



Design Optimization Techniques Applied to Fuel Cell Design

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RCGI

- ✓ Focus on reducing greenhouse gas emissions
- ✓ Support for Brazil to achieve Nationally Determined Contributions (NDCs) through Research and Innovation
- ✓ Transdisciplinary approach: researchers and specialists from different areas of knowledge unite their efforts to find solutions
- ✓ Long-term investment in research
- ✓ Support for Brazil in its consolidation as a global power in renewable energy





Founder Sponsors:



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Research Centre for Greenhouse Gas Innovation Programmes



NBS
How to **incorporate** Nature Based Solutions to abate CO₂?



BECCS
How to **achieve** negative carbon intensity biofuels?



CCU
How to **create and deploy** value chains that unlock novel carbon products?



GHG
How to **develop** new technologies to reduce greenhouse gas emissions?



Advocacy
How to **unlock** CO₂ abatement technologies with the support of standardization, regulation and social acceptance?



InnovaPower
How to **construct** long-term solutions centered on the decarbonization of electrical power systems?

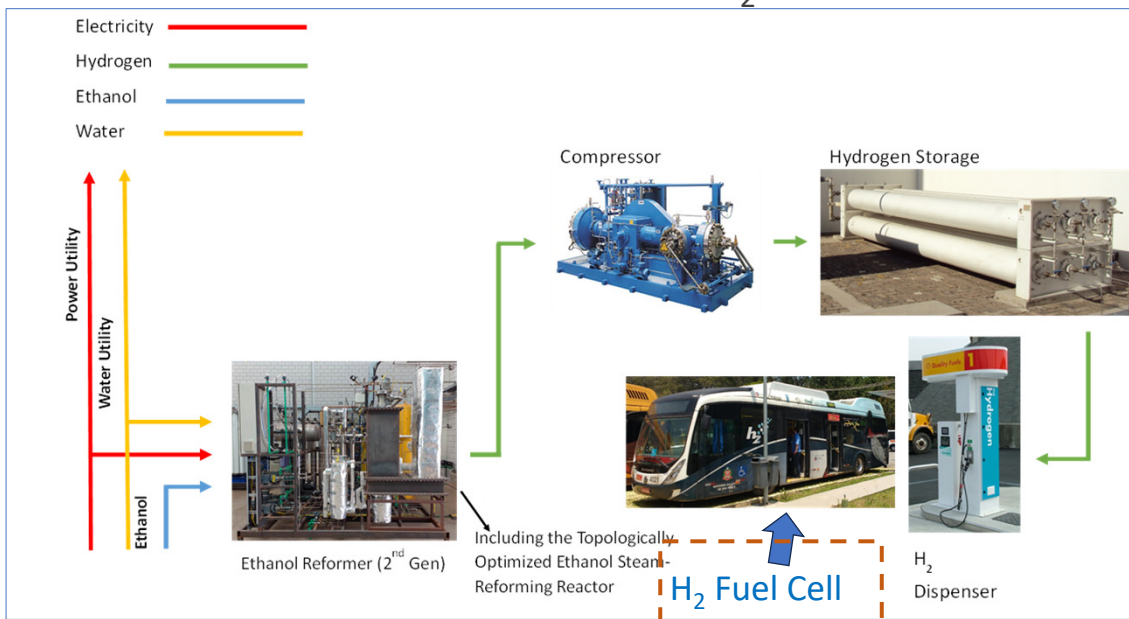


Decarbonization
How to **contribute** with technologies that focus on a decarbonized future?

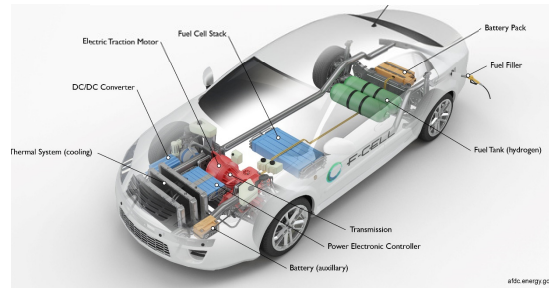
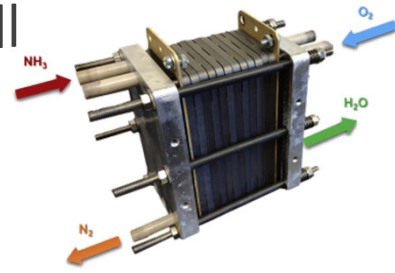
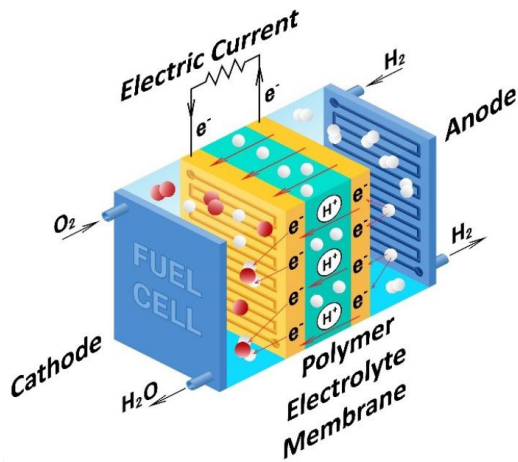


Centre 2 Centre
How to **establish partnerships** between centres around the world concerned with solutions to improve our environment?

Introduction - Context: Ethanol – H₂ Reformer



Introduction – H₂ Fuel Cell

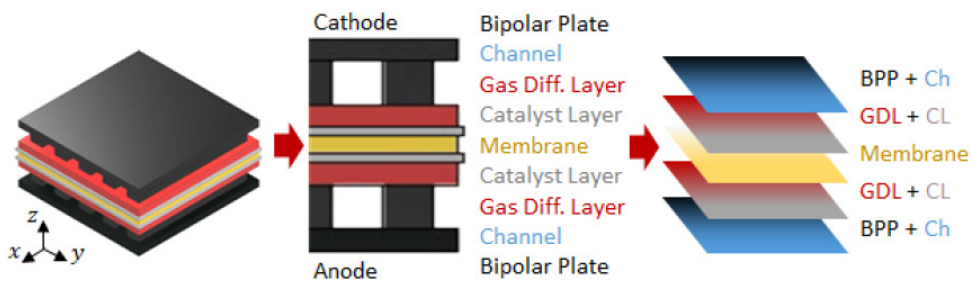


Research Centre for Greenhouse Gas Innovation

Energy Transition RESEARCH & INNOVATION

Introduction – Pseudo 3D

Schematic view of a PEM fuel cell



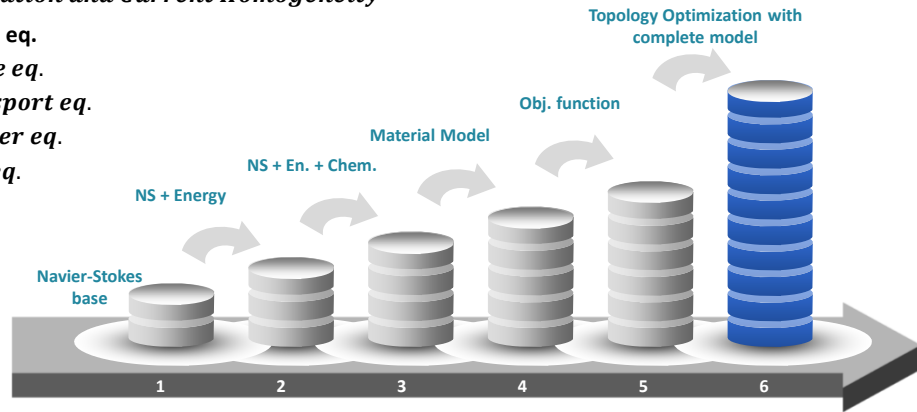
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Energy Transition RESEARCH & INNOVATION

Topology Optimization - Formulation

Maximize: Power Generation and Current Homogeneity

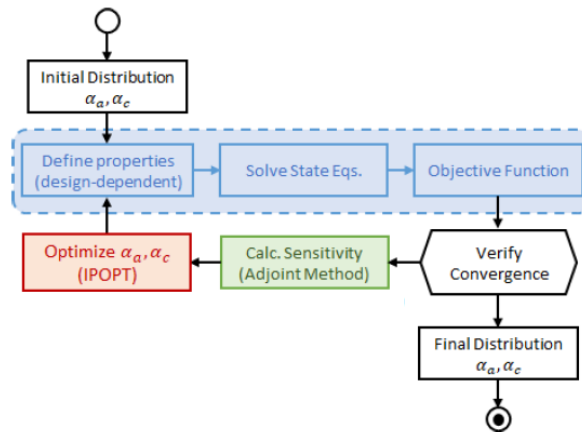
- s. t.
- Navier – Stokes eq.
 - Energy Balance eq.
 - Chemical Transport eq.
 - Membrane Water eq.
 - Phase Change eq.



Topology Optimization - Flow chart

Maximize: Power Generation and Current Homogeneity

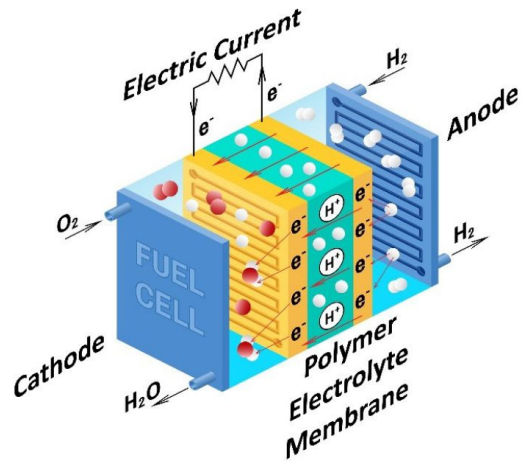
- s. t.
- Navier – Stokes eq.
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Results - Topologies

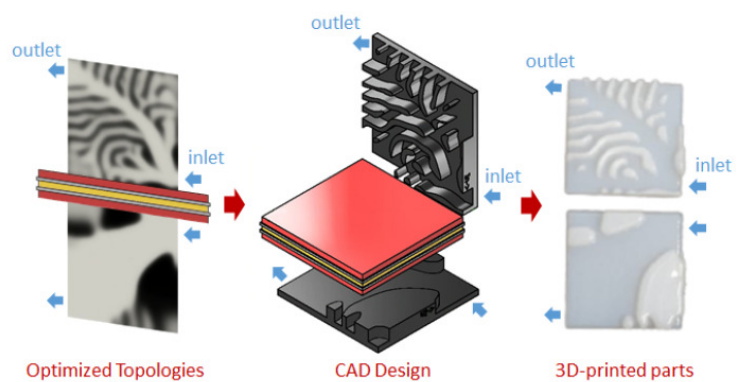
Design Evolution

Maximize: Power Generation and Current Homogeneity



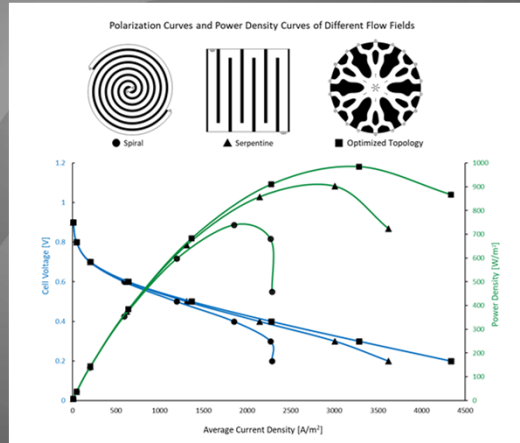
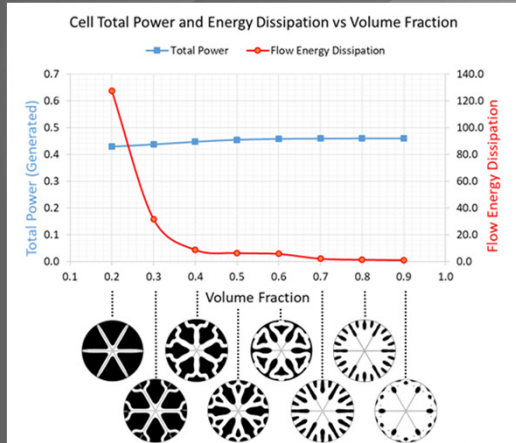
Conclusion

- Multiphase Multiphysics model;
- P3D efficient computational cost;
- Optimization:
 - Larger Electric Power;
 - More Homogeneous Current Density;
- Prototyping





RESEARCH & INNOVATION FOR CARBON NEUTRALITY



Topology Optimization for Fluids – Impeller Design

Numerical examples: 60° sector + 50% volume constraint + 1000 rpm

