# Repeating history

## The Potential for Carbon Dioxide based Industries in Trinidad and Tobago

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# Conclusions

- Trinidad and Tobago's energy sector can realise three significant benefits from carbon capture:

1. **Reversing the current decline in oil production through carbon dioxide enhanced oil recovery ($CO_2$EOR).**
2. Reducing the country's net carbon dioxide ($CO_2$) emissions.
3. Creating new industries

1960s-1985

# Natural Gas Development

# Way marks

- South Chamber of Commerce
- Establishment of Point Lisas Industrial Estate
- Trans-island pipeline- NGC
- Liquefied Natural Gas

## Point Lisas Industrial Estate 1985

| Company | State Ownership (%) | Start-up Year | Cost (MMUS$) |
|---|---|---|---|
| The Iron & Steel Company of T&T | 100 | 1981 | 500.0 |
| TRINGEN 1 | 51 | 1977 | 111.4 |
| Fertilizers of Trinidad and Tobago (FERTRIN 1&2) | 51 | 1982 | 350.0 |
| Trinidad and Tobago Methanol Company (TTMC) | 100 | 1984 | 179.2 |
| Trinidad and Tobago Urea Company (TTUC) | 100 | 1984 | 117.1 |

Point Lisas Industrial Estate 2012

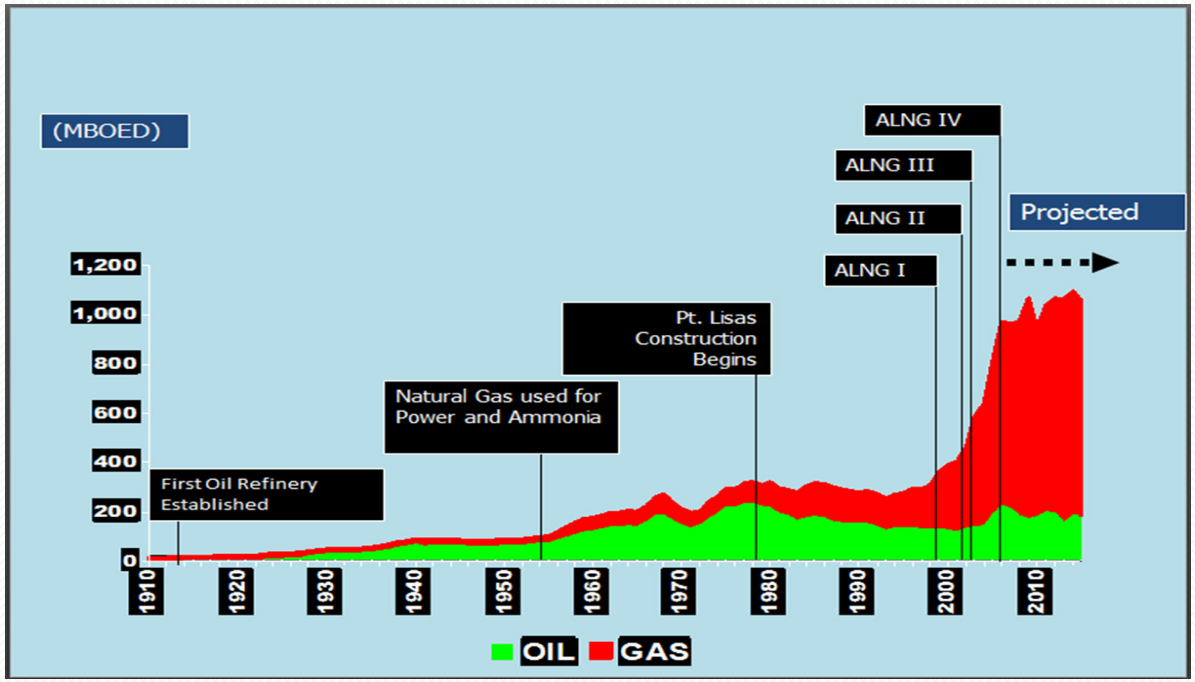
| Plant | | Ownership |
|---|---|---|
| 1 | TTMC I | CL Financial Group (56%), Consolidated Energy Limited (44%) |
| 2 | TTMC II | |
| 3 | CMC | |
| 4 | Methanol IV | |
| 5 | M5000 | |
| 6 | Methanex (Titan) | Methanex Corporation (100%) |
| 7 | Atlas Methanol | Joint-venture with Methanex Corporation (63.1%) and bpTT (36.9%) |
| 1 | Yara | Yara Caribbean (100%) through Yara (Trinidad) Ltd |
| 2 | Tringen I | Yara Caribbean (49%) and GORTT (51%) |
| 3 | Tringen II | |
| 4 | PCS Nitrogen I | Potash Corp Saskatchewan (100%) through PCS Nitrogen Inc |
| 5 | PCS Nitrogen II | |
| 6 | PCS Nitrogen III | |
| 7 | PCS Nitrogen IV | |
| 8 | Pt. Lisas Nitrogen | Koch Nitrogen Industries (50%), Terra Industries (50%) |
| 9 | Caribbean Nitrogen Company | Process Energy/Clico Energy Ltd (30%) |
| 10 | Nitrogen 2000 | Consolidated Energy Limited /FS Petrochemicals (30%)<br>Koch Nitrogen Industries (30%)<br>EOG Resources Trinidad Ltd (10%) |
| 11 | AUM Ammonia Plant | CL Financial Group (56%), Consolidated Energy Limited (44%) |
| 1 | AUM Urea Plant | |
| 1 | AUM Nitric Acid Plant | |
| 1 | AUM Ammonium Nitrate Plant | |
| 1 | AUM UAN Mixing Plant | |
| 1 | AUM Melamine Plants (x 2) | |
| 2 | PCS Nitrogen | Potash Corp Saskatchewan (100%) through PCS Nitrogen Inc |
| 1 | Phoenix Park Gas Processors | NGC (51%), Conoco Phillips (39%), and Pan West (10%) |
| 1 | Nu Iron Unlimited | NUCOR Corporation |
| 2 | Mittal Steel Company | Arcelor Mittal Trinidad Ltd |
| 1 | Methanol-to-Power | MHTL & UTT |

Source: Ministry of Energy and Energy Affairs

# Way marks

1960s to 2000s

- South Chamber of Commerce
- Establishment of Point Lisas Industrial Estate
- Trans-island pipeline- NGC
  - (TT$4.6 Billion post-tax profit)
- Liquefied Natural Gas



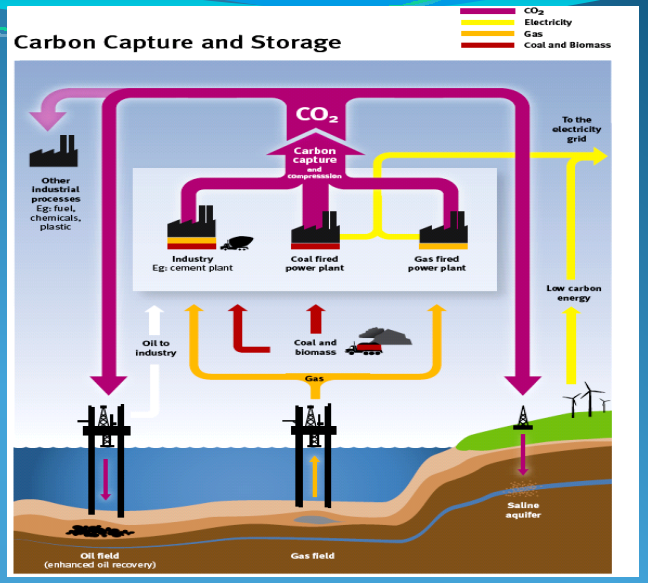

**Source: Ministry of Energy and Energy Affairs**

# National Energy Commission Focus

- Petrochemicals
- Alternative Energy
- Inorganic Chemicals
- Biochemical and Agro-based products
- Plastics
- Metals

*"to develop and manage suitable infrastructure in order to facilitate and promote the various activities relevant and appropriate to natural gas-related operations."*

**Energy Efficiency, Energy Services, Common Utilities**



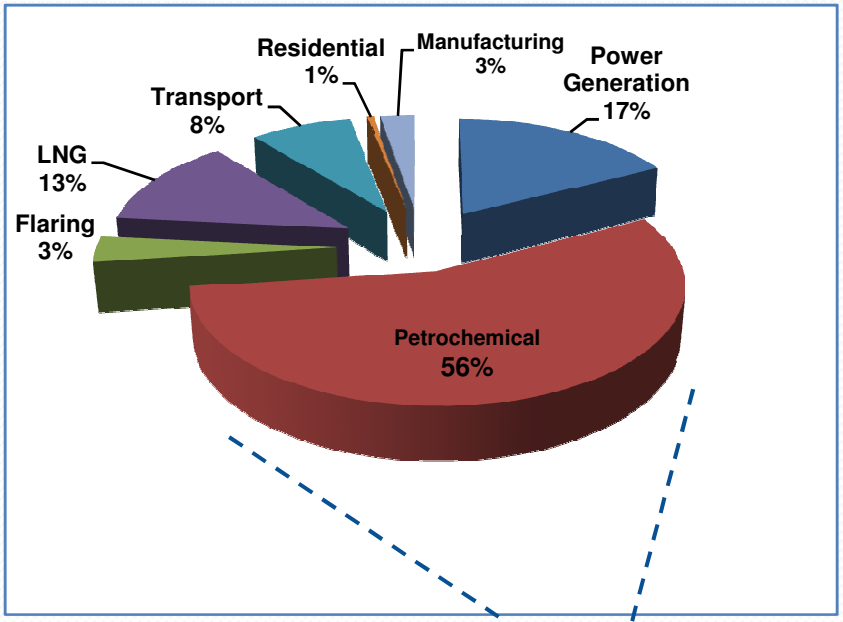

# $CO_2$ Development

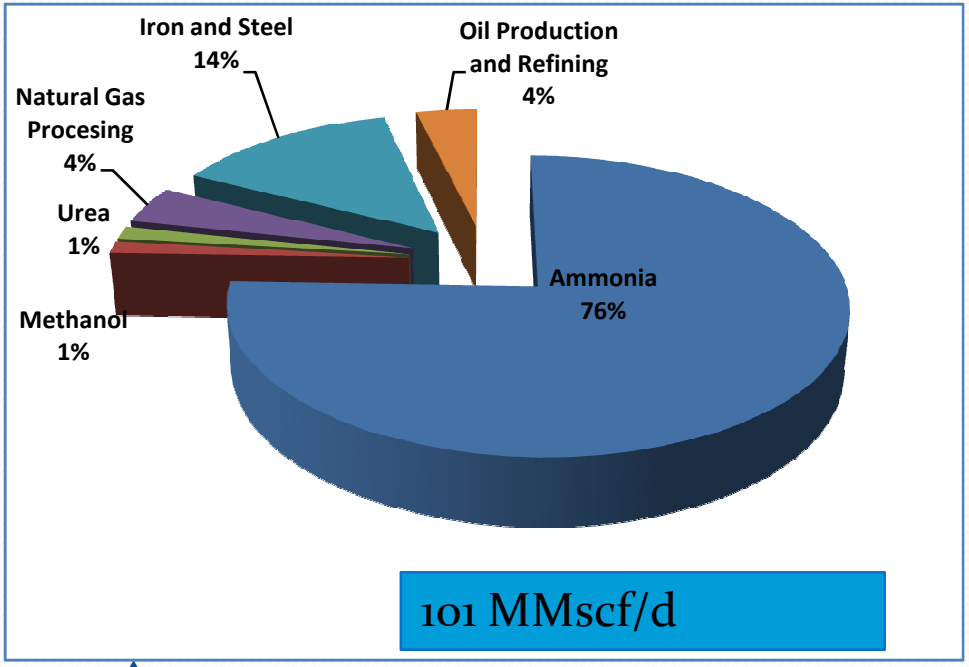

# Motivation

- Climate Change Issues
  - Global Warming
  - Increasing concentration of greenhouse gases (mainly $CO_2$ )
    - Flooding
    - Stronger and more frequent hurricanes
    - Sea level rising
    - Disease
    - Displacement
- Large $CO_2$ emissions
- Signatory to the Kyoto Protocol

# Motivation

Contributions of the Various Sectors to $CO_2$ Emissions in T&T (2009)




Breakdown of the Petrochemical Sector (2009)

## Trinidad & Tobago $CO_2$ Emissions

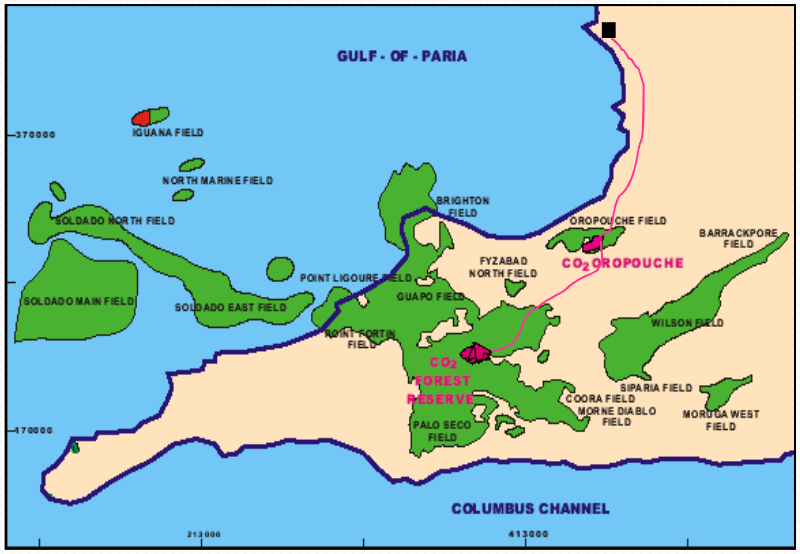
Source: Boodlal et al (2009)

Carbon Storage

# $CO_2$ Enhanced Oil Recovery

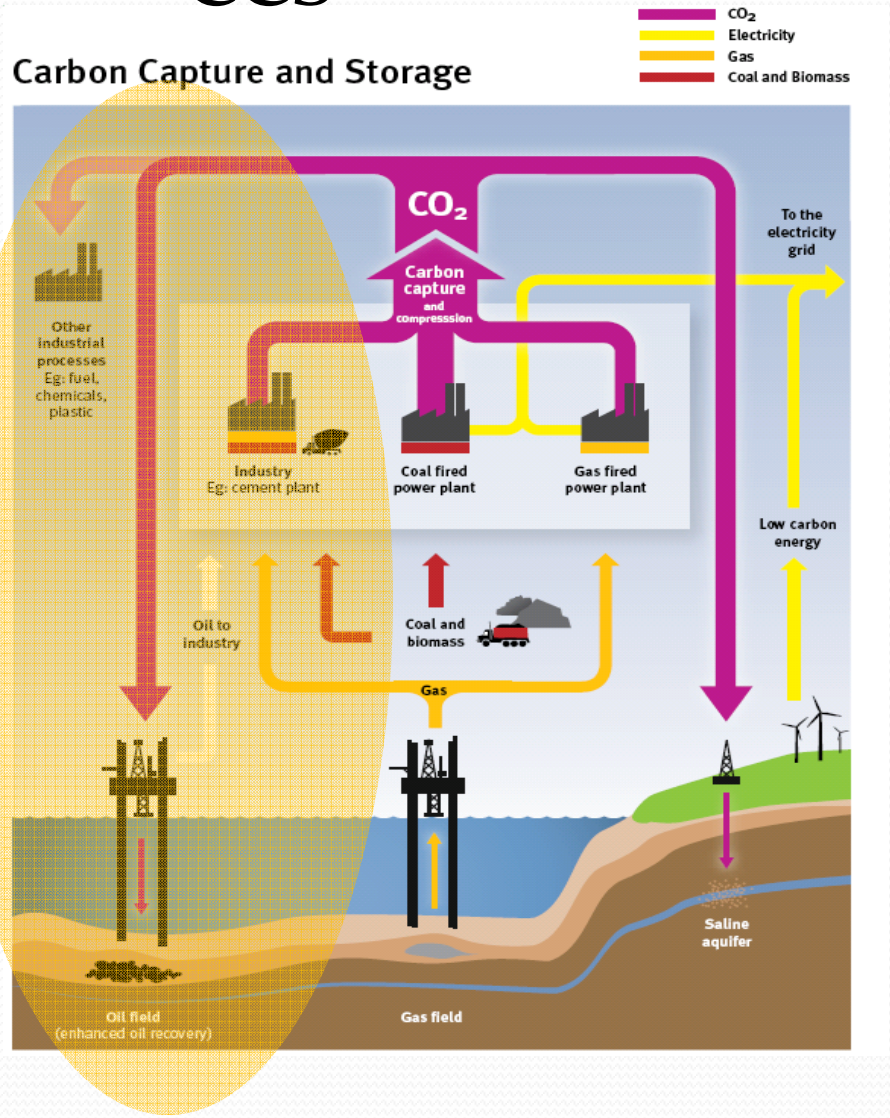
# Heavy Oil in Trinidad and Tobago

- Reserves
  - 2 billion barrels
  - 8-3,500 cp at reservoir conditions
- Production
  - 20,000 bbl/day
  - 30% of total oil production
- Primary recovery
  - 5-20%
- Potential Revenue
  - US$40/t$CO_2$




Source: Mohammed- Singh and Singhal, 2005
Hosein et al, 2011

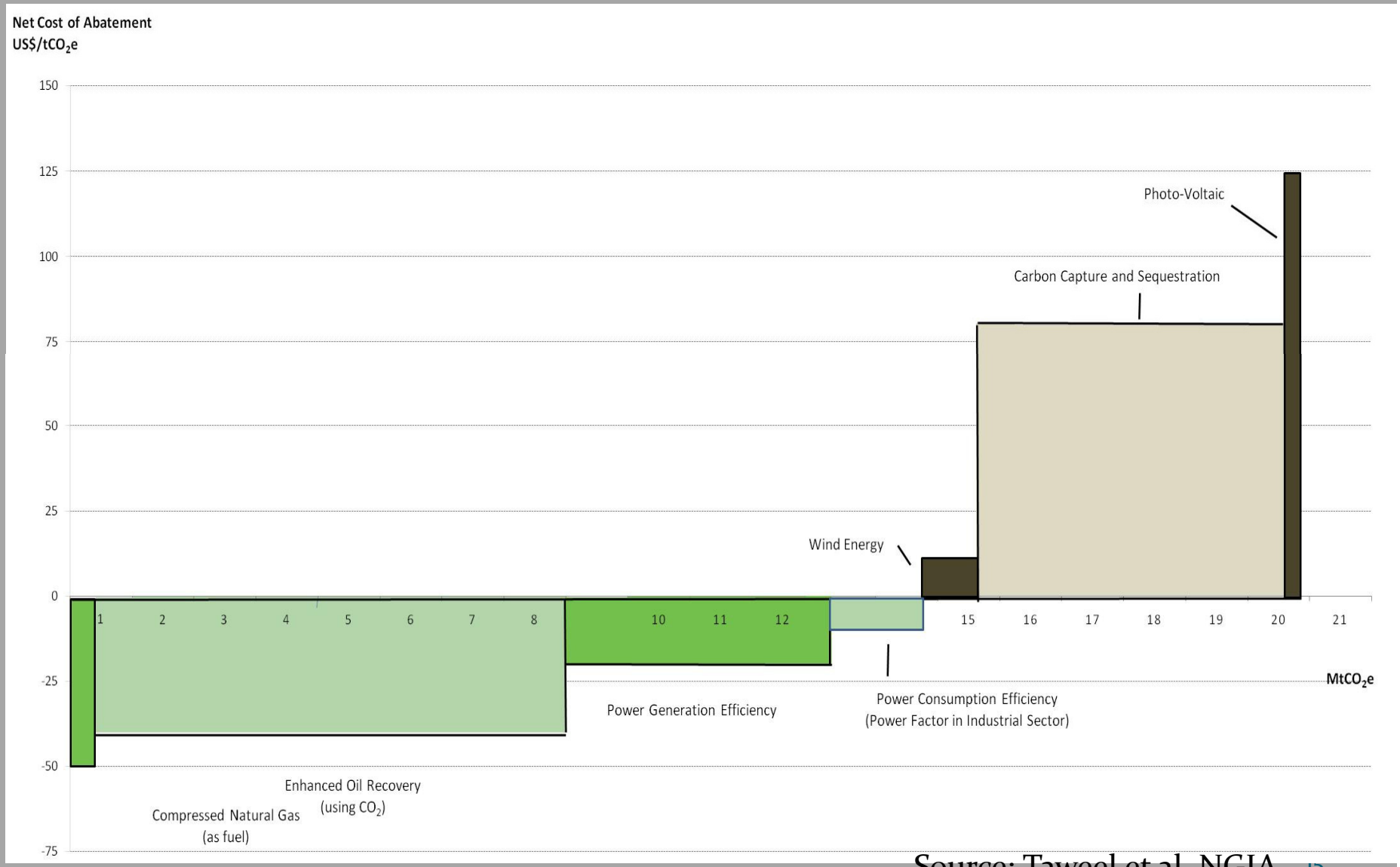
# CCS




Reproduced from Blunt, 2010

- Subsurface $CO_2$ storage
  - Increase oil recovery
  - Can attract international funding and investment
  - Established technology
  - Revenue generating activity

# $CO_2$ Abatement T&T




Source: Taweel et al. NGIA

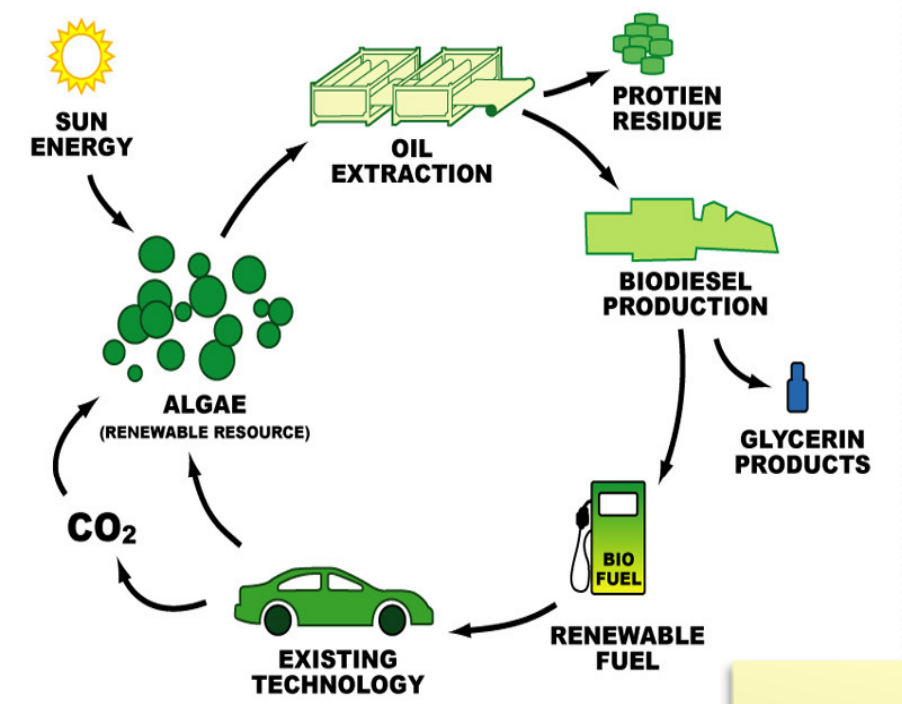
# Carbon Reuse Technologies

# Concrete Curing

- Reduce cost of process
- Increase safety of process
- Can use $CO_2$ from the process

- Technology being developed for commercial use

# Algae Cultivation




- Can produce biodiesel
- Can be blended in petroleum refineries
- Does not compete with arable land
- Reduce demand for petroleum derived fuels

•Technology being developed for commercial use

•Large land space needed

# Liquid Fuel production

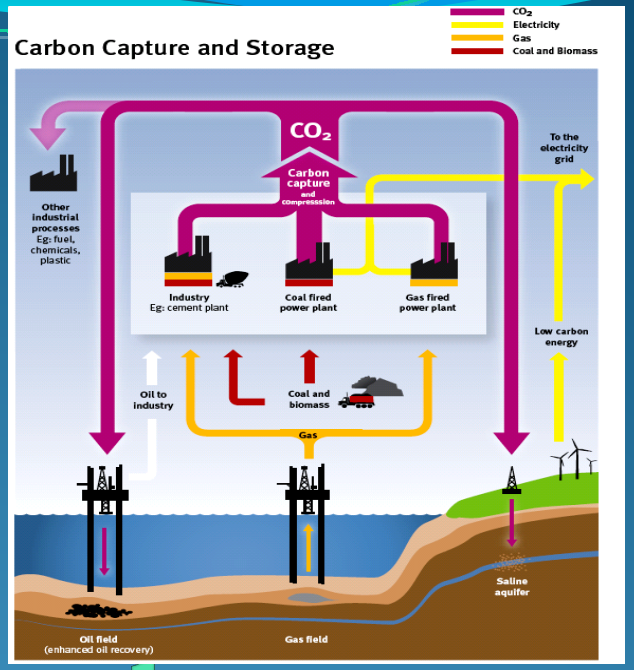
- Biofuels for transportation market
- Reduce use of petroleum derived fuels
- Electric vehicles may be more competitive

•Technology being developed for commercial use
•High capital cost
•Low thermal efficiency

# Plastics


- Reduce demand for petroleum derived fuels

Technology being developed for commercial production



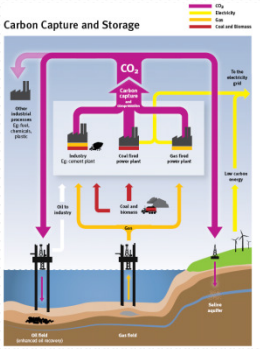

# $CO_2$ Development

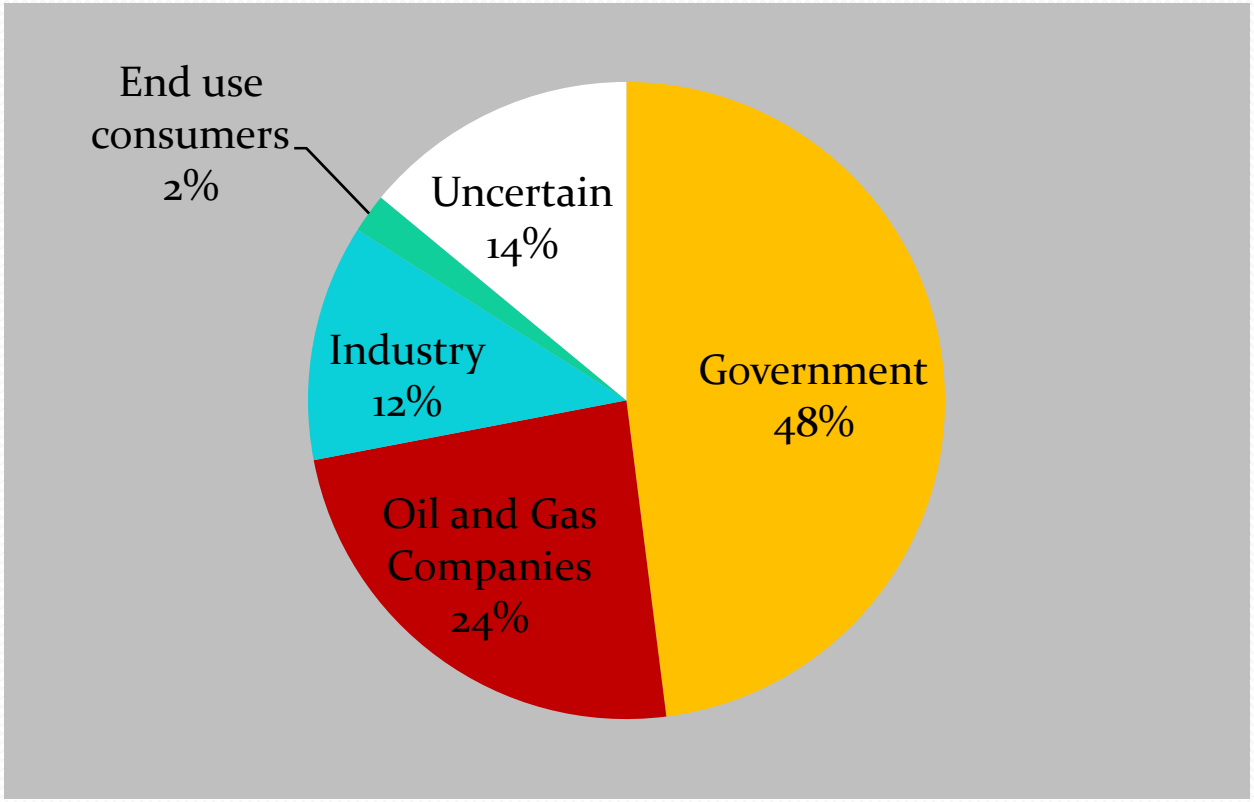

## Will History repeat itself?

Initiative
Investment,
Incentives,
Innovation

**Who is going to pay?**

# Who should pay for CCS?




**Source: Alexander, Boodlal and Bryant, 2011**

# Cost

- Research

- Proprietary technology

- Pilot projects

  - Feasibility studies
- Infrastructure
- Land

# Funding & Incentives

## Government

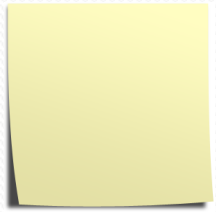
- Incentives and disincentives
  - Carbon tax
  - Natural gas pricing
- Regulate & Facilitate
  - **Policy**
  - **Regulations**

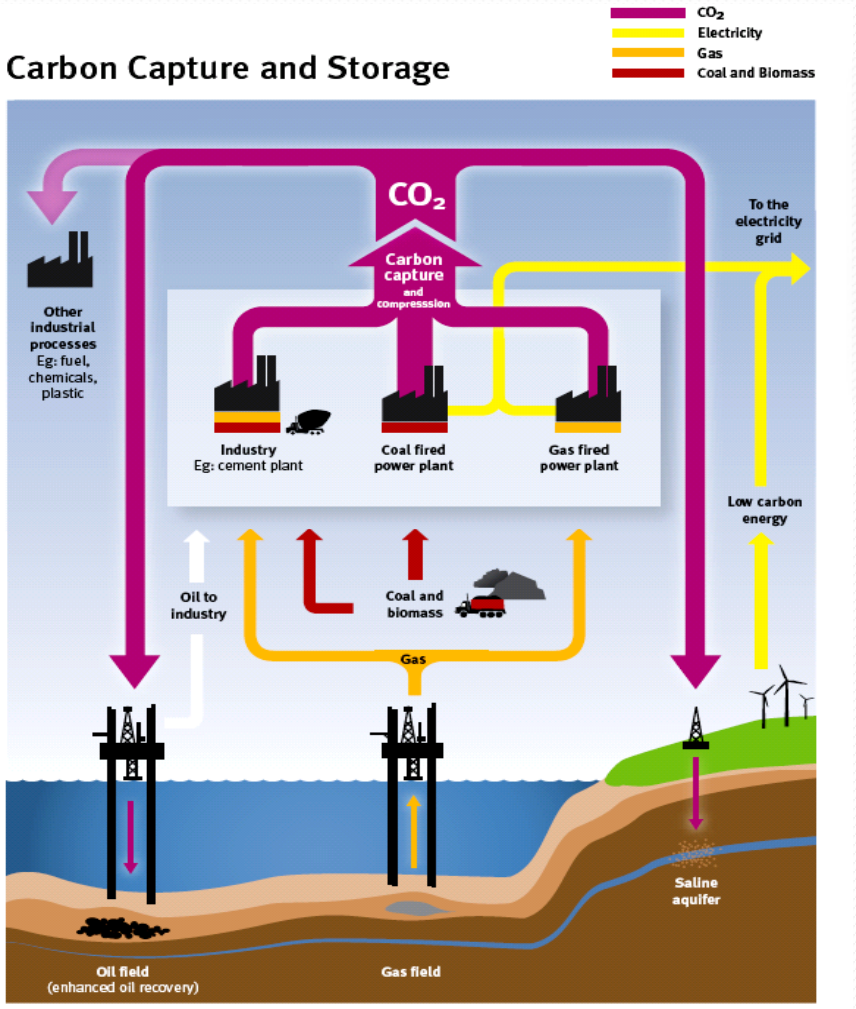
## Private Investors

- Carbon market
- Low or Carbon neutral manufacturing
  - **Environmentally friendly products**
- Possible low cost alternative to petroleum derived products

## International Organisations

- UNFCCC
- UNDP
- IEAGHG






# $CO_2$ Development

*Everything is doable…at a price*