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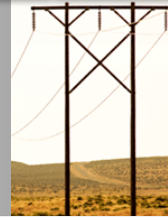
# Carbon Capture & Storage

**SANEA: Action for Energy**  
**4-5Jun09**



**Dr A D Surridge**  
**Senior Manager Advanced Fossil Fuels**  
**Head: Centre for Carbon Capture and Storage**  
**SANERI**  
**tonys@saneri.org.za**

## Principle



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### **Extract Carbon Dioxide from Fossil Fuel Use**

Electricity Generation Stations [ $\sim 12\%$   $\text{CO}_2$ ]

Synthetic Fuel Plants [ $\sim 95\%$   $\text{CO}_2$ ]

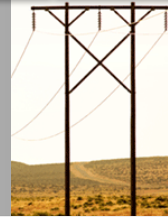
etc

### **Inject Carbon Dioxide back into Geological Formations** [from whence the fossil fuel came]

Depleted Oil and Gas Fields

Deep Saline Aquifers

# Greenhouse Gas



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**Carbon Dioxide is the Most  
Copious Greenhouse Gas Emission**



**Global Climate Change**

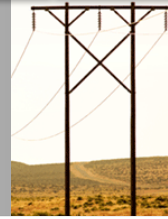


**Negative Socio-Economic Impacts**

**ERGO**

**Need to Limit Carbon Dioxide Emissions**

# Plant Lifetime



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## World-Wide:

Use of Fossil Fuels shall Increase

- New Plant Construction
- 40-60 years Lifetime of Plant

## Southern Africa:

Existing Plant and Life Extension

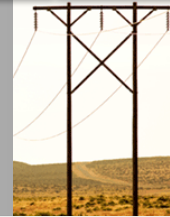
New Coal Fired Electricity Generation Plant

- Eg Medupi/Kusile etc

New Syn-Fuel Plant

## TRANSITION TO NUCLEAR AND RENEWABLES

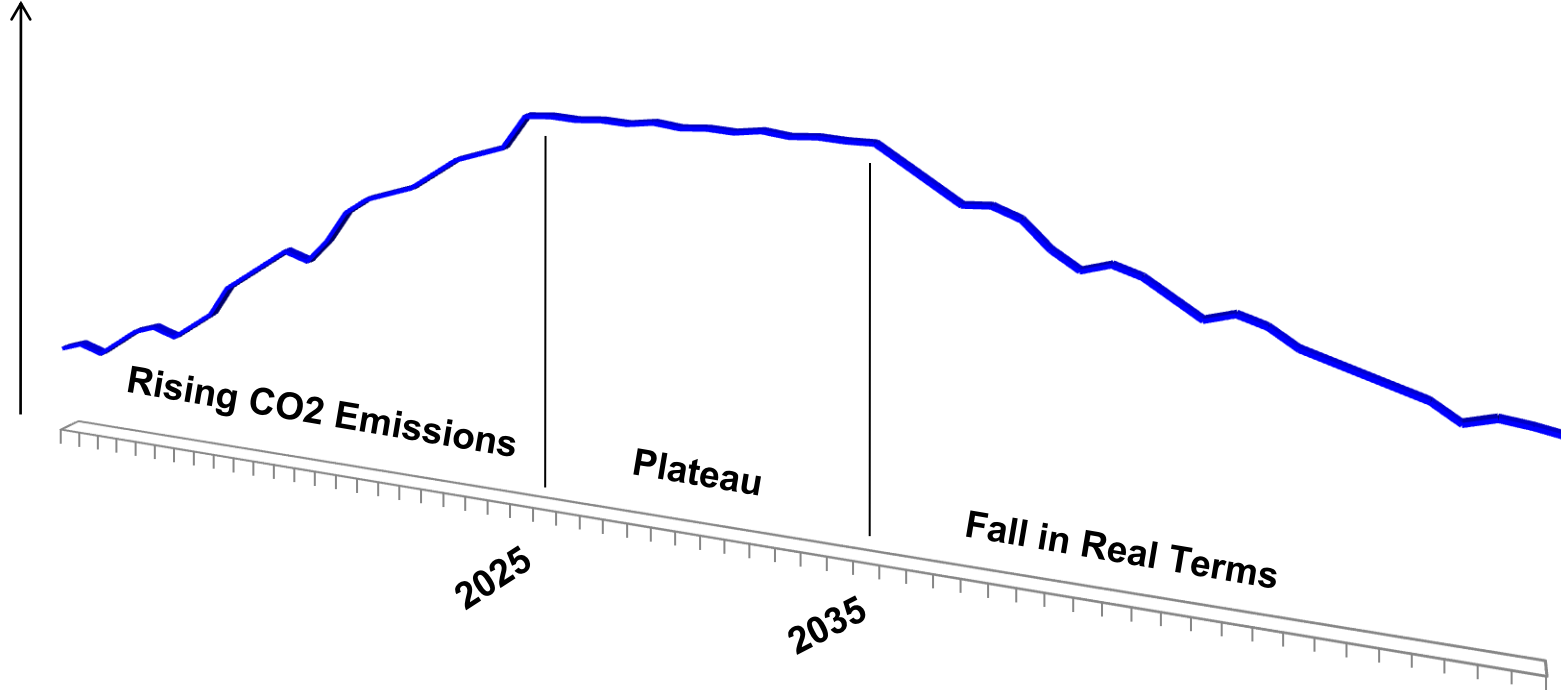
# South Africa Carbon Dioxide Emissions Projection



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## Climate Change Summit Announcement - Mar09

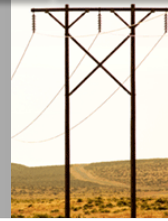
CO2 Emissions



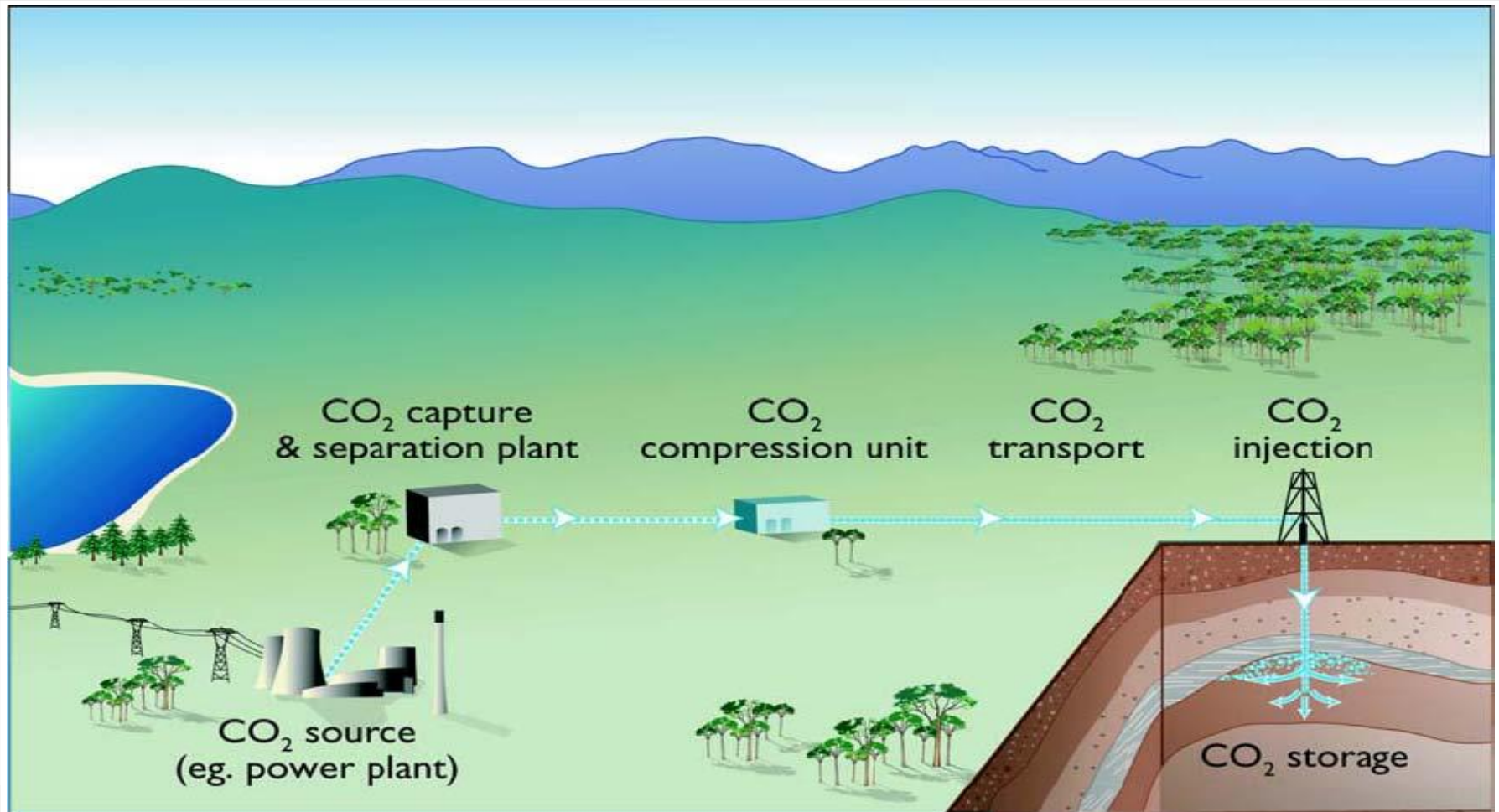
**New Plant to be Capture Ready**



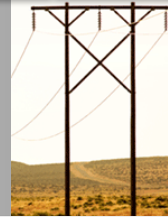
# Four Stages



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# Capture Technology



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## Capture:

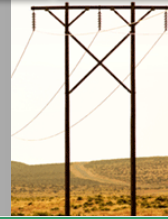
### Existing Technology

- Chemical – Amine

### Widespread Research to Improve Efficiencies and Lower Costs

- Chemical
- Membrane
- Chemical/Membrane Hybrid
- Oxy-Combustion
- Integrated Gas Combined Cycle

# Capture Technology



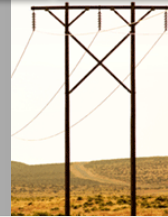
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Source: ABB Lummus

E.S. Rubin, Carnegie Mellon

# Transport Technology



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## Transport:

Existing Pipeline Technology

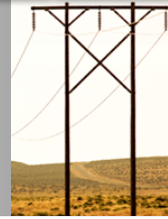
- Compression
- Transport

CO<sub>2</sub> Acidic [cf CH<sub>4</sub>]

Long Distances Add to Cost

Regulatory Systems in Place

# Injection Technology



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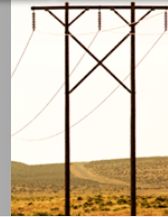
## Injection:

Widespread Experience [greater than three decades]

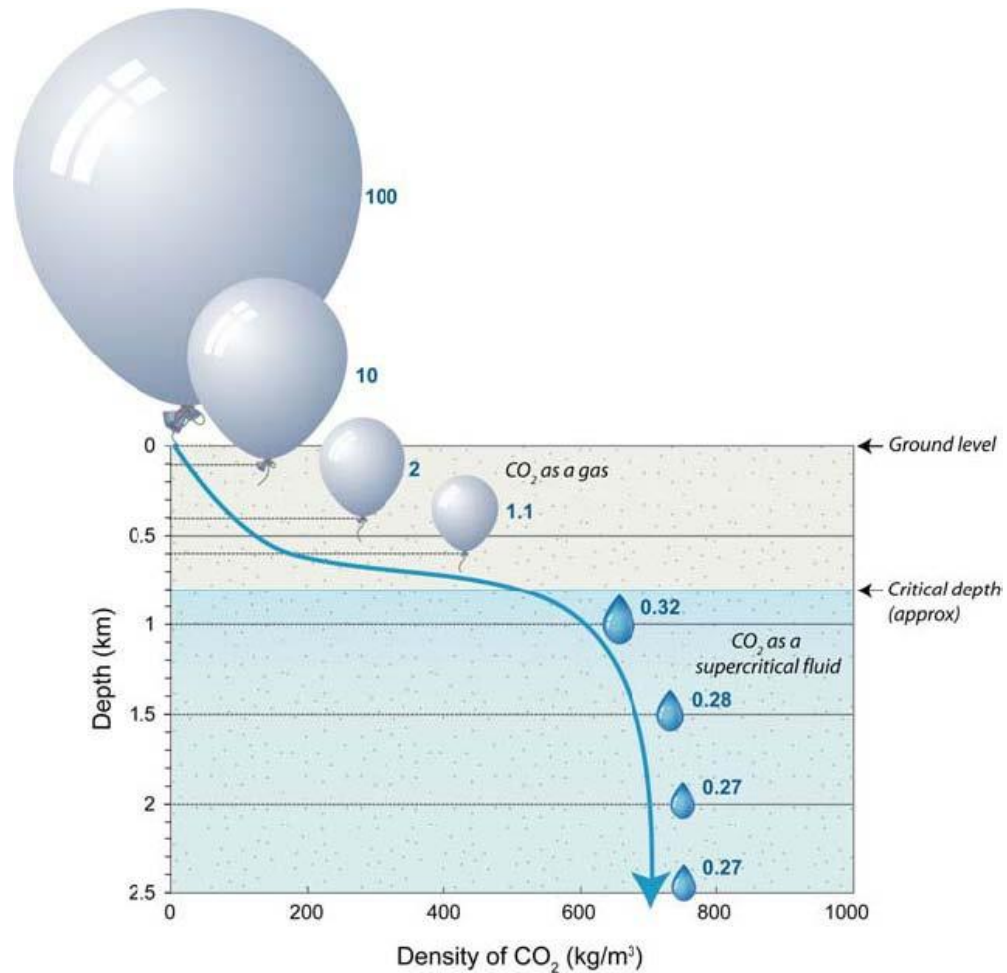
- Enhanced Oil/Gas Recovery - decades
- CO2 Storage
  - Sleipner
  - 1 million tonnes CO2 per year
  - Storage Less Expensive than C Tax

Inject below 800m Depth

# Compression

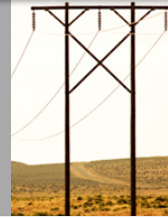


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# Injection Formations



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## Geological Formations:

Depleted oil/gas fields

Un-mineable Coal Seams

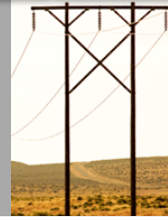
Deep Saline Aquifers

## Characteristics:

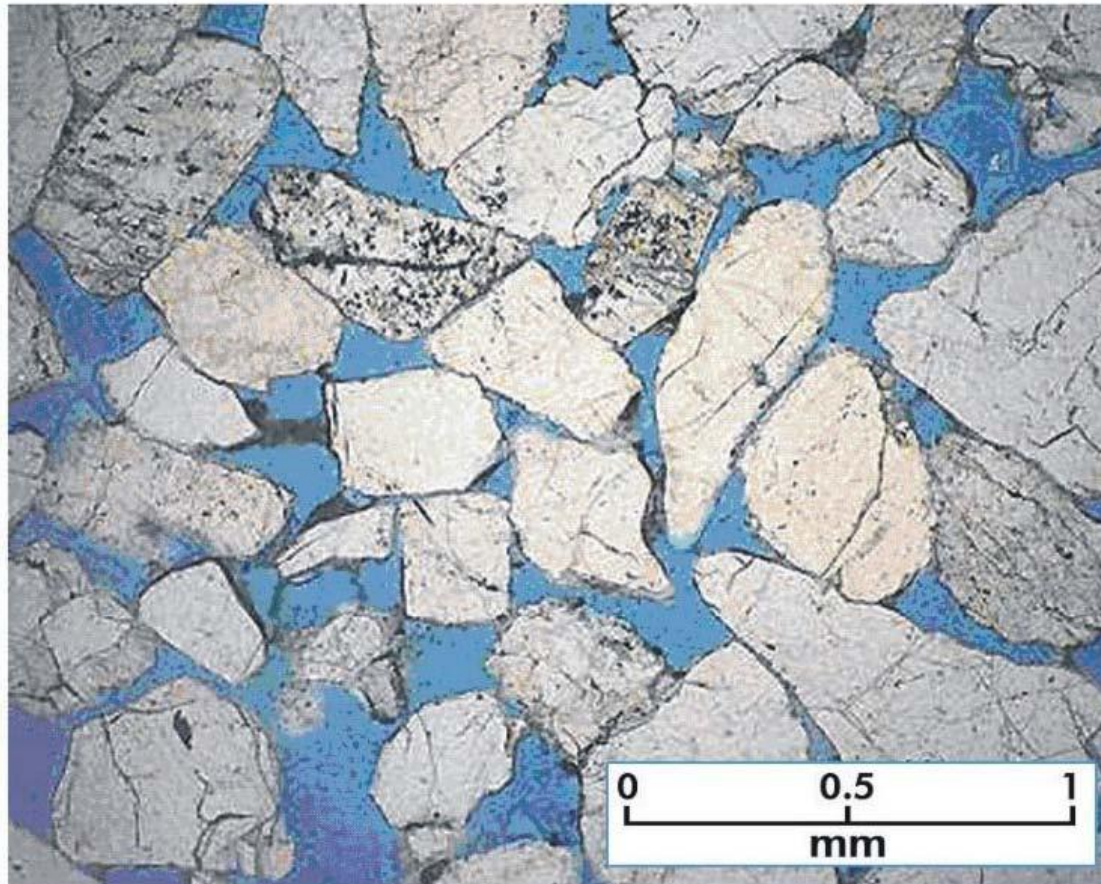
Cap Rock

High Porosity / High Permeability

# Injection Rock

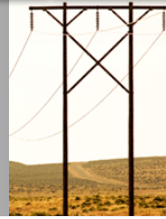


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# Permanency



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## Permanency Stages of Trapped CO<sub>2</sub>:

### Structural Trapping

- Overlaying cap rock

### Residual Trapping

- Tiny pores in rock – capillary pressure of water

### Solubility Trapping

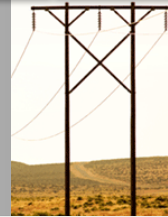
- Dissolve in saline water

### Mineral Trapping

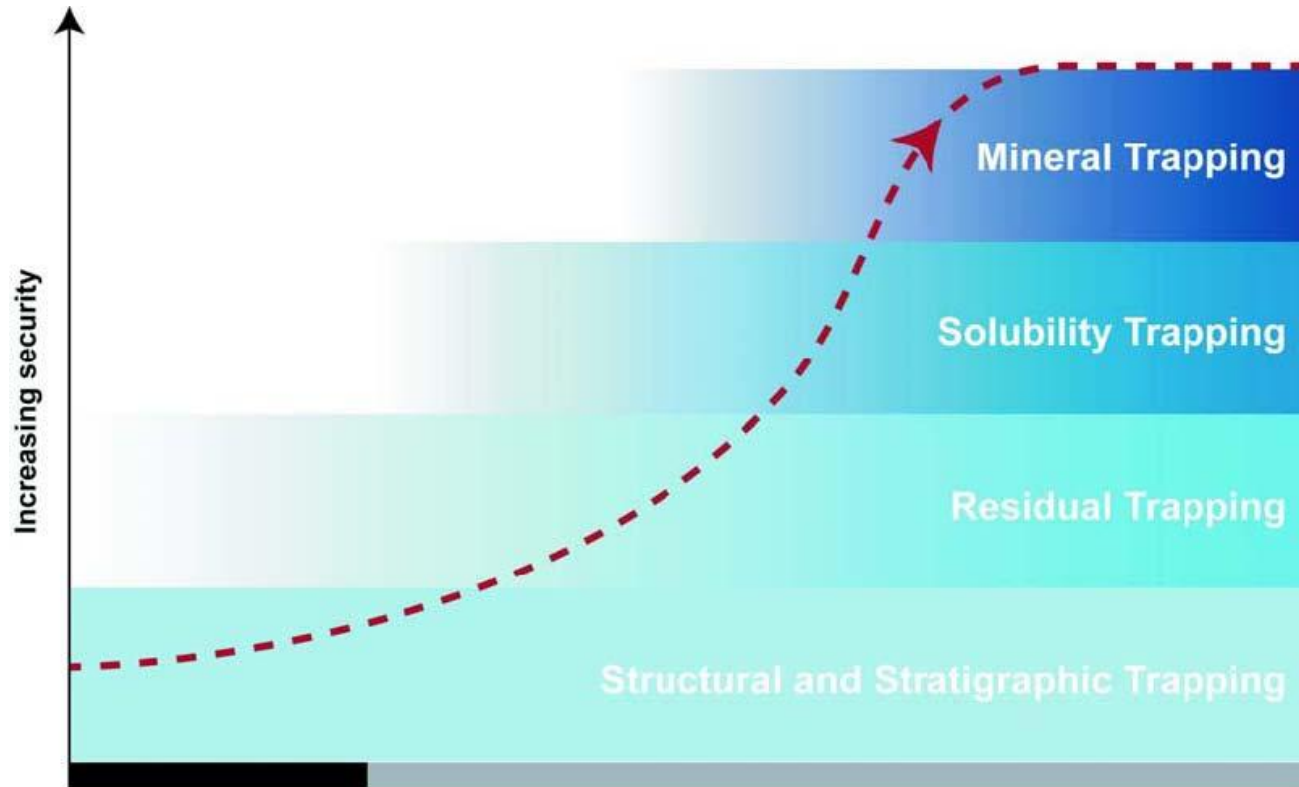
- React chemically with surrounding rocks – become part of rock

INCREASING PERMANENCY

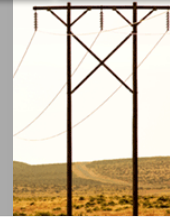
# Carbon Capture & Storage Injection Technology



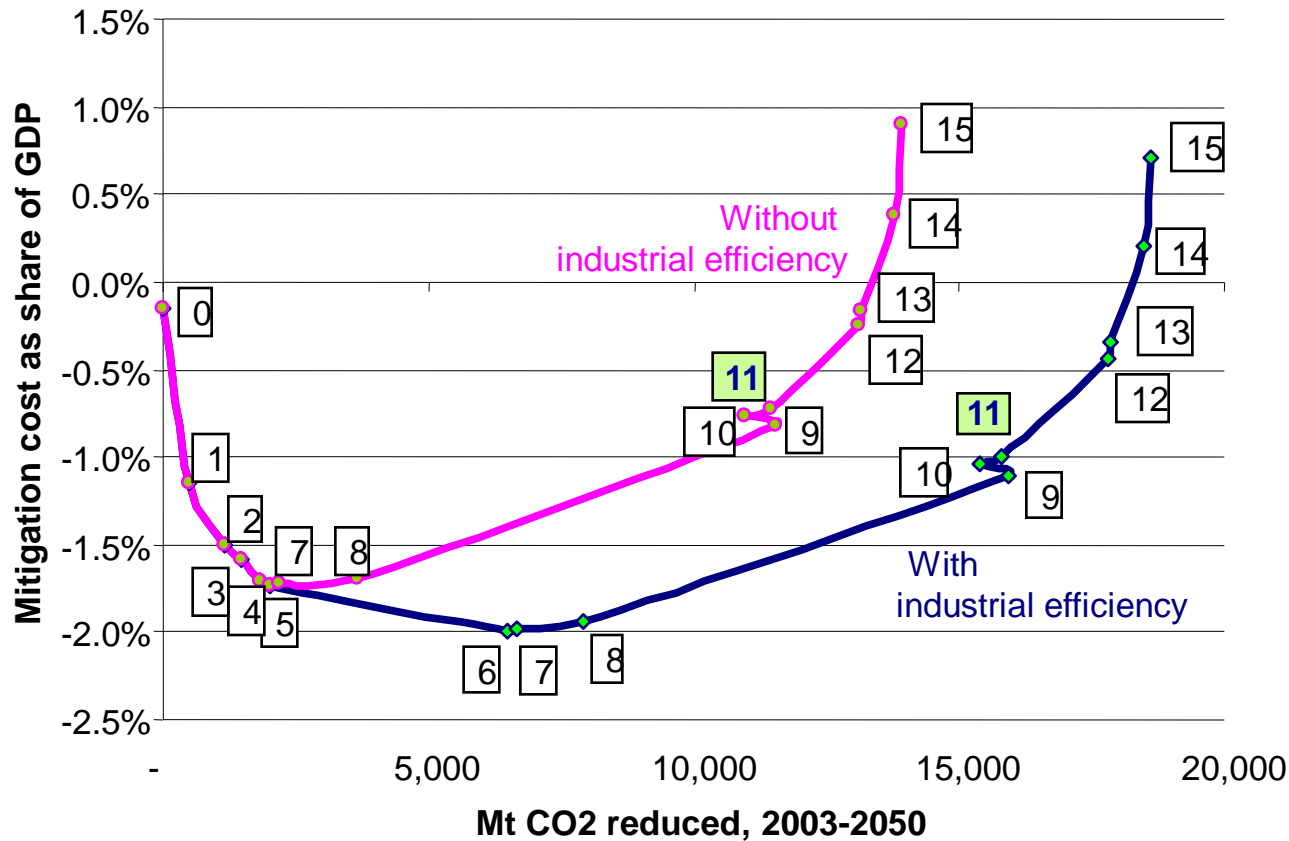
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# SA Long Term Mitigation Scenario



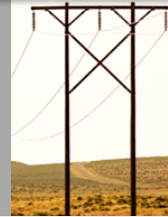
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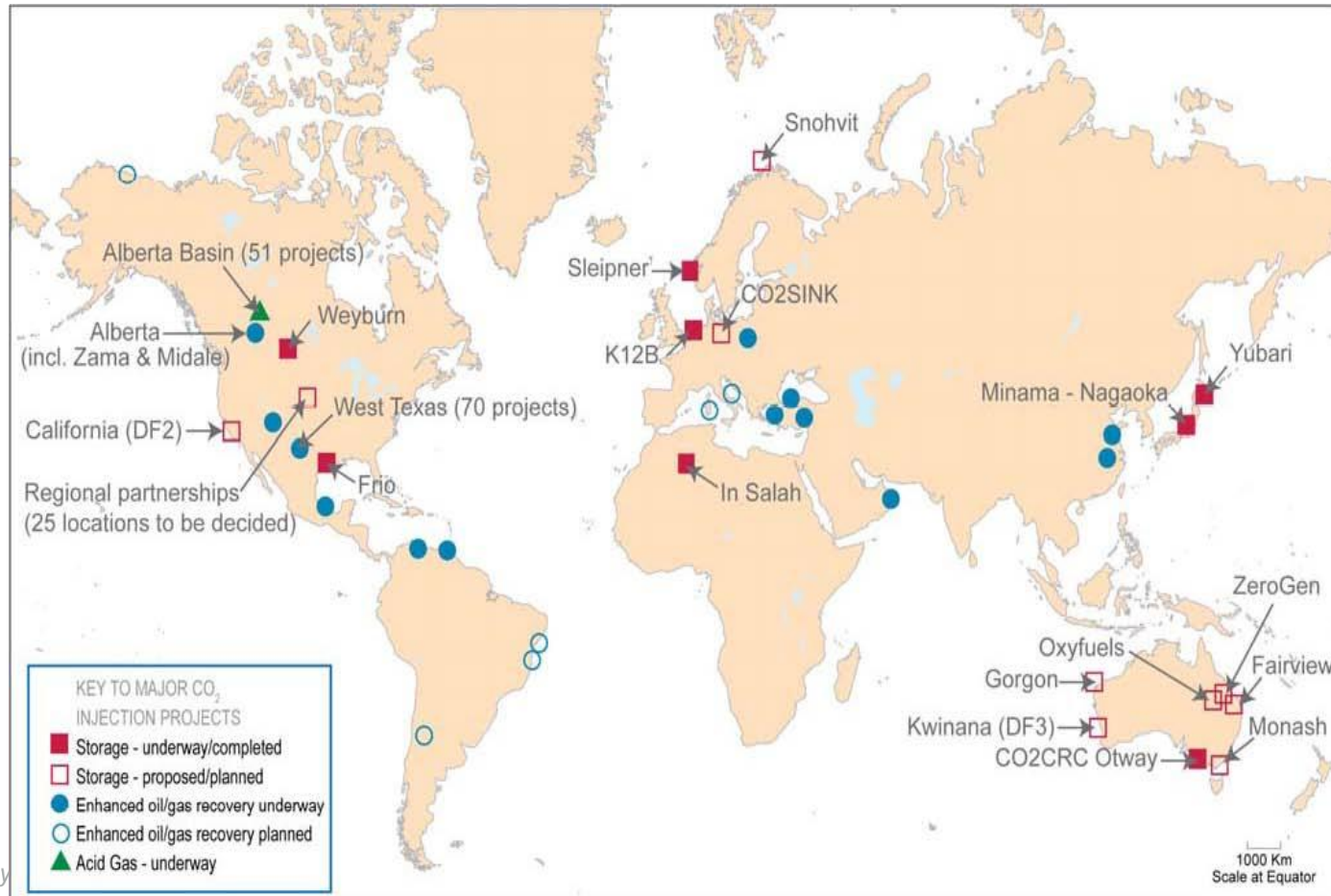
- 0 Limit on low-efficiency vehicles
- 1 +Passenger modal shift
- 2 +Improved vehicle efficiency
- 3 +SWH subsidy
- 4 +Commercial efficiency
- 5 +Residential efficiency
- 6 +Industrial efficiency
- 7 +Cleaner coal
- 8 +Nuclear
- 9 +Escalating CO2 tax
- 10 +Renewables
- 11 +CCS 20 Mt**
- 12 +Subsidy for renewables
- 13 +Biofuels
- 14 +Electric vehicles in GWC grid
- 15 +Hybrids

Mitigation costs as share of GDP, for runs of combined wedges -each time adding another as in list at right

# World Projects

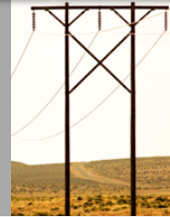


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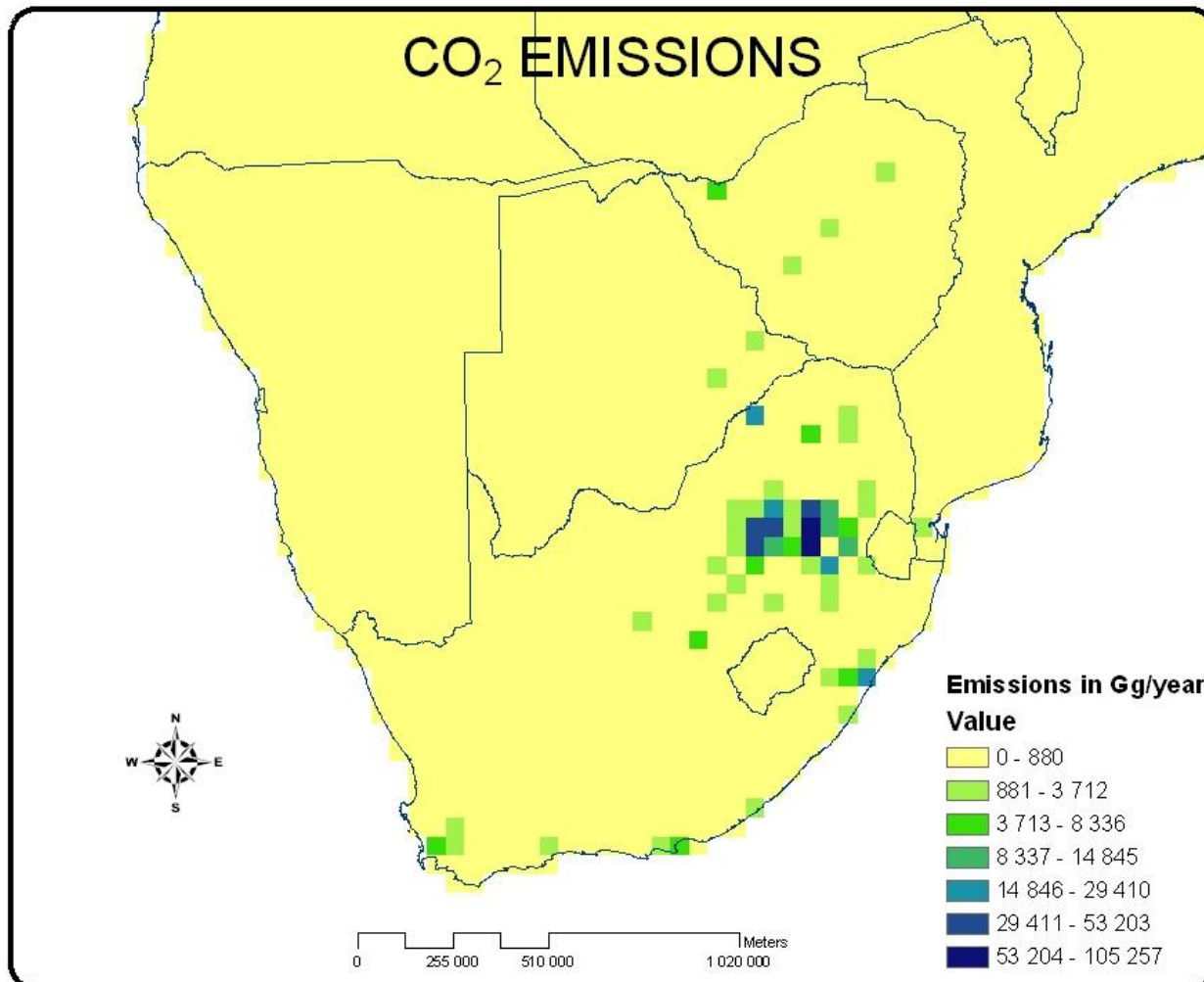


Energy

# CO<sub>2</sub> Emissions

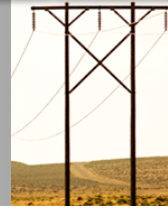


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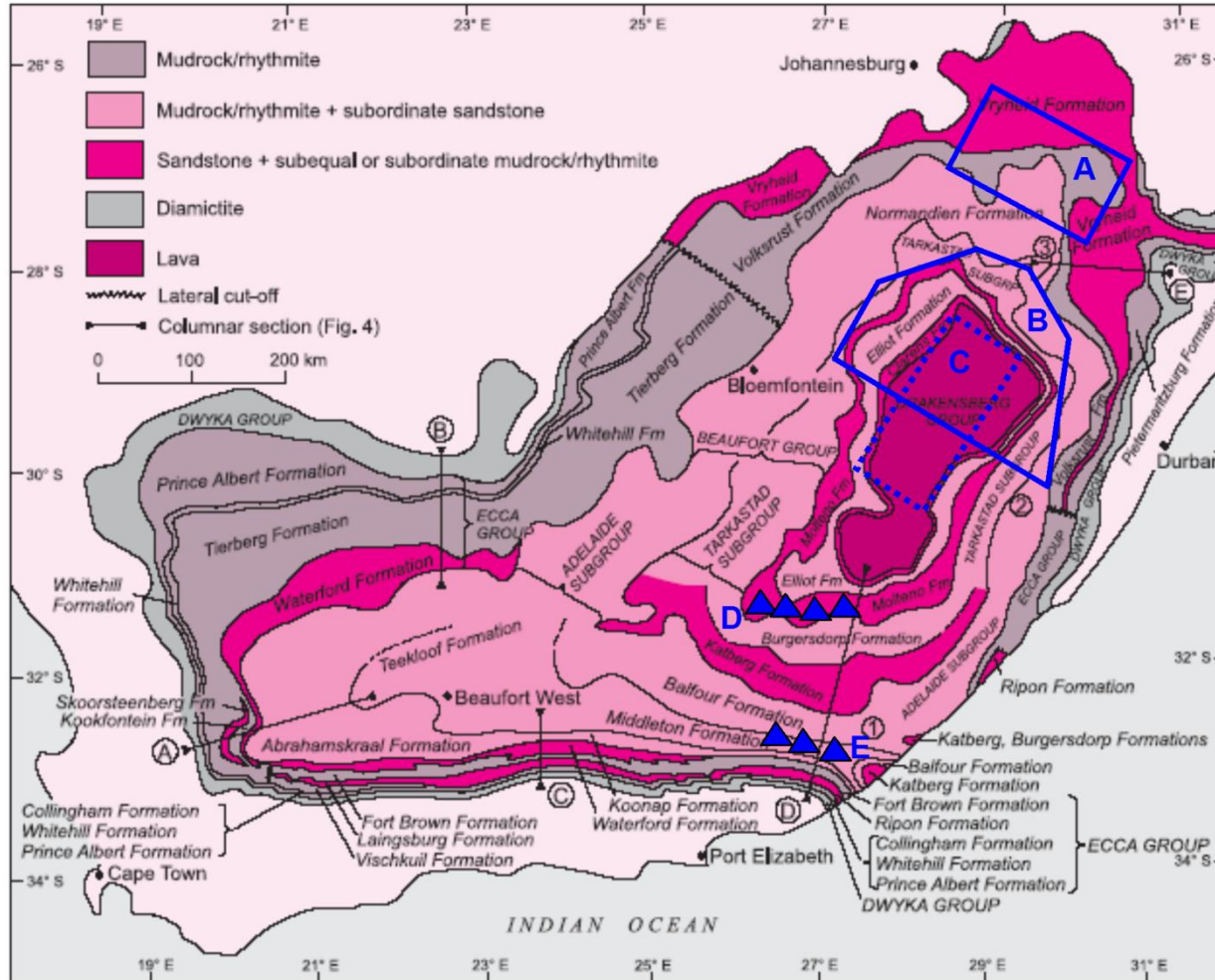


# CCS STORAGE GEOLOGY

## Deep Saline Aquifers



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← A: ~183 GT Storage Potential

← B: ~80 Gt Storage Potential

← C: ~24 Gt Storage Potential

← D&E: Storage Potential Undetermined

## CCS STORAGE GEOLOGY Preliminary Estimation



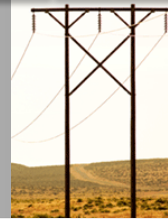
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AREA	NAME	Gigatonnes CO <sub>2</sub>
<b>A</b>	Vryheid Formation	183 (0)
<b>B</b>	Free State, KwaZulu Natal & Lesotho	80
<b>C</b>	Molteno & Clarens Formations	24
<b>D &amp; E</b>	E Cape	?
<b>Other</b>	Above-Ground	?
<b>TOTAL</b>		<b>~287 (104) Gt</b>

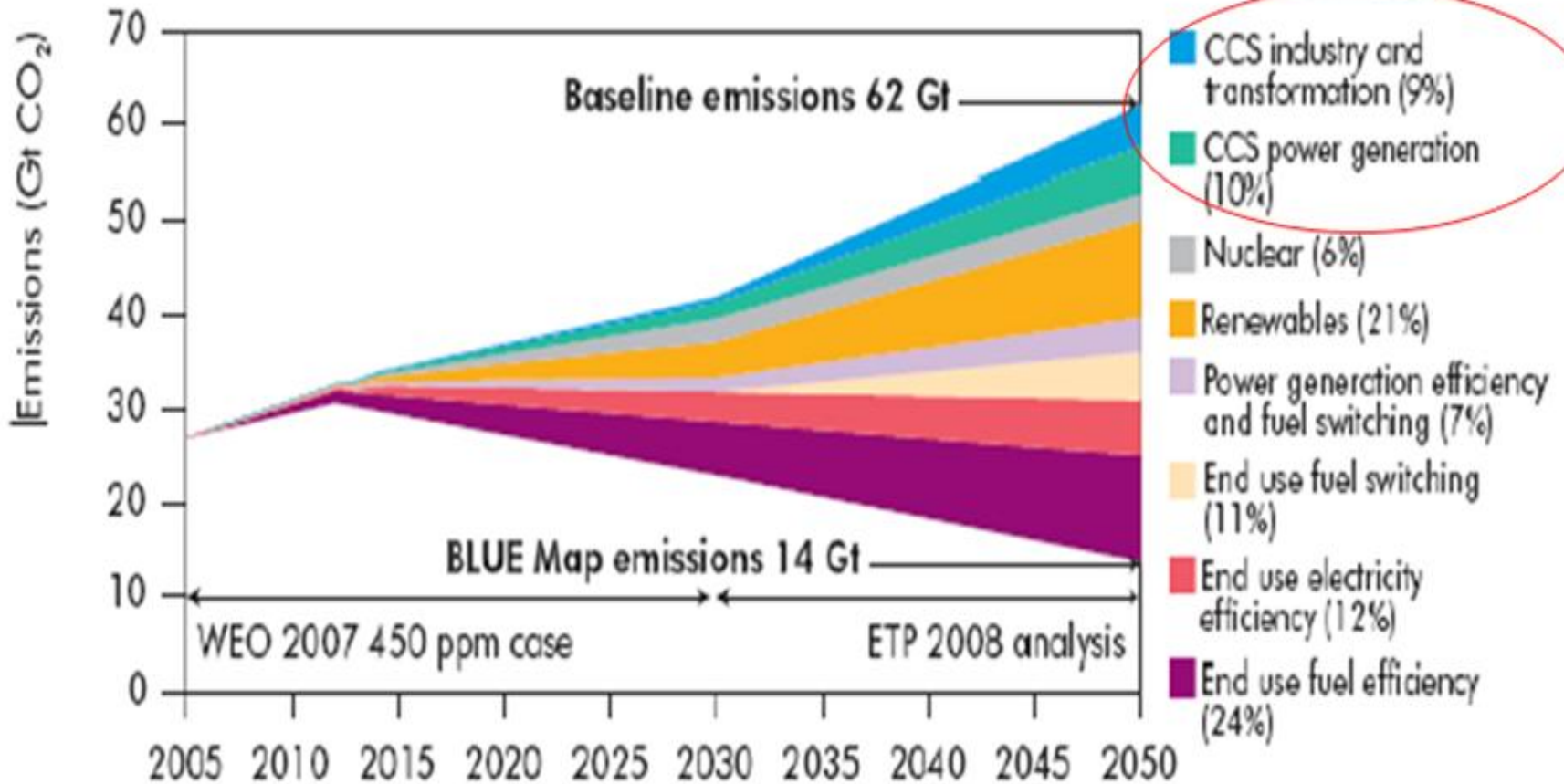
>11x (4 x) current sequestratable 287 million tonnes per year for 100 years

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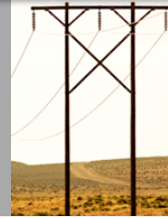
# Storage Needed I



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# Storage Needed II



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- IEA: 19% of total emissions
- SA LTMS: 5% of total emissions
- Say Store 40Mt/y for 100 y:

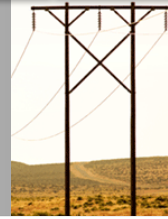
Need 4 Gt

- Theoretical Calculation:

Possible 104 Gt

## Incentive to Continue Investigations

# Geological Storage Atlas



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## Geological Storage of Carbon Atlas

### Definitive Information Regarding Geological Storage Potential

- Undertaken by Council GeoScience – Some Data from Petroleum Agency

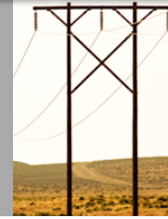
### Financially Supported by:

- PetroSA
- AngloCoal
- Eskom
- Sasol
- SANERI

**Inception Meeting – 4Sep08**

**Scheduled Publication mid 2010**

# CCS Conference Training Courses

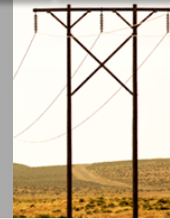


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- 🔥 **Introductory Course - 28Sep09**
  - CO2CRC Australia
- 🔥 **Carbon Capture and Storage Conference 29Sep/20Oct09**
  - Official Opening of South African Centre for Carbon Capture and Storage**
  - International Expertise**
- 🔥 **Legal Framework Course – 10Oct09**
- 🔥 **Advanced Geological Storage Course – 20Oct09**
  - British Geological Survey

# South African Centre for Carbon Capture & Storage

Established 30Mar09



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## South African Centre for carbon capture & storage

### Core Parties

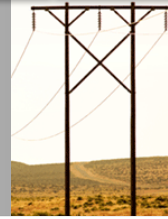


### Participants



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# South African Centre for Carbon Capture & Storage



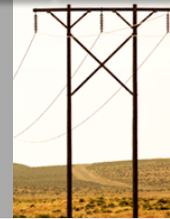
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**VISION:** carbon capture and storage demonstration plant to be operational in South Africa by the year 2020



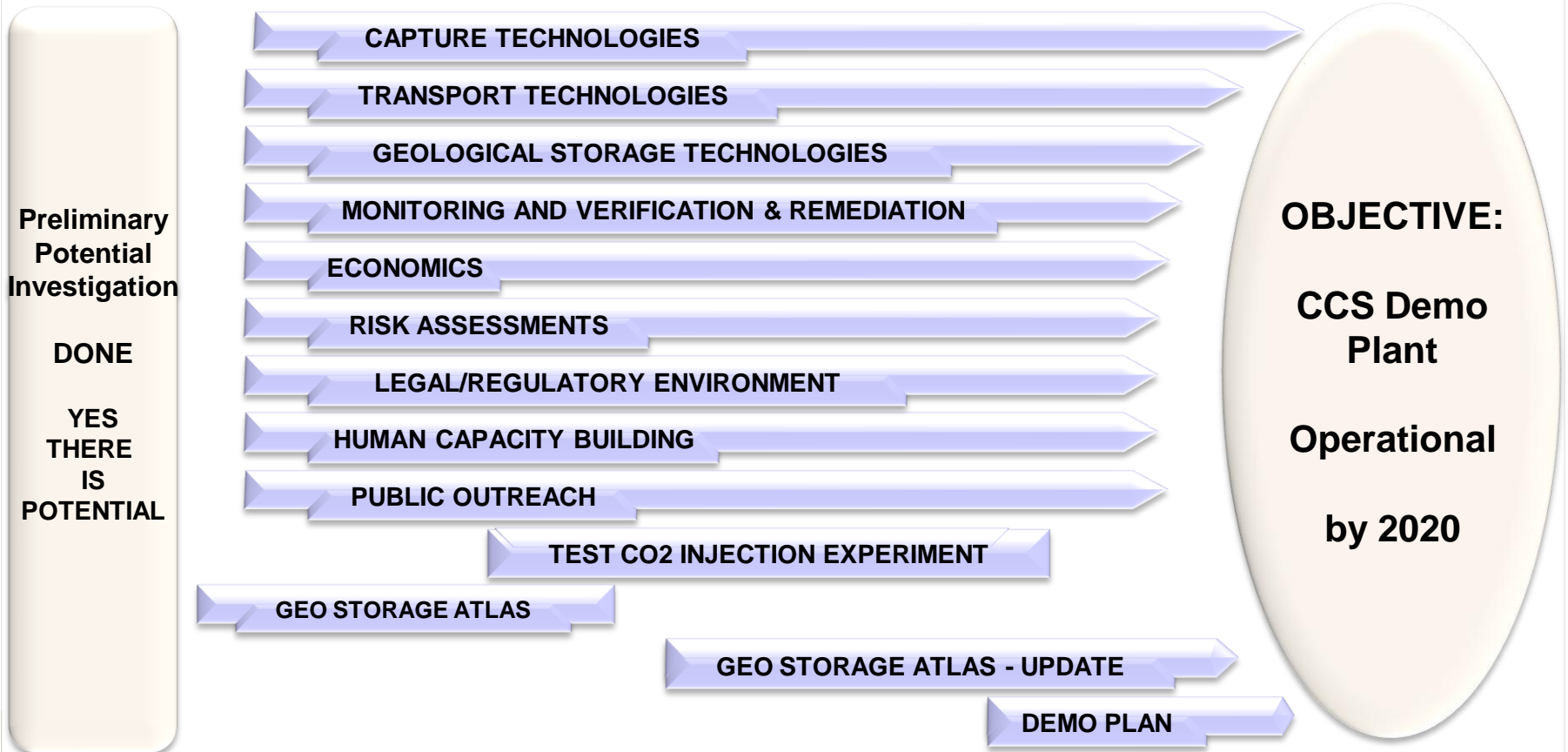
**MISSION:** develop in country human and technical capacity to undertake the envisioned demonstration plant

# Mission Country Readiness

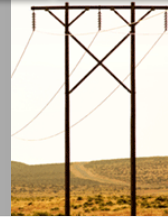


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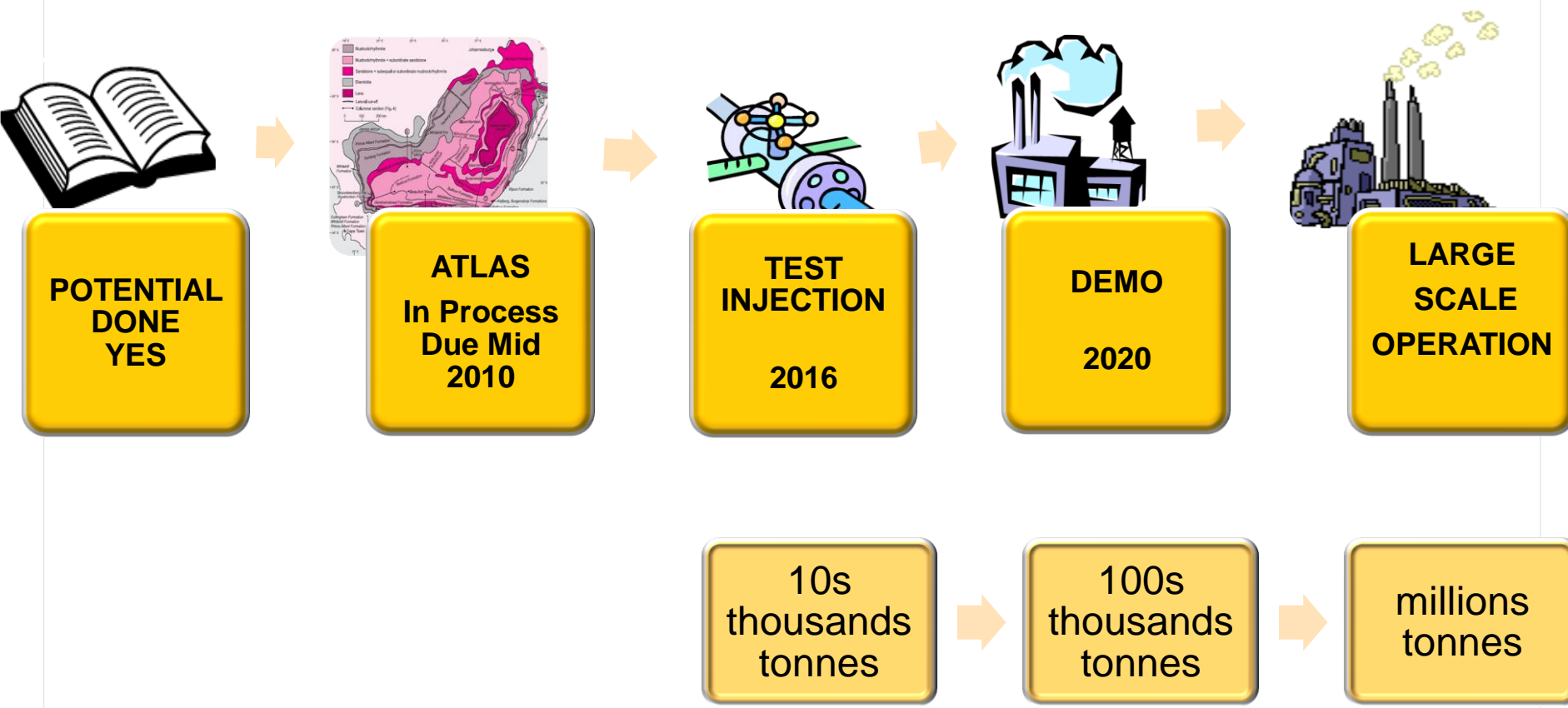
*Enablers in place that facilitate the implementation of carbon capture and storage*

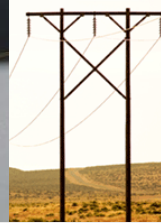
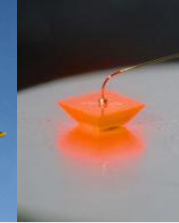


# CCS in South Africa Time/Scale



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# Thank You