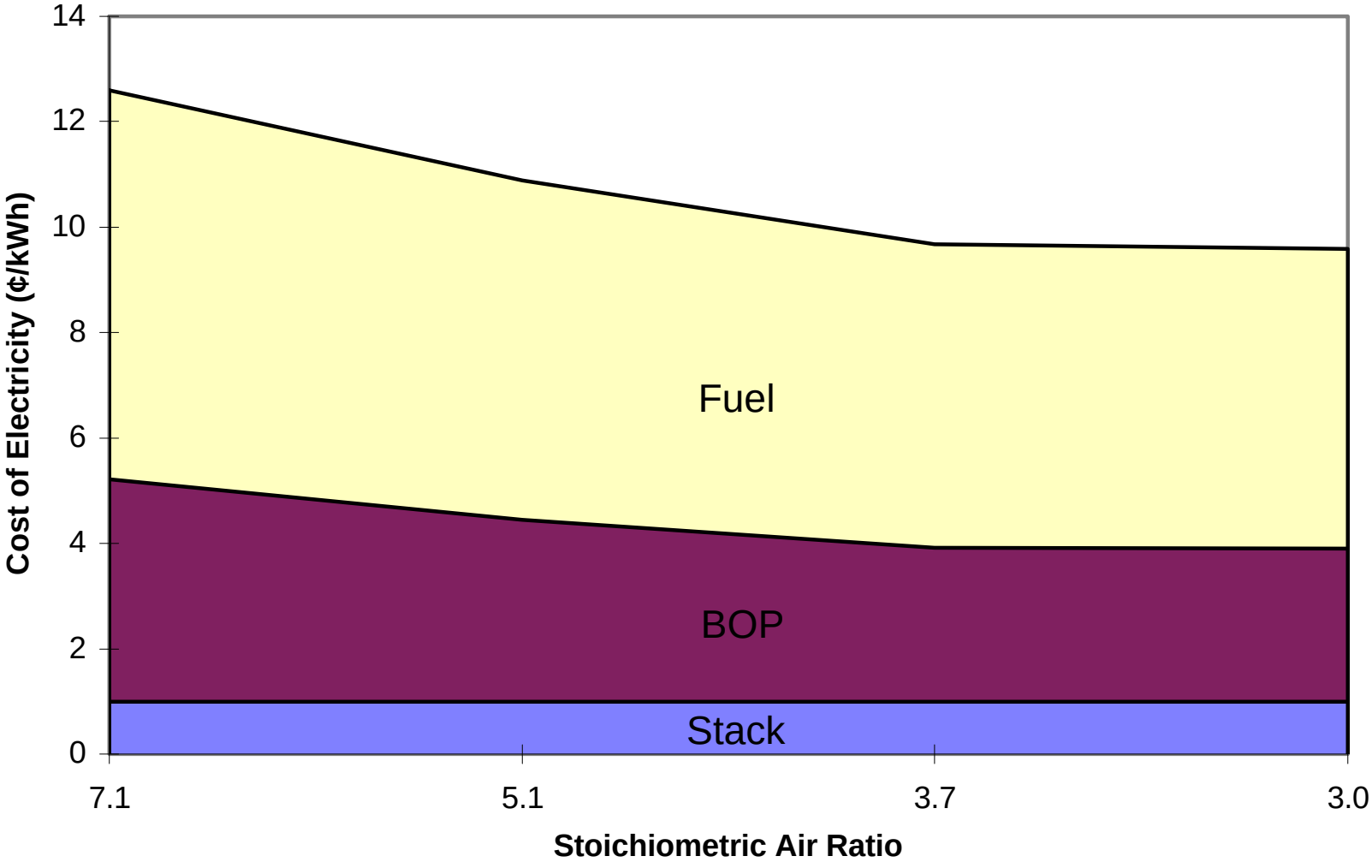
Excess Air Affects Preheater and Compressor Capital Costs and Energy Efficiency



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Goal

- **Fuel Cell with ASR = 0.2 Ω cm^2**
  - Cathode: 0.07 Ω cm^2
  - Electrolyte: 0.06 Ω cm^2
  - Anode: 0.07 Ω cm^2

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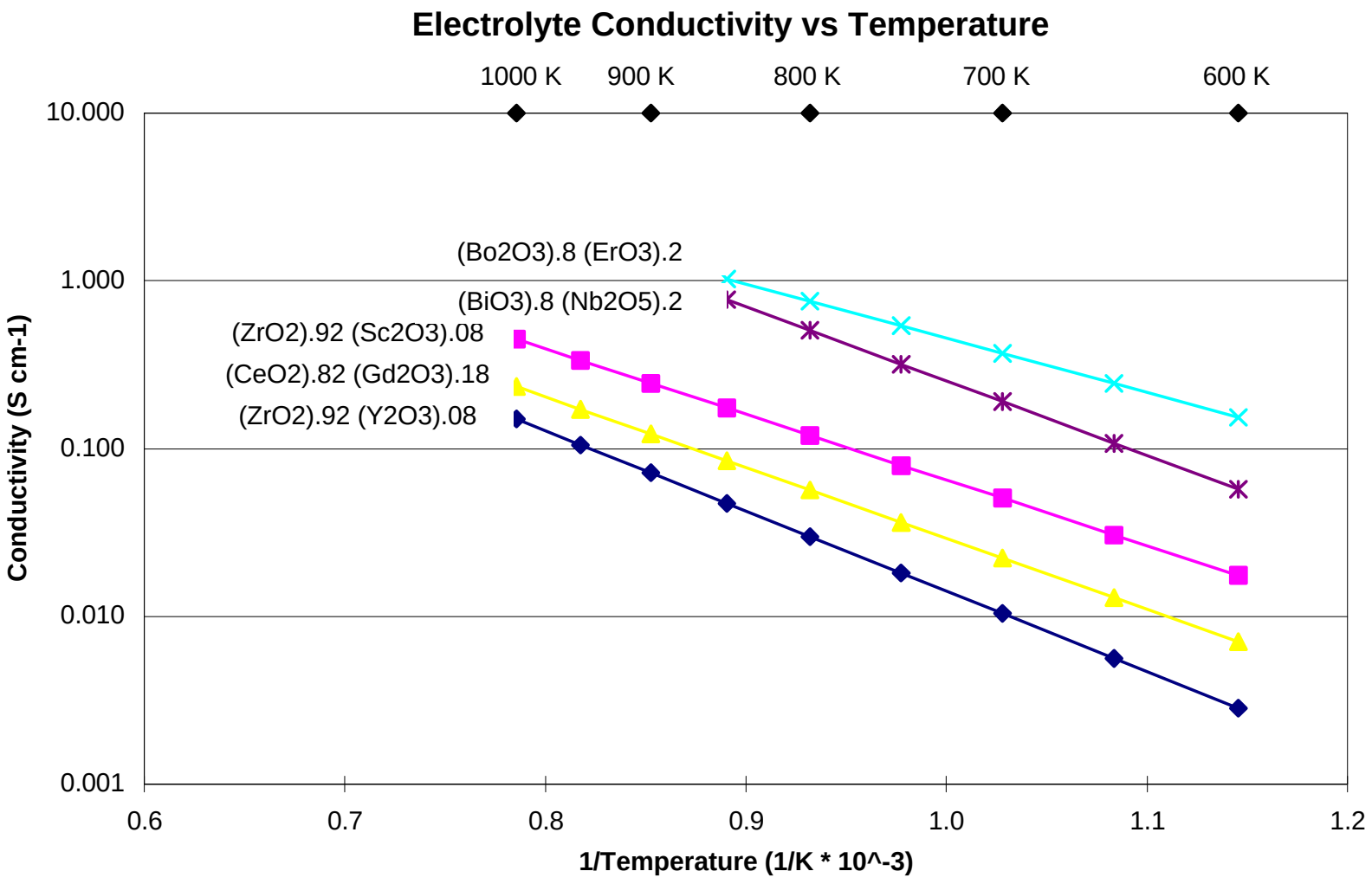
Electrolyte

- **How Thin Is Thin Enough?**
  - As a function of operating temperature



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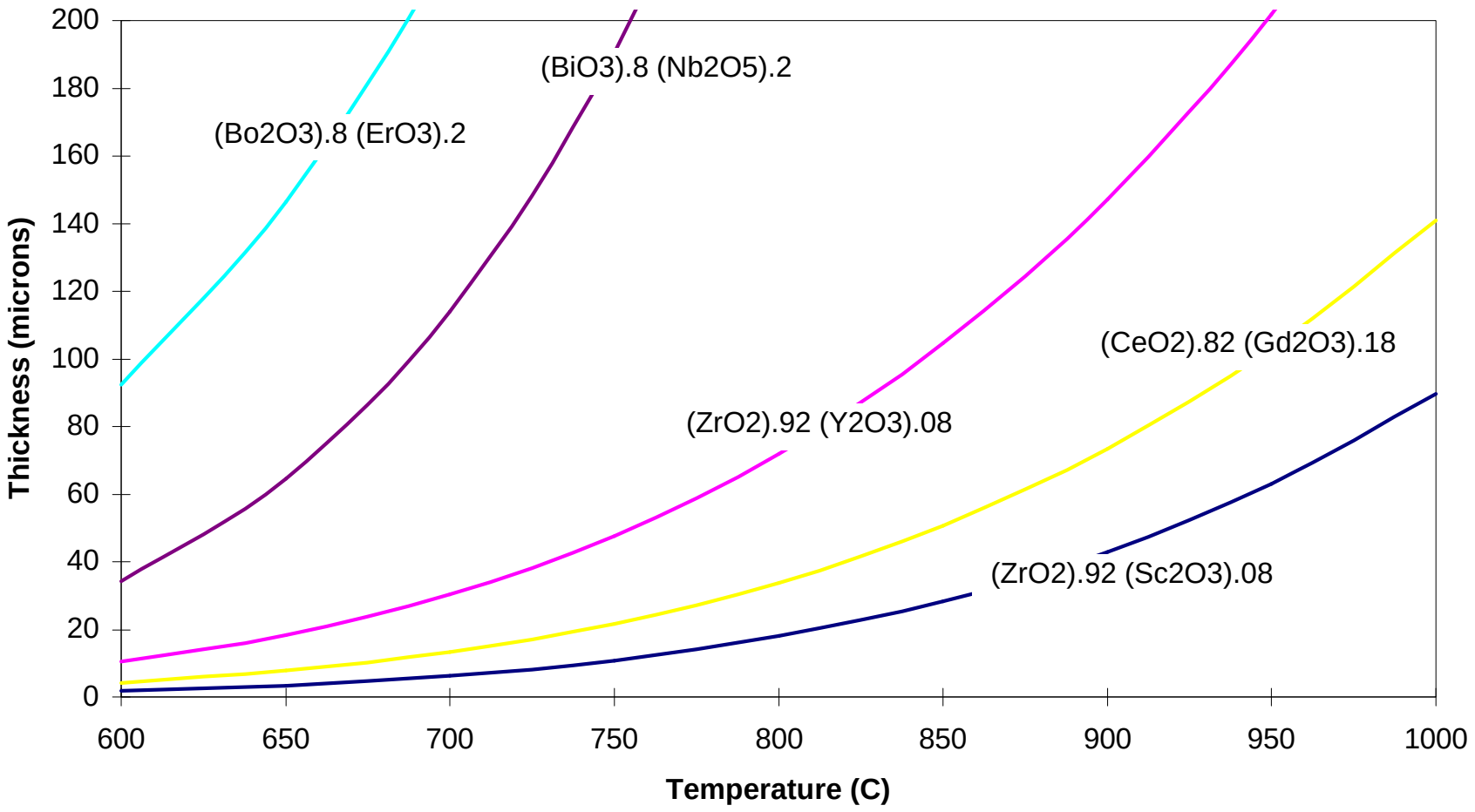
Required Electrolyte Thickness as a Function of Temperature



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Electrodes
Mass Transfer Limitations

- **ASR Budget = 0.01 Ω cm^2**
- **Allowable Cathode Thickness = 400 μm**
  Allowable Anode Thickness = 2000 μm

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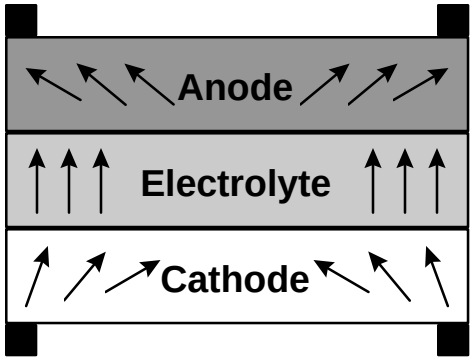
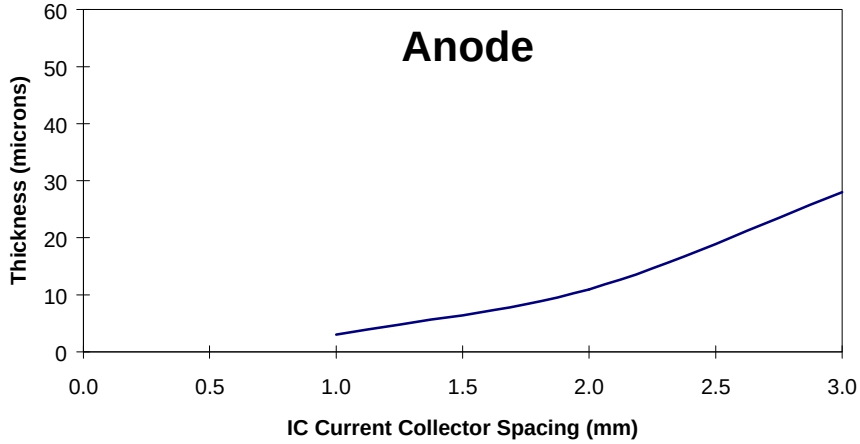
Electrodes

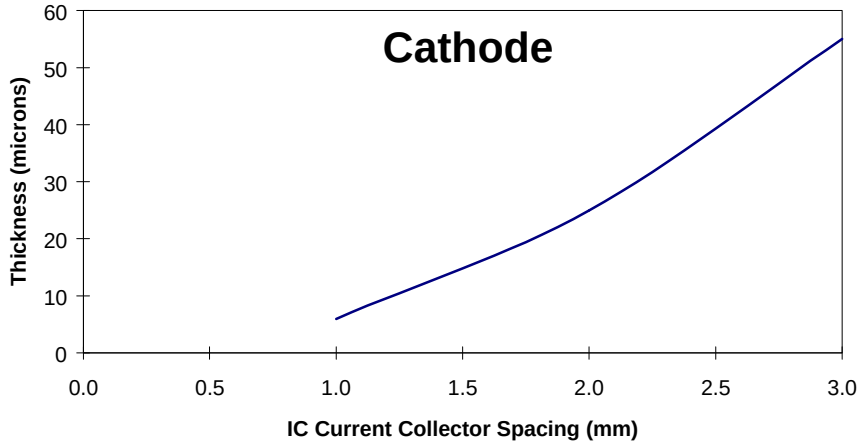
Electrical Resistance = 0.01 Ωcm^2

Minimum Thickness Required to Control <u>Lateral</u> Resistance



Interconnect





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Electrode Thickness Requirements

	Electrical Conduction		Mass Transfer
Anode	3-30 μm	⟷	2200 μm
Cathode	6-60 μm	⟷	400 μm

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Electrode Performance

- **Dominated By Electrocatalytic Performance**
- **Overall Modeling Such As This Does <u>NOT</u> Provide Guidance**

Conclusions

- **Performance Budgets Can Provide Useful Guides for Setting R&D Goals**
- **Stack Performance Affects Overall Cost By Controlling:**
  - Electrical (ASR and excess air) efficiency
  - Stack cost
  - BOP cost
- **Several Methods Are Available to Prevent YSZ Electrolyte Conductivity From Being Rate Limiting at 700-800°C**
- **Mass Transfer and Ohmic Resistance Rarely Limit ASR in a Planar Cell**

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