

SECURITY

**The world  
needs more energy  
and less CO<sub>2</sub>**

CARBON  
ENERGY



# **CARBON CAPTURE AND STORAGE**

## **Promising Technologies for Mitigating Carbon Dioxide Emissions**

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# OVERVIEW

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- THE ENERGY CHALLENGE
- COMMITTED TO CO<sub>2</sub> MANAGEMENT
- CARBON CAPTURE SYSTEMS
- CCS DEMONSTRATION PROJECTS
- DEVELOPING A FRAMEWORK FOR FURTHER INVESTMENT
- CONCLUSION

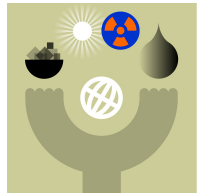


## THREE HARD TRUTHS... SIGNAL TURBULENT TIMES AHEAD

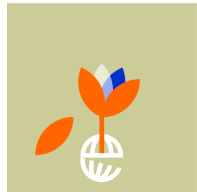
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- Global energy demand is accelerating



- Easy oil & gas supply will struggle to keep pace

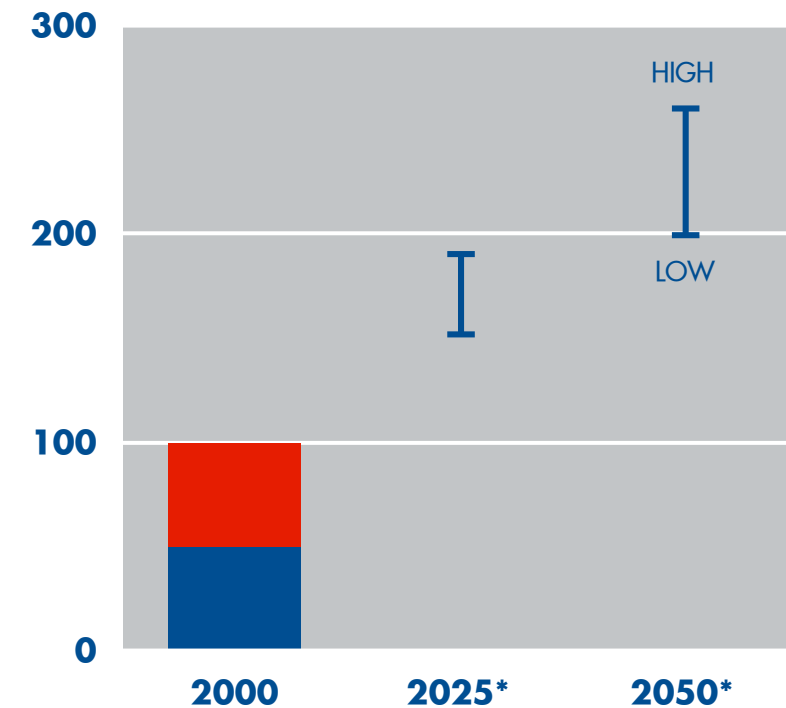


- Flight into coal causes climate stresses and make dealing with CO<sub>2</sub> imperative

# THE CHALLENGE – TWICE THE ENERGY WITH HALF THE CO<sub>2</sub>

## RIISING GLOBAL ENERGY DEMAND

100= Global primary energy demand 2000

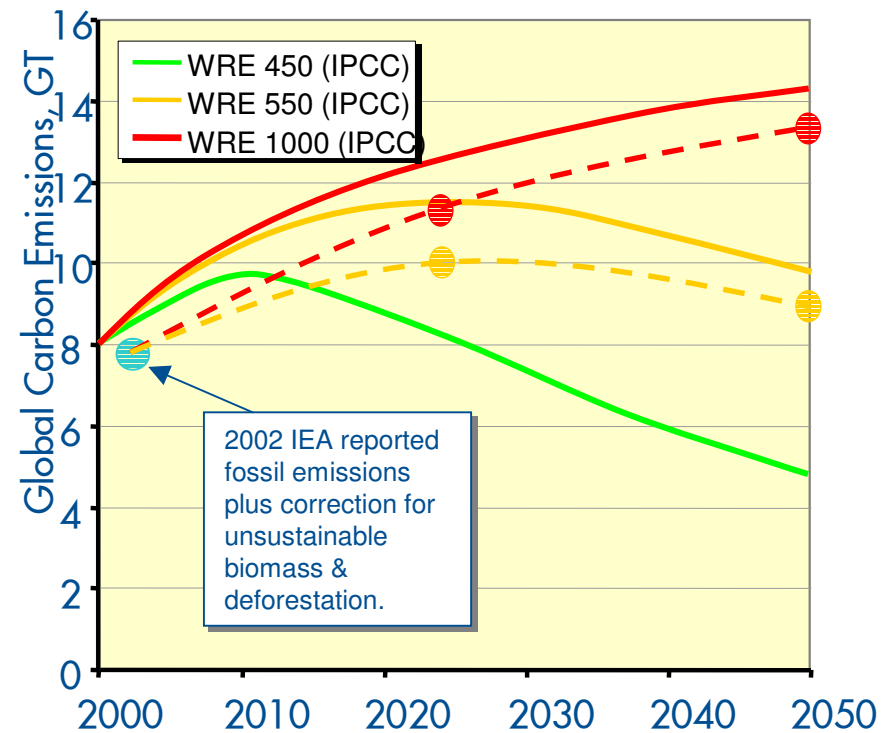


REST OF THE WORLD  
OECD

\* Shell estimates

## CARBON EMISSION PROFILES

Theoretical CO<sub>2</sub> profiles from IPCC 3rd Report



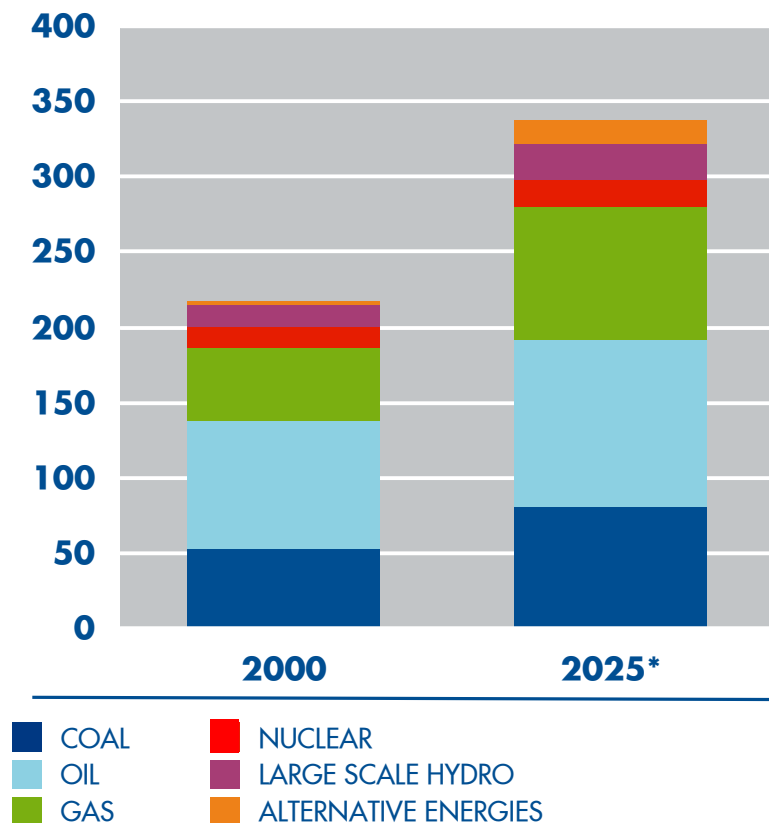
# THE ENERGY CHALLENGE

## RISING GLOBAL ENERGY DEMAND

- Today hydrocarbons supply 80 - 85% of the global energy portfolio
- Renewables supply approx 2% of the world energy portfolio
- By 2025 Renewables could supply up to 10% of the world energy portfolio
- By 2050 Renewables could supply up to 30% of the world's energy needs

## CHANGING ENERGY MIX

Million barrels oil equivalent per day



# THE ENERGY CHALLENGE

## POLICY IMPLICATIONS

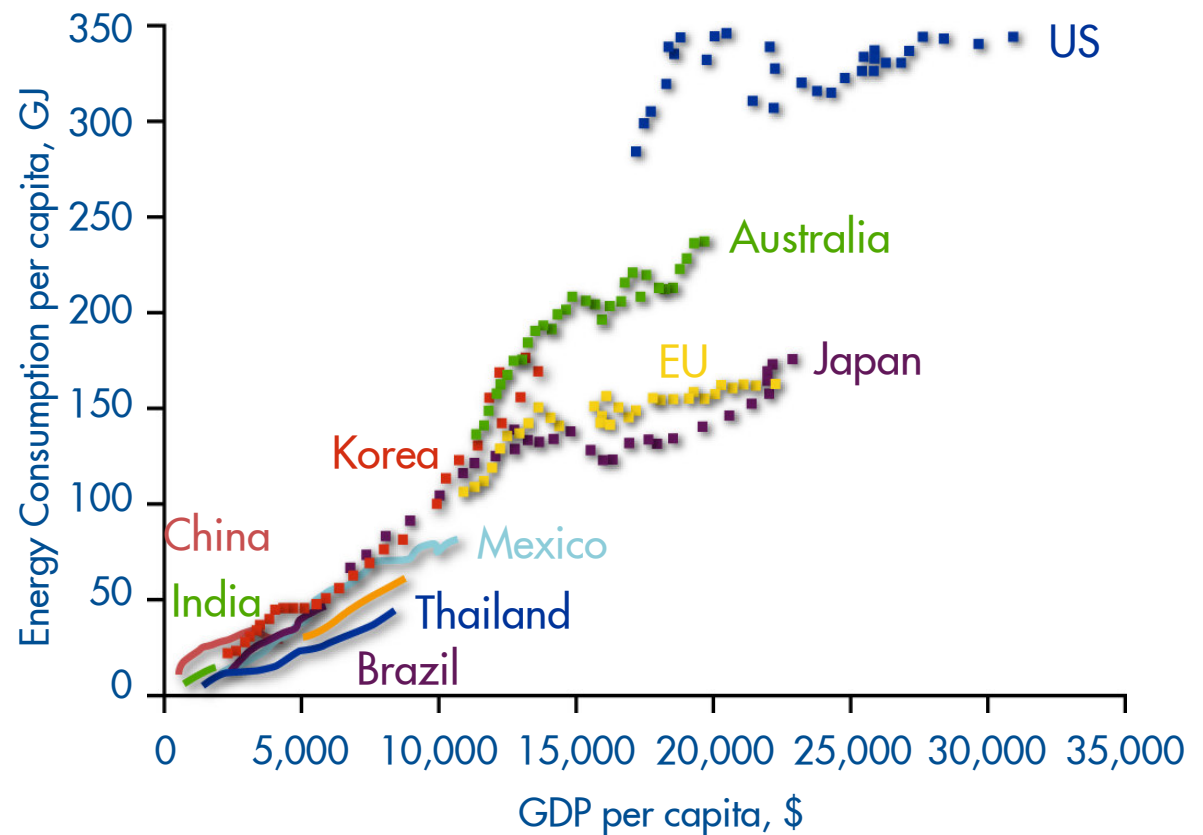
### INFRASTRUCTURE EFFICIENCY GAINS

- Efficiency standards for appliances, lights, air conditioning etc.
- Encourage radical building design
- Urban planning decisions
- Education & awareness

### TRANSPORT EFFICIENCY GAINS

- Public transport infrastructure
- Vehicle efficiency standards
- Consumer behaviour

## THE ENERGY LADDER



Source: IMF, BP





# THE ENERGY CHALLENGE – ‘TRILEMMA’

## POLICY IMPLICATIONS

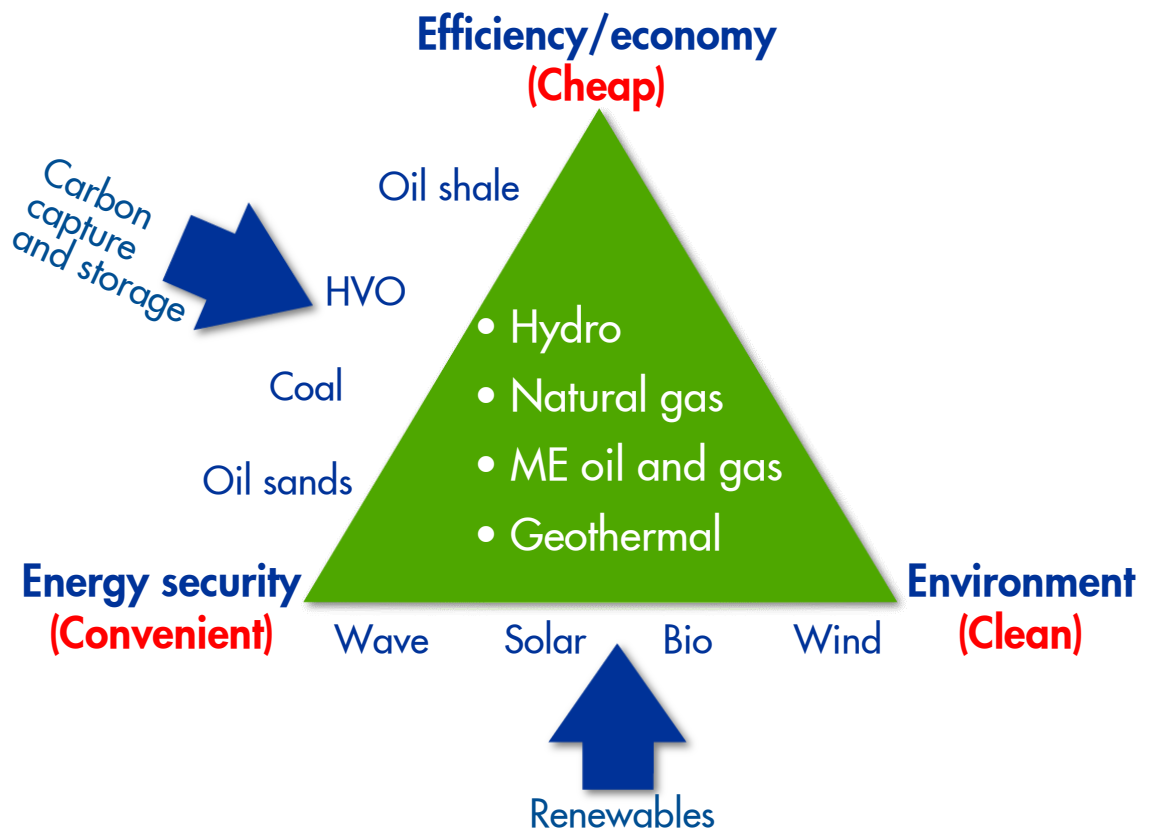
### RENEWABLES

- Renewable Energy Certificates
- Support for 2<sup>nd</sup> Generation Bio-Fuels
- Fast track planning

### CARBON BASED ENERGY

- Cap & Trade
- Rules & Recognition for CCS
- Fiscal support for large scale CCS demonstrations
- Support for infrastructure (pipelines & grids)
- CO<sub>2</sub> certification of fuels leading to fuels standards

## THE THREE C's



# COMMITTED TO CO<sub>2</sub> MANAGEMENT

## A voluntary commitment

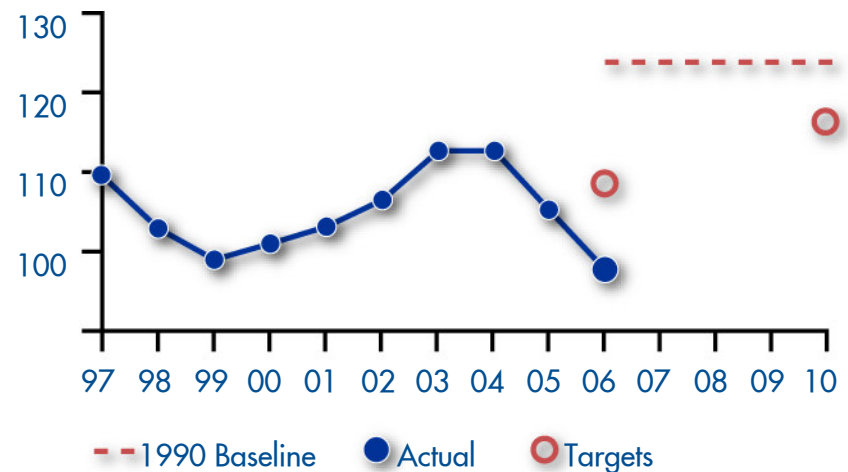
We set an aggressive, voluntary CO<sub>2</sub> emissions target – to reduce emissions from Shell operations in 2010 to at least 5% lower than the 1990 level, even while we grow our business

In 2005, our emissions fell to 105 million tonnes CO<sub>2</sub> equivalent – 15% below the 1990 level of 123 million tonnes

This has been accomplished by reduced flaring and increased efficiency in our operations

## Greenhouse gas emissions

Million tonnes CO<sub>2</sub> equivalent



# LEADERSHIP IN CO<sub>2</sub> MANAGEMENT

## MANAGING OUR OWN CO<sub>2</sub> EMISSIONS

### BASELINE EMISSIONS



Improving efficiency  
Reducing flaring  
Leading designs  
CO<sub>2</sub> for enhanced oil recovery  
CO<sub>2</sub> sequestration  
Renewables offsets  
CO<sub>2</sub> credit trading

### REDUCED NET EMISSIONS

## ADDRESSING CO<sub>2</sub> INTENSITY

Increasing gas and LNG supply  
CO<sub>2</sub> sequestration / EOR  
Clean coal technologies  
Biofuels  
Renewables & Hydrogen

### EXAMPLES

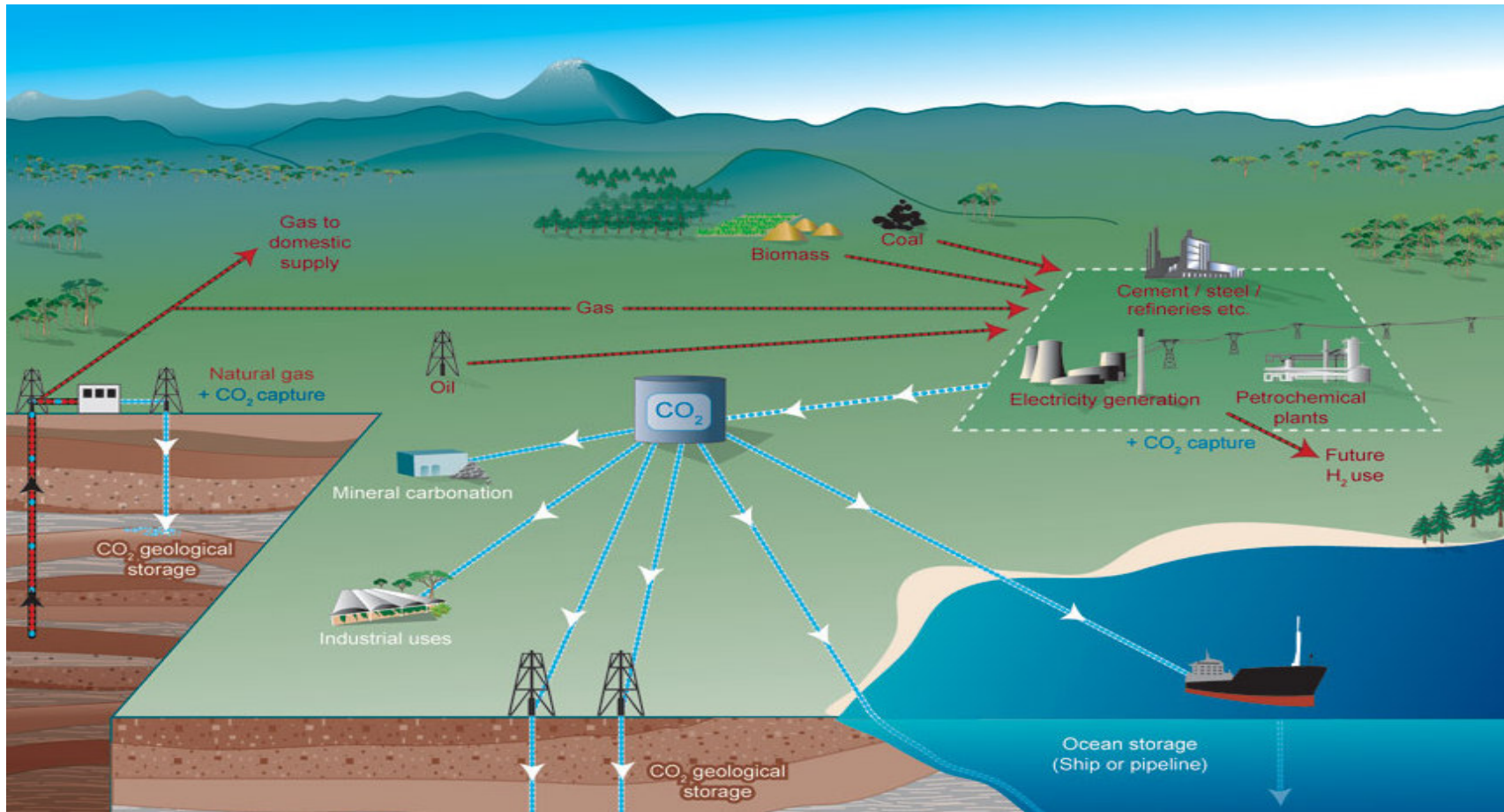
Pernis CO<sub>2</sub>



ZeroGen



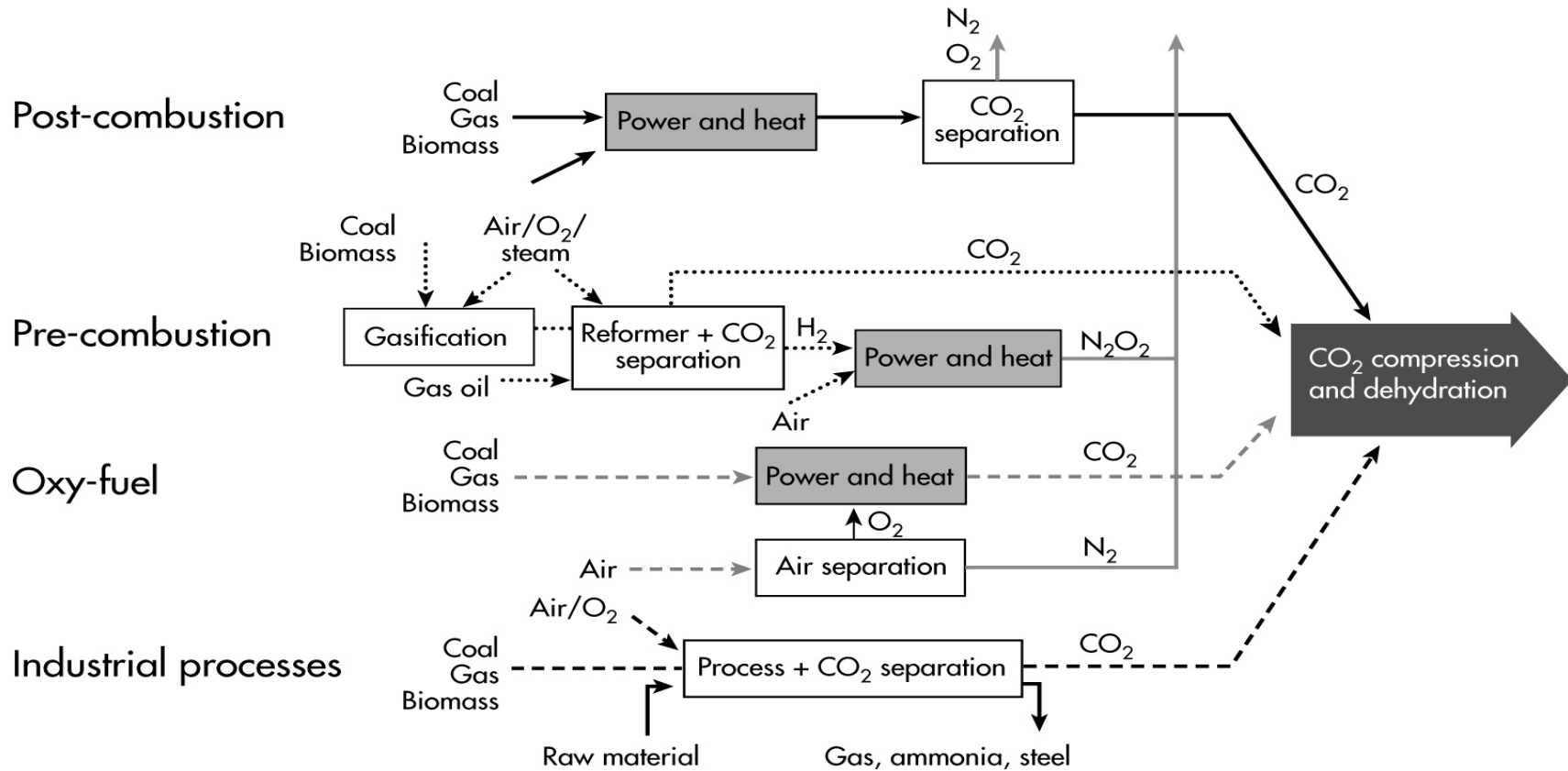
# SCHEMATIC DIAGRAM OF POSSIBLE CCS SYSTEMS



Source: IPCC



# OVERVIEW OF CO<sub>2</sub> CAPTURE PROCESSES AND SYSTEMS



Source: IPCC



# CARBON CAPTURE & STORAGE – CO<sub>2</sub>SINK

## PROJECT DESCRIPTION

- To advance the understanding of science and technical processes of underground storage of CO<sub>2</sub>
- To build confidence towards future European CO<sub>2</sub> geological storage
- To provide real case experience for the development of regulatory frameworks for geological storage of CO<sub>2</sub>
- First European onshore CCS project near a major population centre





# TEST CENTRE MONGSTAD

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- TCM's purpose is to develop knowledge and test solutions that will reduce costs as well as technical and economic risks associated with a large-scale carbon capture plant.
  - TCM achieves these goals through cooperation with leading vendors of capture technologies and through construction/operation of demonstration plants
  - The Test Centre at Mongstad is planned as a joint venture between the Norwegian State and a few key European oil and energy companies
  - The project is at its preliminary stage of development and final investment decision is expected 1st half 2008
- 



# CARBON CAPTURE & STORAGE

## ZeroGEN PROJECT, AUSTRALIA

### Project description

- World's first CO<sub>2</sub> capture and storage coal power project in design
- Integrated coal-based gasification plant, Rockhampton
- 200-km CO<sub>2</sub> pipeline
- CO<sub>2</sub> storage in reservoir ~2km below surface
- Resulting in low CO<sub>2</sub> base-load electricity

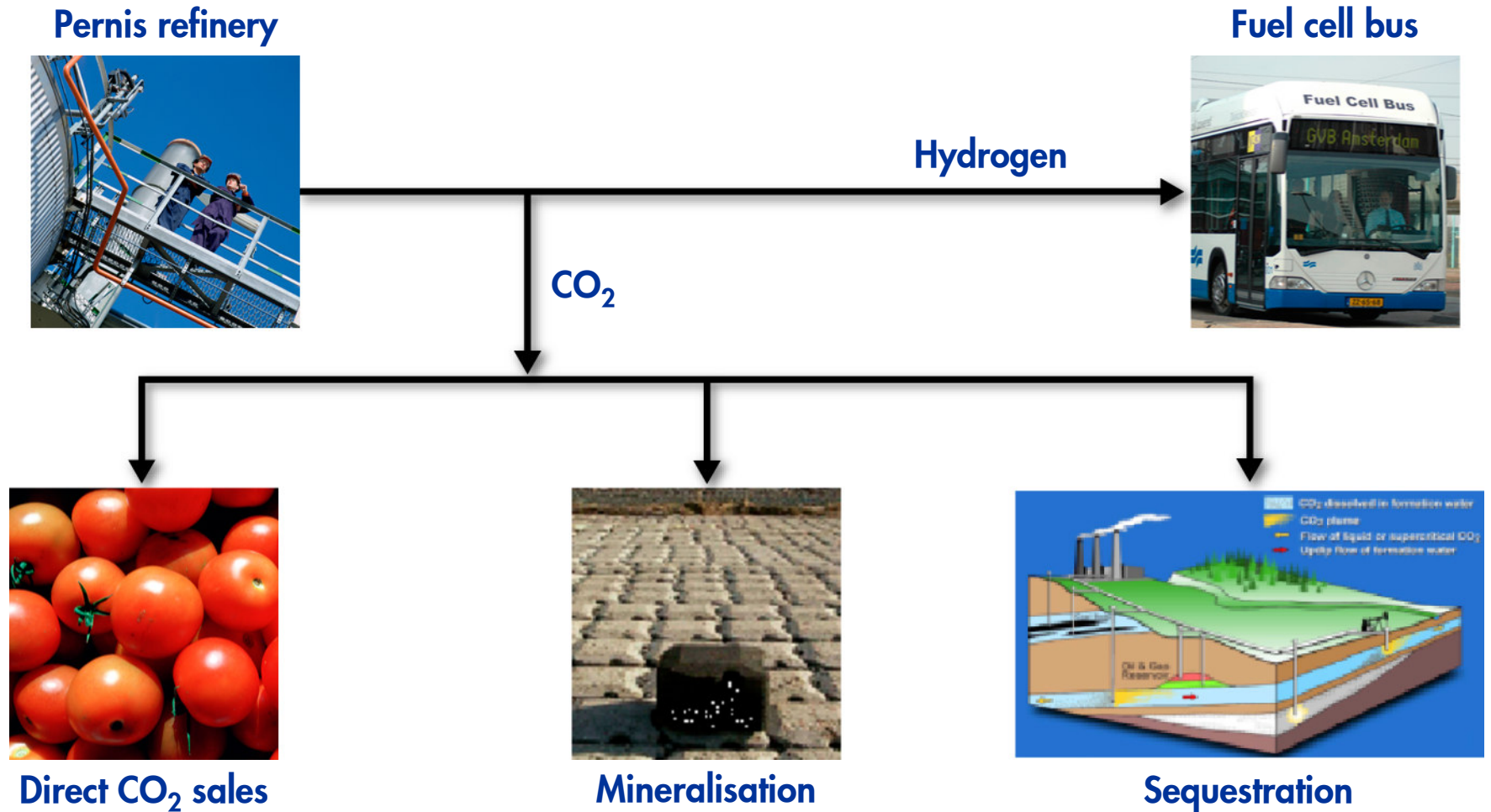
### Project status

- Shell and Stanwell agreement
- Feasibility work ongoing





# ROTTERDAM DEMONSTRATION PROJECT



# HALTEN CO<sub>2</sub> EOR STUDY REACHES CONCLUSION

- A technically demanding Halten CO<sub>2</sub> Project study was launched in 2006 by Shell and Statoil
- Low Emission power production in Norway is proving to be highly challenging
- The capture and use of CO<sub>2</sub> from gas fired power for enhanced oil recovery at Draugen, though technically attainable, is not commercially viable
- Study results indicated lower than expected EOR volumes and higher than expected costs.
- The project will continue, focusing upon the possibility of CO<sub>2</sub> capture and storage in a deep saline aquifer offshore



# MANY REGULATORY INSTRUMENTS & MARKET SECTORS

## REGULATORY INSTRUMENTS

- Climate change is a societal responsibility with the solution to be led by government
- All sectors of the economy must contribute to that solution
- Types of CO<sub>2</sub> regulations commonly discussed and in operation are:

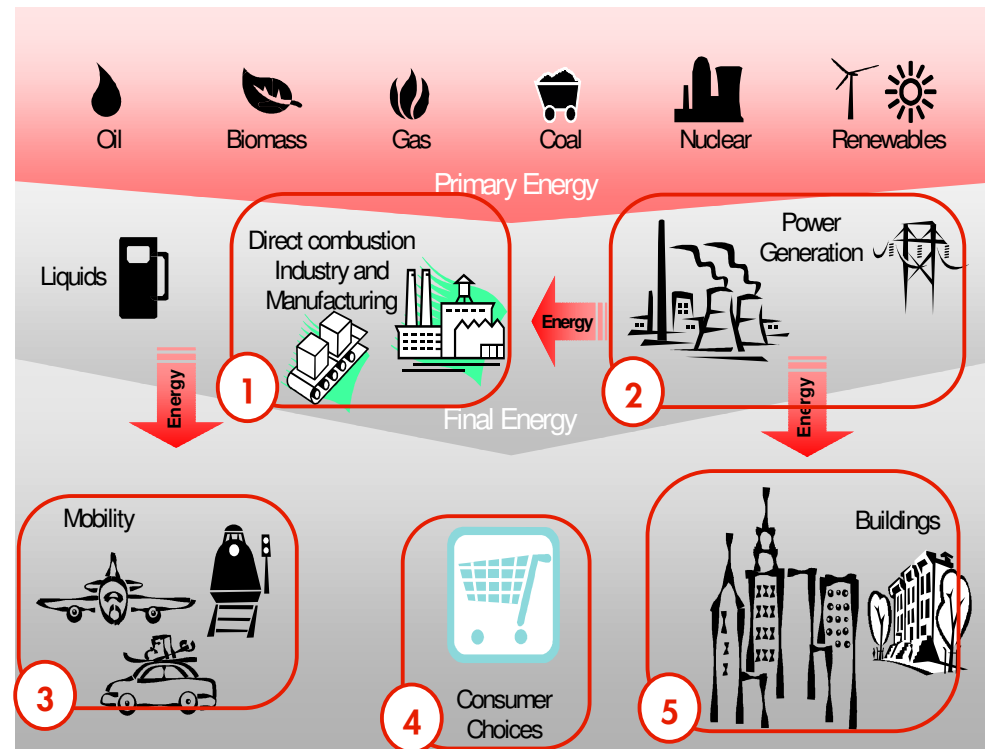
Cap-and-Trade

Command and Control (mandates)



Carbon Tax

- These types of legislation can be considered to be distinct. They can be applied simultaneously in a particular region

## MARKET SECTORS



# THE POLICY REQUIREMENTS

	Power Generation / Industry & Manufacturing	Transport	Commercial & Domestic (Buildings)
<b>Discover, Develop &amp; Demonstrate</b> 	<ul style="list-style-type: none"> <li>• Fiscal support for large-scale CCS demonstration</li> <li>• Support for infrastructure (e.g. grids &amp; pipelines)</li> </ul>	<ul style="list-style-type: none"> <li>• Support for advanced fuel development</li> <li>• Public transport infrastructure</li> </ul>	<ul style="list-style-type: none"> <li>• Urban planning decisions</li> <li>• Encouraging radical design</li> <li>• Education and awareness</li> </ul>
<b>Deploy</b> 	<ul style="list-style-type: none"> <li>• “Cap-and-Trade”</li> <li>• CCS rules and recognition</li> <li>• Renewable Energy Certificates</li> <li>• “Fast-track” planning</li> </ul>	<ul style="list-style-type: none"> <li>• Vehicle efficiency standards</li> <li>• CO<sub>2</sub> certification of fuels, leading to fuel standards</li> <li>• Consumer behaviour</li> </ul>	<ul style="list-style-type: none"> <li>• Efficiency standards (appliances, air-con)</li> <li>• Use of project mechanisms linked to GHG market</li> <li>• Encouraging “electrification”</li> </ul>



# DEVELOPING A FRAMEWORK FOR FURTHER INVESTMENT

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- As the bridge to a more sustainable energy system, CCS is therefore considered a key solution for combating climate change, within a portfolio of solutions. Indeed, the IPCC has identified CCS as the most promising technology for the rapid reduction of global emissions - by up to 55% by 2100.\*
- Shell continues to support the principles of market mechanisms and emissions trading as tools to assist in reducing CO<sub>2</sub> emissions at the lowest cost to society. Therefore, Shell's view is that emissions trading is a more effective policy instrument than carbon taxes.
- Shell supports the use of emissions trading via the EU-Emissions Trading Scheme and Clean Development Mechanism as the primary mechanisms for incentivising CCS.



\* IPCC Special Report on Carbon Dioxide Capture and Storage, 2005



# DEVELOPING A FRAMEWORK FOR FURTHER INVESTMENT

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- Additional transitional incentives will be required to bridge the 'financing gap' created by the short-term, finite nature of existing trading schemes.\*
- Acceptance of CCS technology by policy-makers and the public as a whole requires the creation of an effective regulatory framework.
- Liability regimes also need to be defined for CO<sub>2</sub> capture and storage. A framework should be fit for purpose and based on existing subsurface expertise as used in the oil & gas industry.



\* i.e. 2012 for EU ETS Phase II; the Kyoto CDM/JI; and International Emissions Trading under Article 17 of the Kyoto Protocol



# CONCLUSIONS

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- Fossil fuels will be needed for much of this century.
  - We accept that CO<sub>2</sub> emissions must be managed.
  - Many new zero-CO<sub>2</sub> energy technologies are far from commercial and will need further support.
  - Voluntary action will not deliver the changes needed.
  - A policy framework will be needed to help reduce CO<sub>2</sub> emissions.
  - Shell strongly supports the inclusion of CCS in emissions trading schemes and particularly the CDM by 2008.
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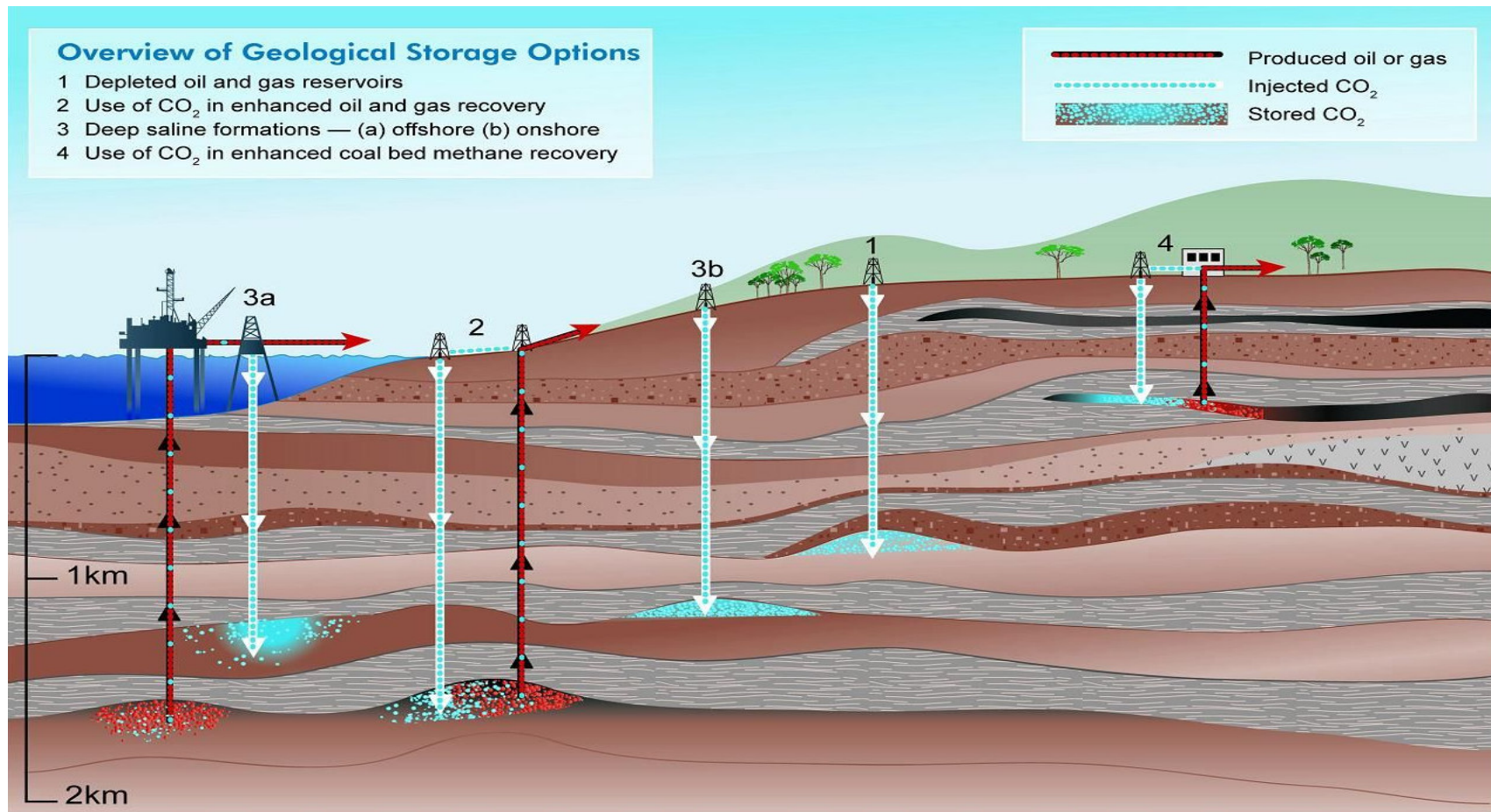
## Backup Slides

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# CO<sub>2</sub> STORAGE



# MATCHING REGULATIONS TO SECTORS

## APPLYING REGULATORY INSTRUMENTS

### Cap-and-Trade

- Suitable if the 'Make or Buy' premise applies
- Mostly applicable to large emitters in the Power & Industry & Manufacturing
- Incentive based system

### Command and Control (mandates)

- Suitable if emitter has insufficient scope for 'Make or Buy' premise.
- Mostly applicable to small emitters (mobility, buildings, consumer choices)

### Carbon Tax

- Fiscal instrument to raise money for gov't.
- May result in behavioural changes, the outcome is not guaranteed
- society needs certain delivery of CO<sub>2</sub> targets.

## THE CAP & TRADE 'MAKE OR BUY' PREMISE

