

Geothermal Carbon Dioxide Removal: New Zealand Research Direction



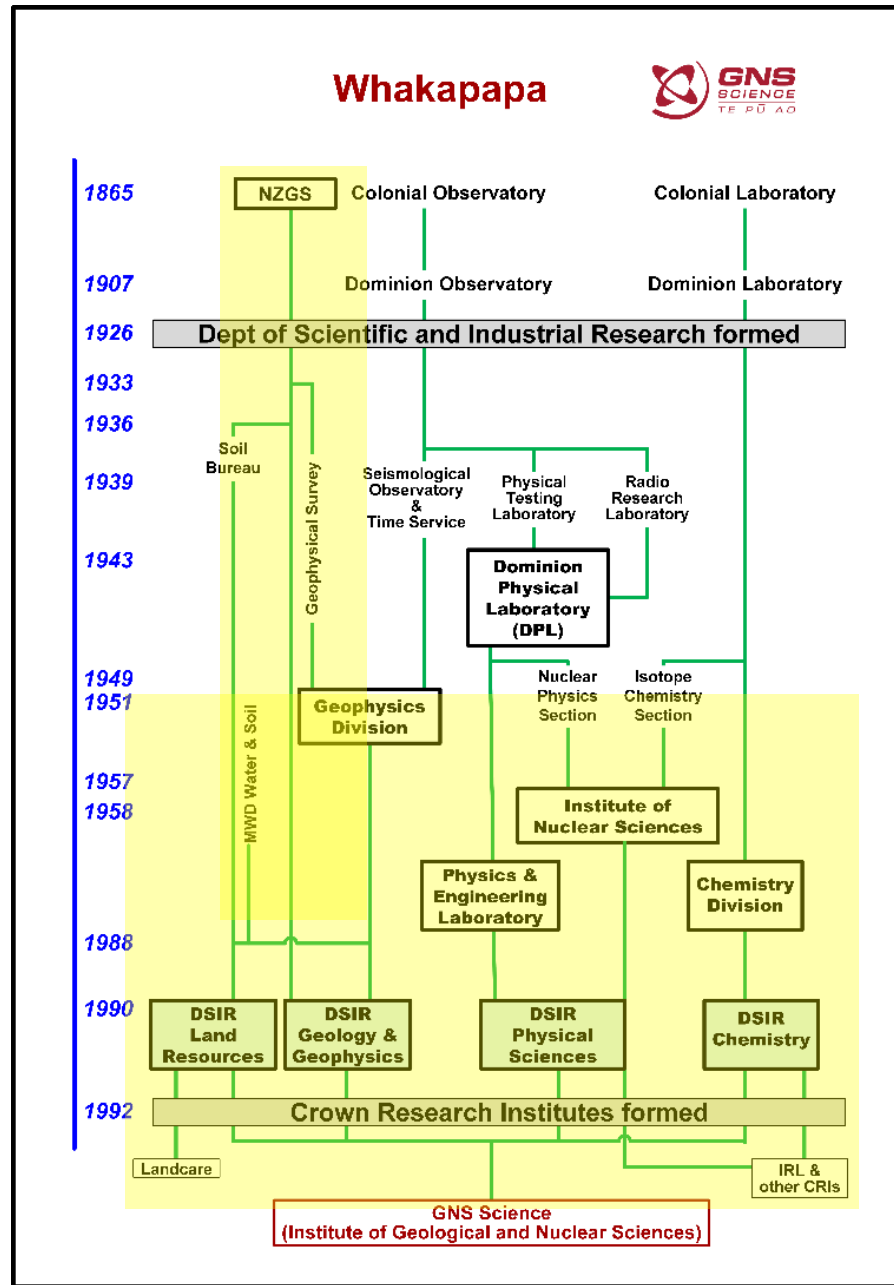
Dr Murray McCurdy
Senior Scientist – Earth Resources and Materials
Programme Leader – Materials for a Low Carbon Future



Overview

- **About GNS Science**
- **GNS Science background in CCS**
- **Problem of CO₂ in NZ Geothermal**
- **CO₂ utilisation**
- **Current research directions**

GNS Science



GNS Science

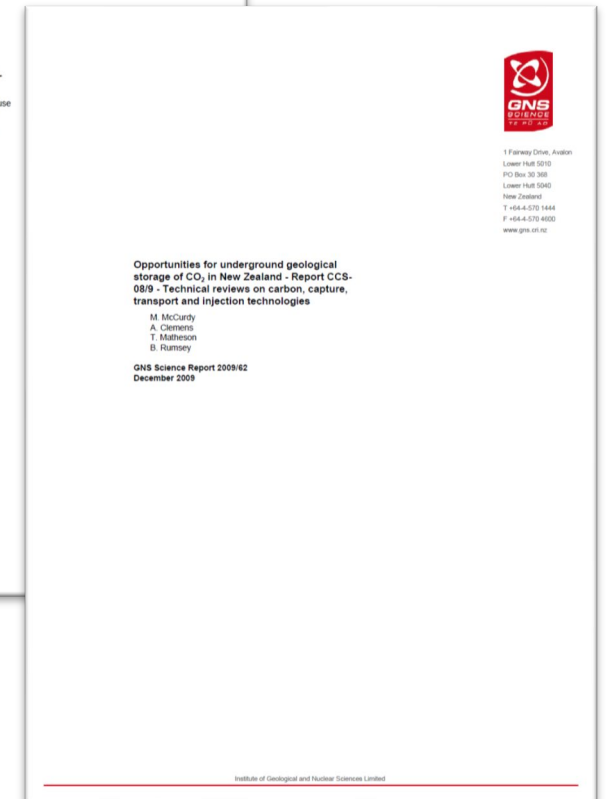
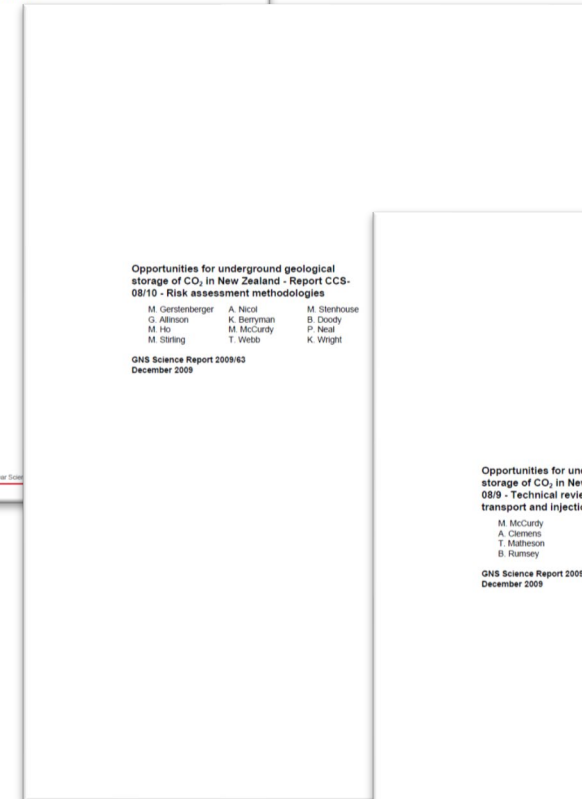


Energy Futures:

- Geothermal energy
- Hydrogen energy
- Technologies for low carbon future
- Earth energy
- Energy systems

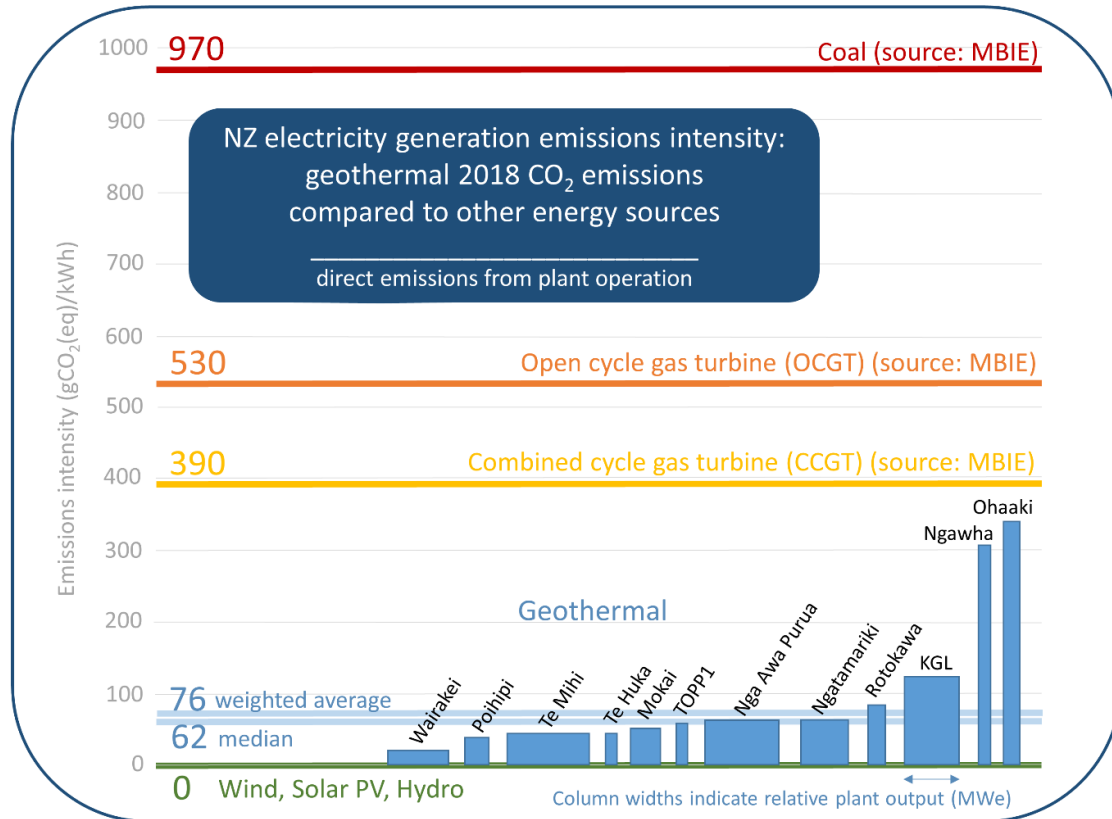
GNS Science CCS

- **Comprehensive assessment of CCS storage options 2008-2010**
- **More than enough storage capacity:**
 - 200-300Mt offshore
 - ~15,000Mt onshore
- **Failed to gain traction**

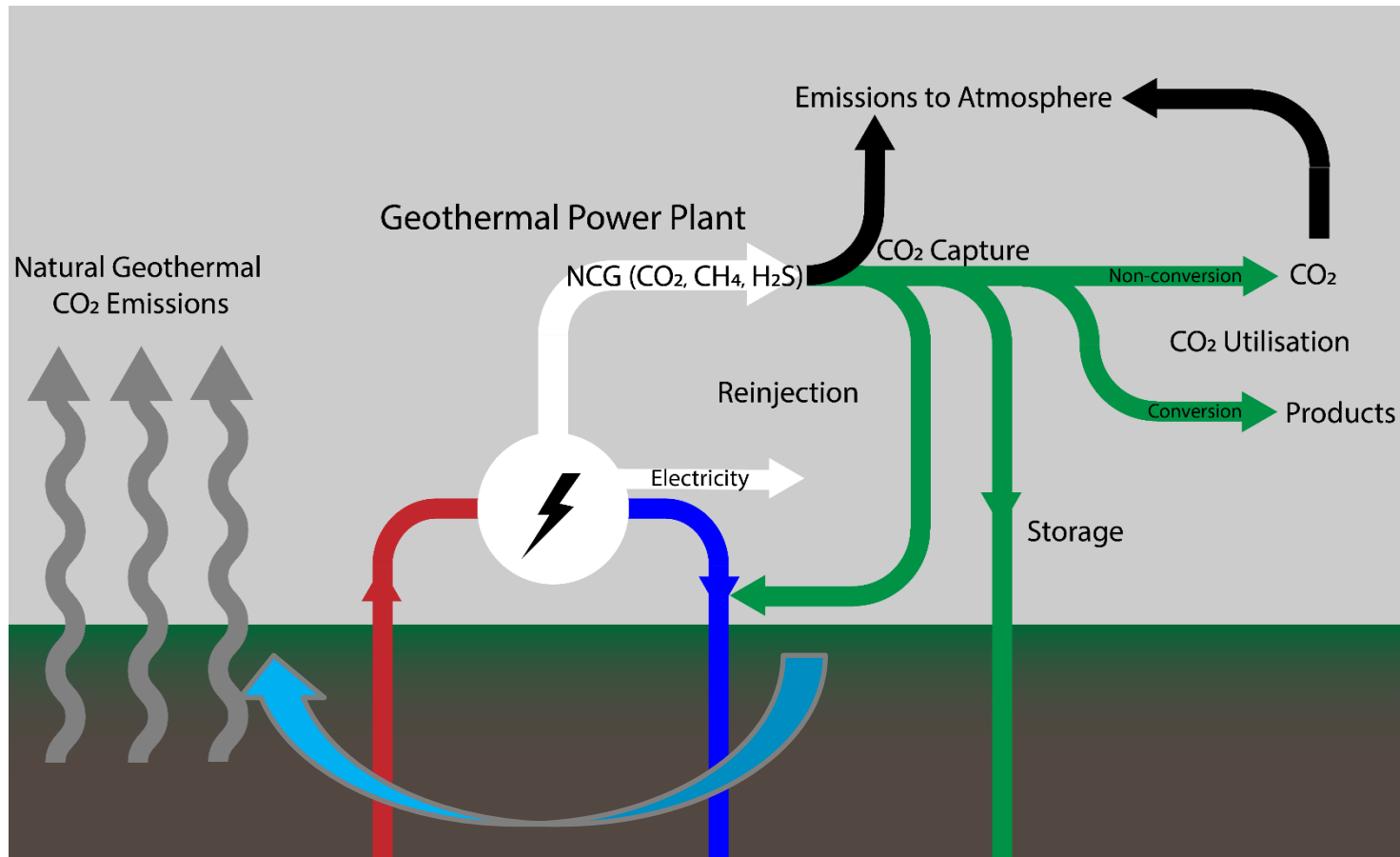


NZ Geothermal CO₂

- ~1% of total GHG emissions
- ~2.5% of energy GHG emissions
- Will become more significant in future

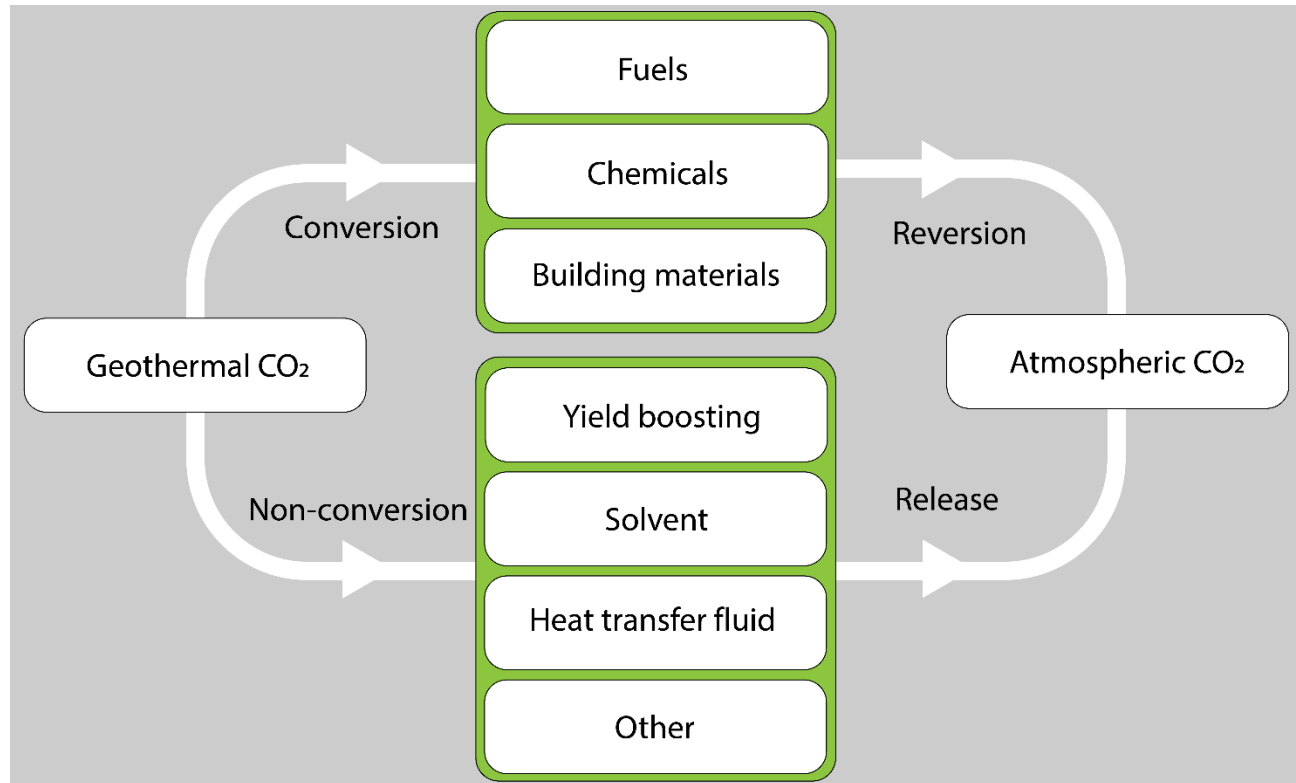


Geothermal CO₂ Emissions



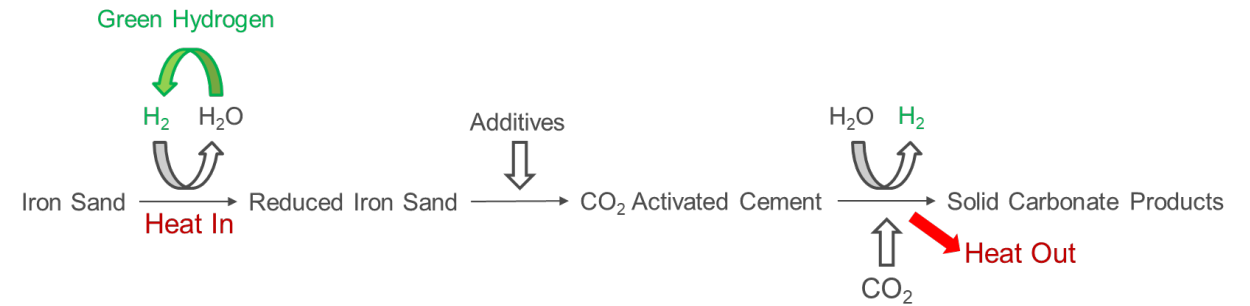
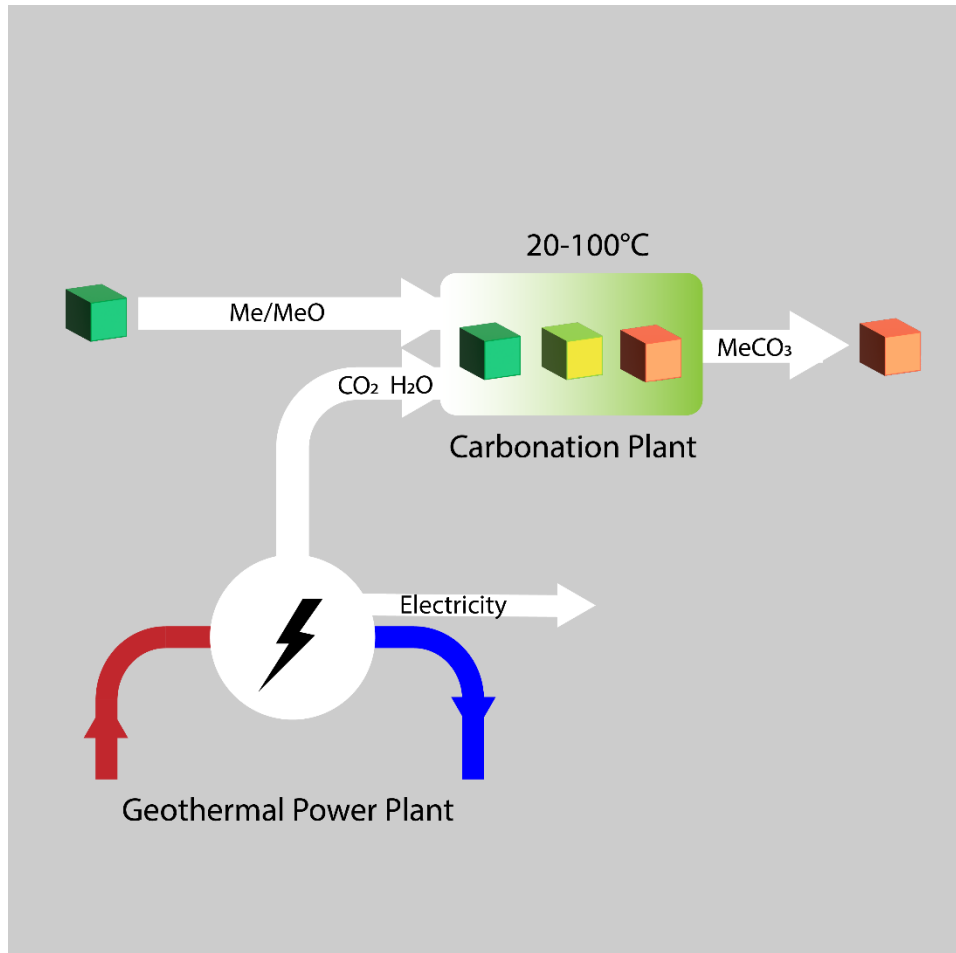
- **Currently emit NCG to atmosphere**
- **Reinjection trials**
 - How will this impact natural emissions?
- **CO₂ utilisation**
 - NCG as a resource stream

CO₂ Utilisation



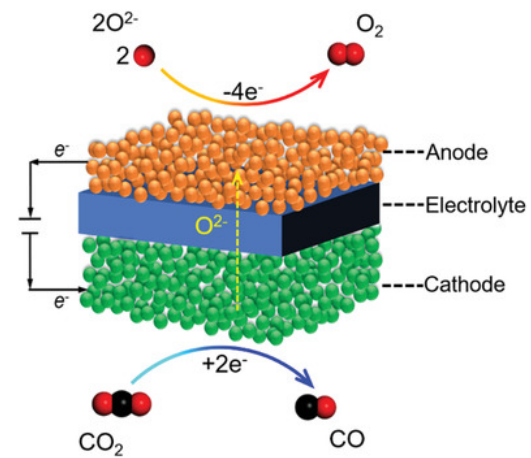
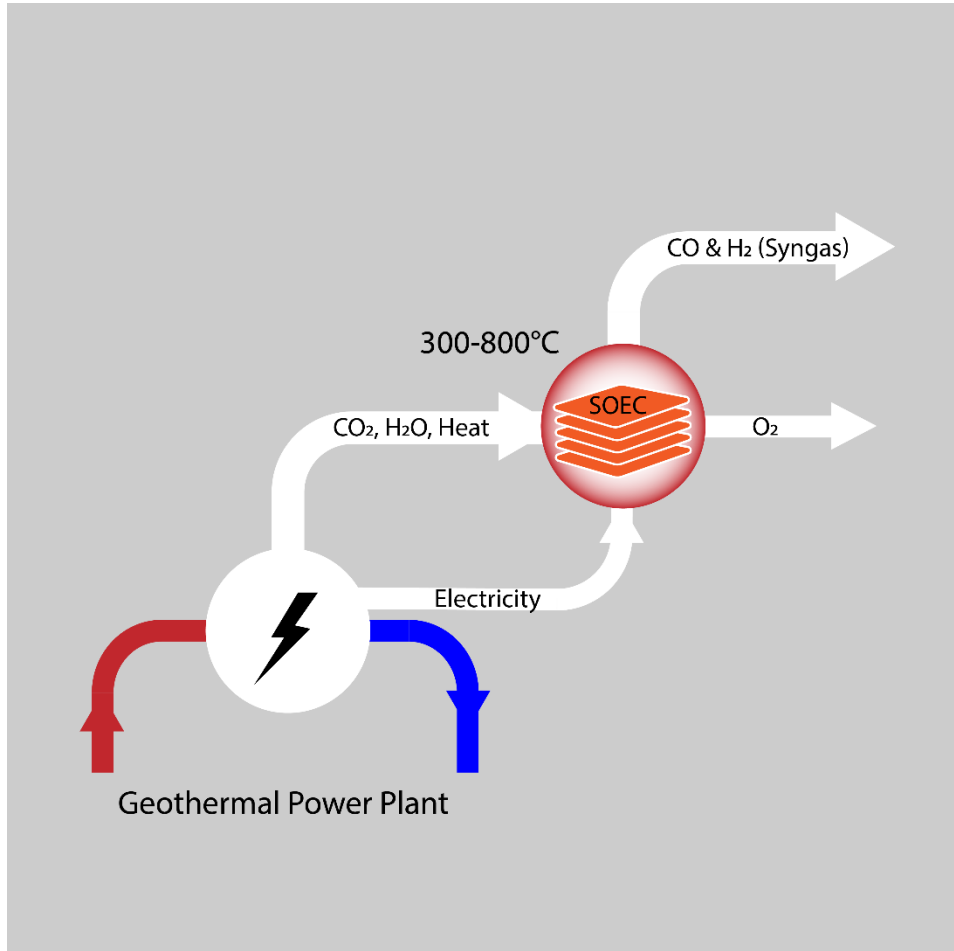
- **Many options for CO₂ utilisation**
- **Key characteristics:**
 - Stable
 - Long-lasting
 - Utility/Value
 - Measurable

Carbon Absorbing Infrastructure

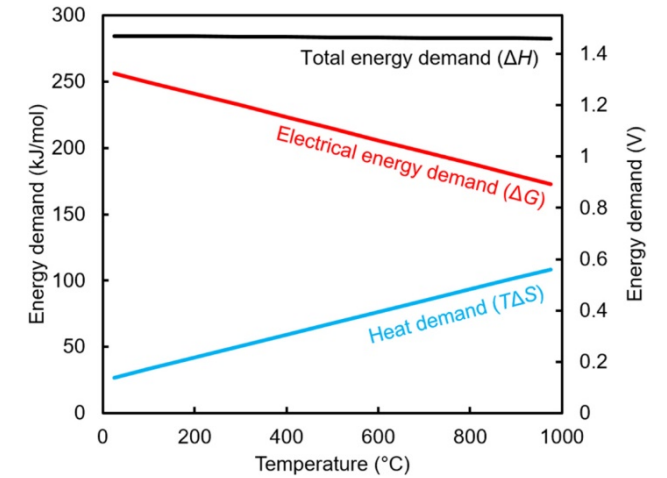


- **Potential for direct use of NCG stream**
- **Drivers from construction sector**
- **Need to understand upstream processes**

Solid Oxide Electrolysis



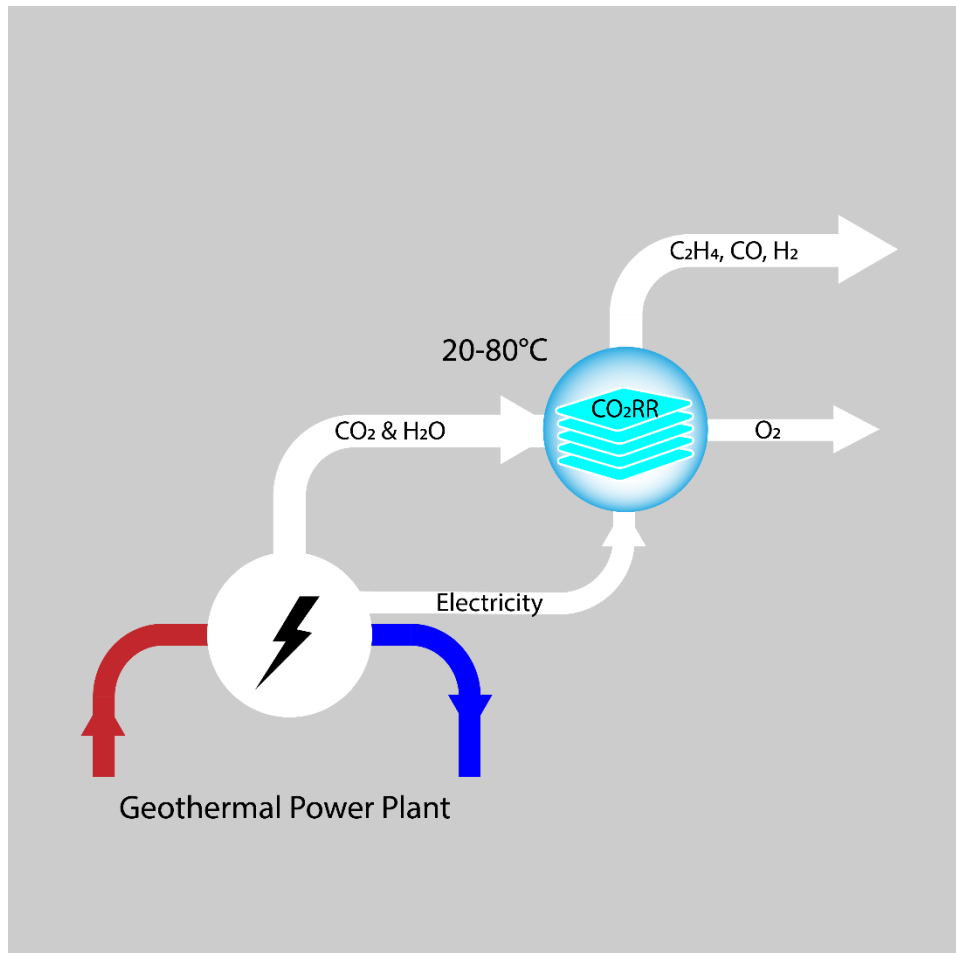
Solid Oxide Electrolysis cell
(Adv. Mater. 31 (2019) 1902033)



Thermodynamics for CO₂ electrolysis
(Journal of The Electrochemical Society 167 (2020) 044508)

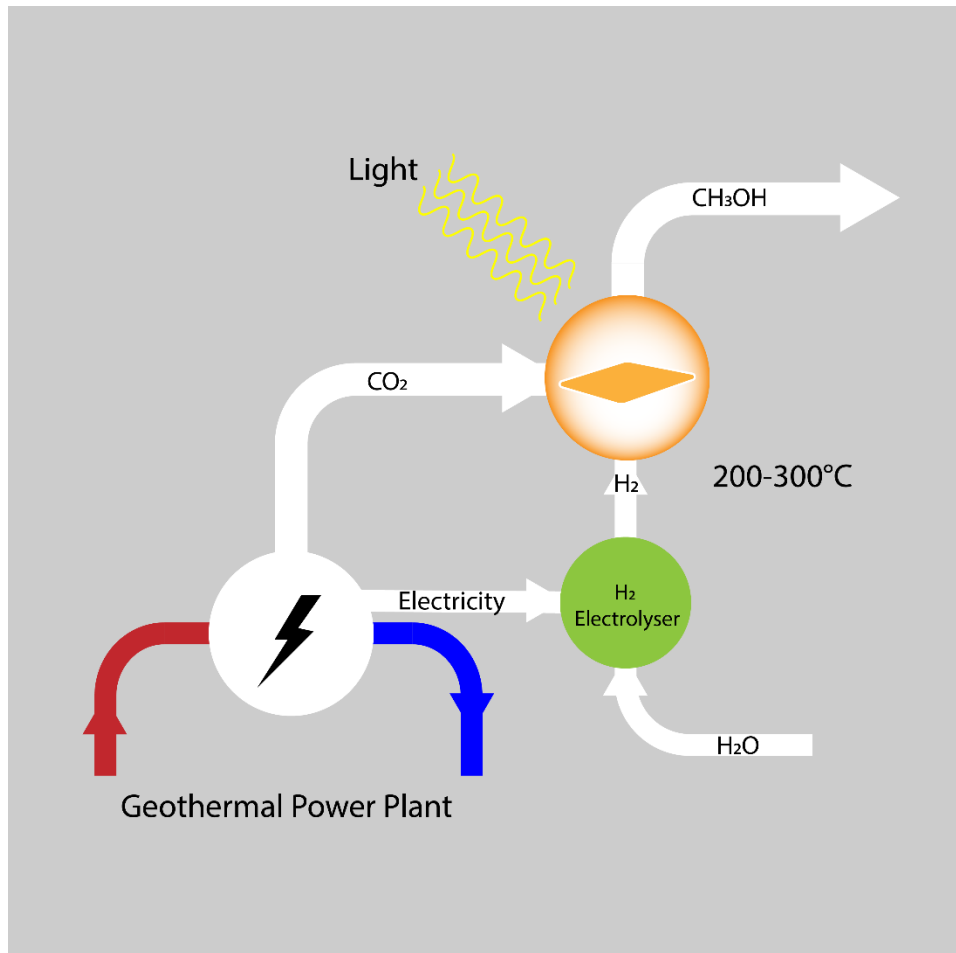
- Efficient process
- Directly substitute heat for electricity
- Temperature and materials challenges

Electrocatalytic CO₂RR



- Potential for on-step conversion to products
- Low temperature operation
- Catalyst development is required

Photothermal Catalysis



- Heat and light used to drive reactions
- Light replaces pressure in shifting equilibrium
- Can use natural or artificial light
- Complex catalysts required

Summary

- **CO₂ emissions from geothermal energy will be a significant problem in the future if not dealt with.**
- **Our current approach is to view CO₂ as a resource for conversion into useful products.**
- **Multiple pathways to products each with advantages and disadvantages**