



CO₂ CAPTURE AND STORAGE Implementation and Economics

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Future Fuels and CO₂

**First International Scientific and Business
Congress on Protecting the Climate**

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•**IMPORTANT NOTE:** Although this slide pack may contain references to projects located in countries that are subject to comprehensive United States economic sanctions, no "US Person" has been involved in the development of any of those projects.

•The United States Securities and Exchange Commission (SEC) permits oil and gas companies, in their filings with the SEC, to disclose only proved reserves that a company has demonstrated by actual production or conclusive formation tests to be economically and legally producible under existing economic and operating conditions. We use certain terms in this presentation, such as "resources" that the SEC's guidelines strictly prohibit us from including in



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



- **Global energy demand is accelerating**



- **Easy oil & gas supply will struggle to keep pace**



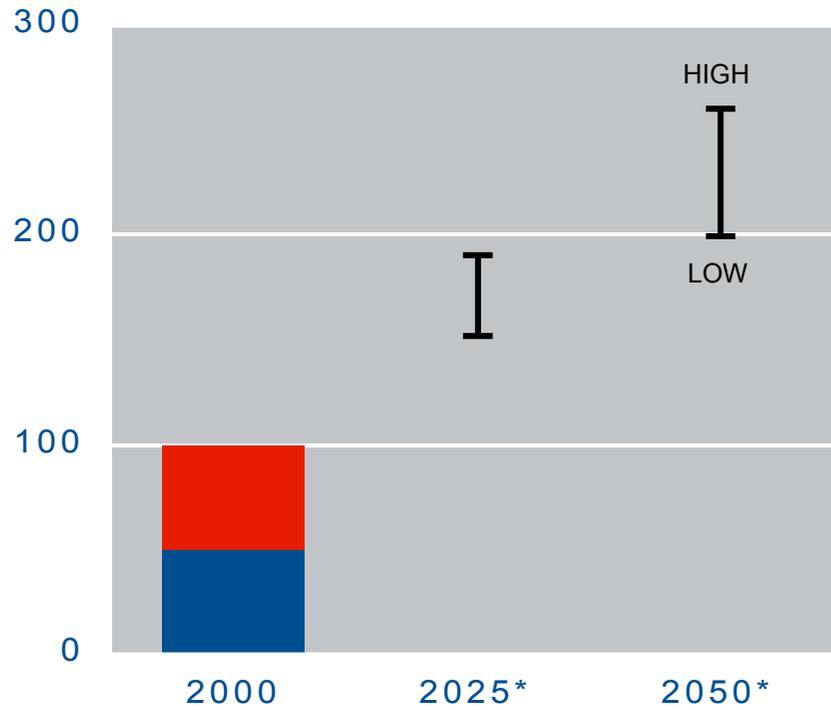
- **Flight into coal causes climate stresses and make dealing with CO₂ imperative**



THE CHALLENGE – TWICE THE ENERGY WITH HALF THE CO₂

RISING GLOBAL ENERGY DEMAND

100= Global primary energy demand 2000

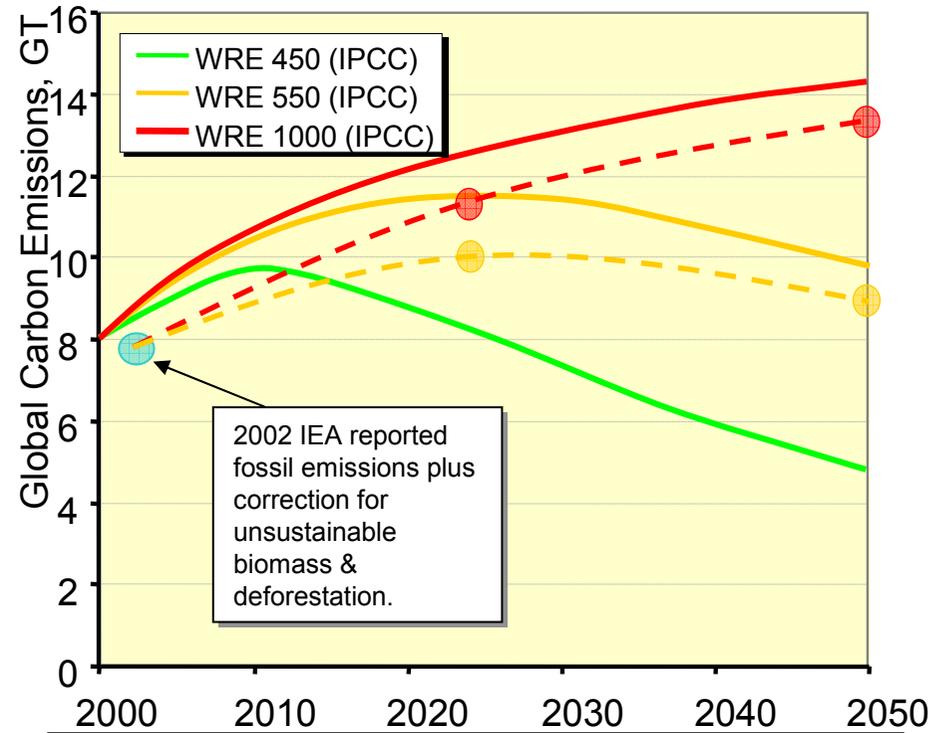


- REST OF THE WORLD
- OECD

* Shell estimates

CARBON EMISSION PROFILES

Theoretical CO₂ profiles from IPCC 3rd Report



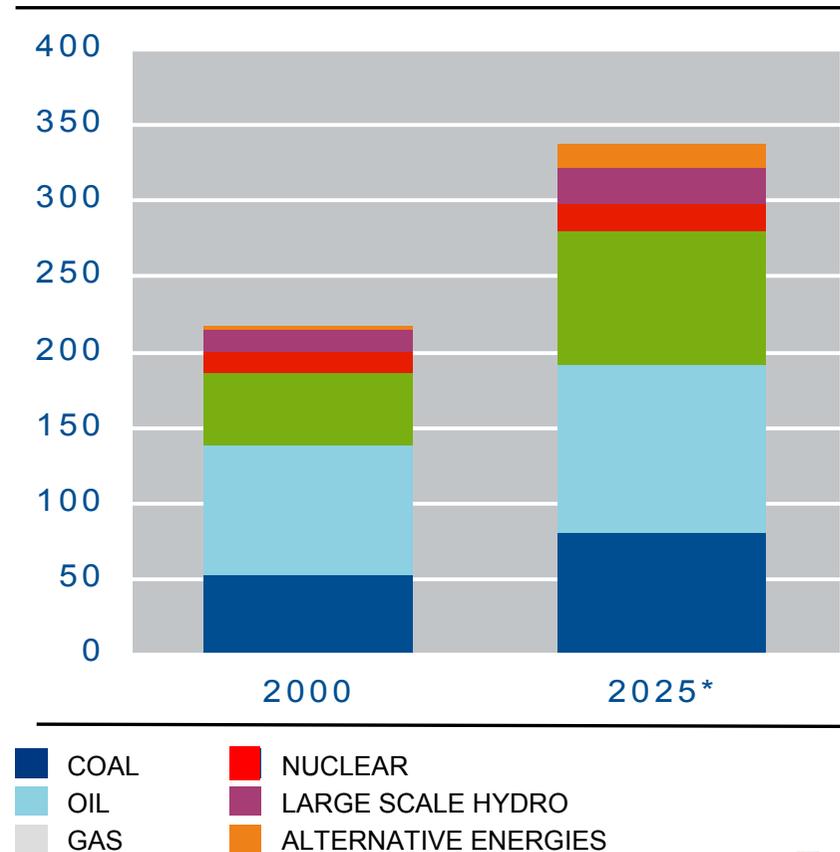
THE ENERGY CHALLENGE

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

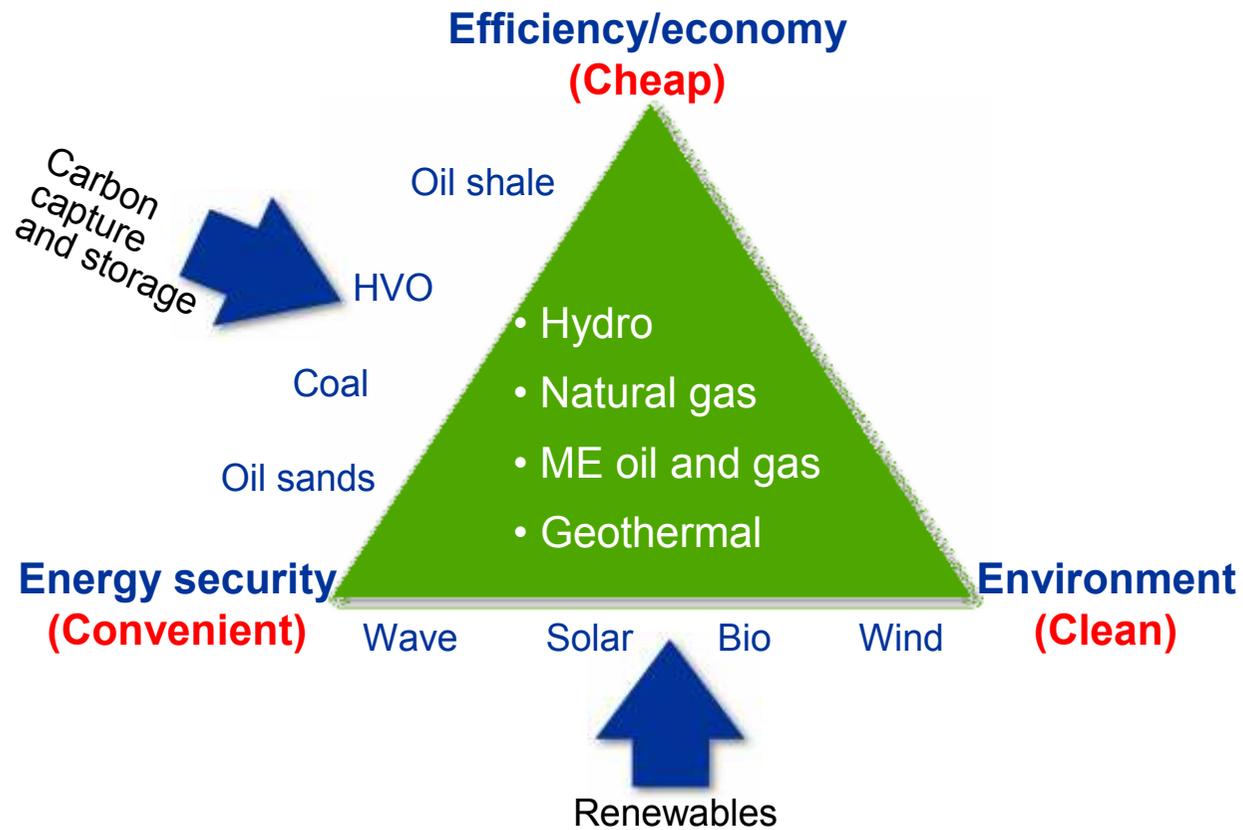
CHANGING ENERGY MIX

Million barrels oil equivalent per day

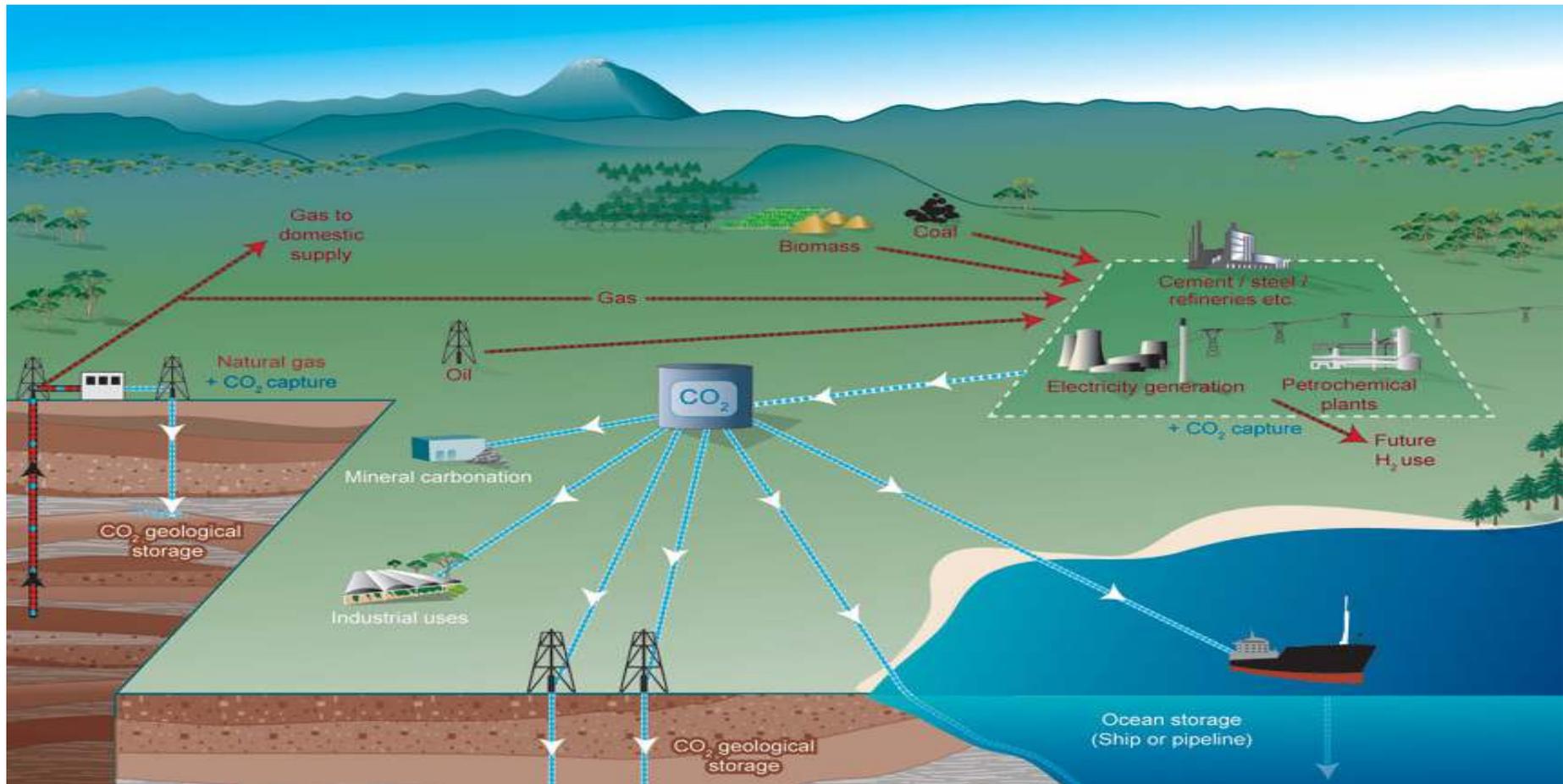


THE ENERGY CHALLENGE – ‘TRILEMMA’

THE THREE C's



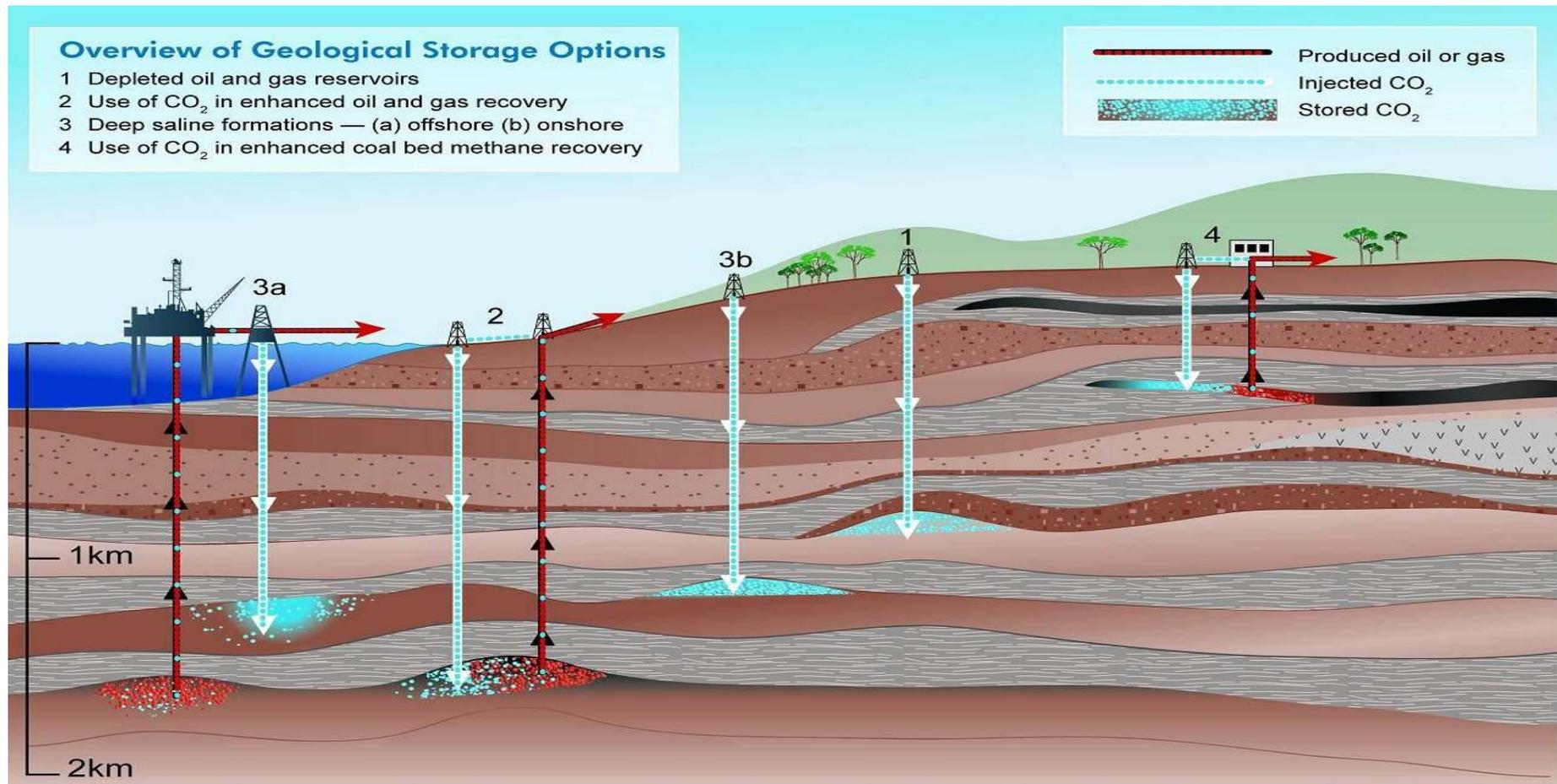
SCHEMATIC DIAGRAM OF POSSIBLE CCS SYSTEMS



Source: IPCC

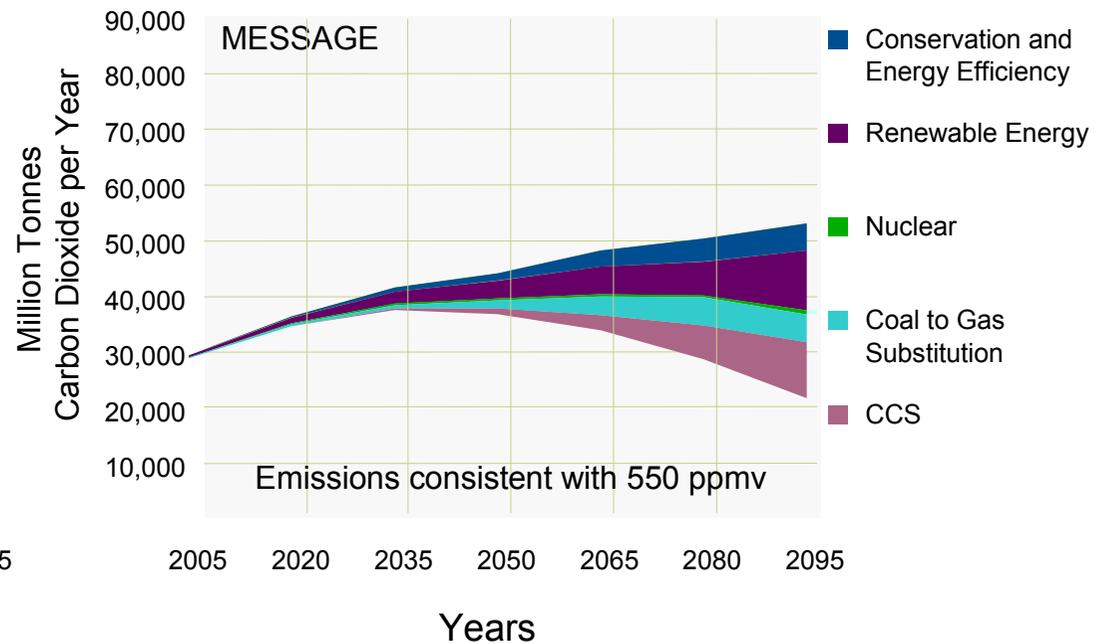
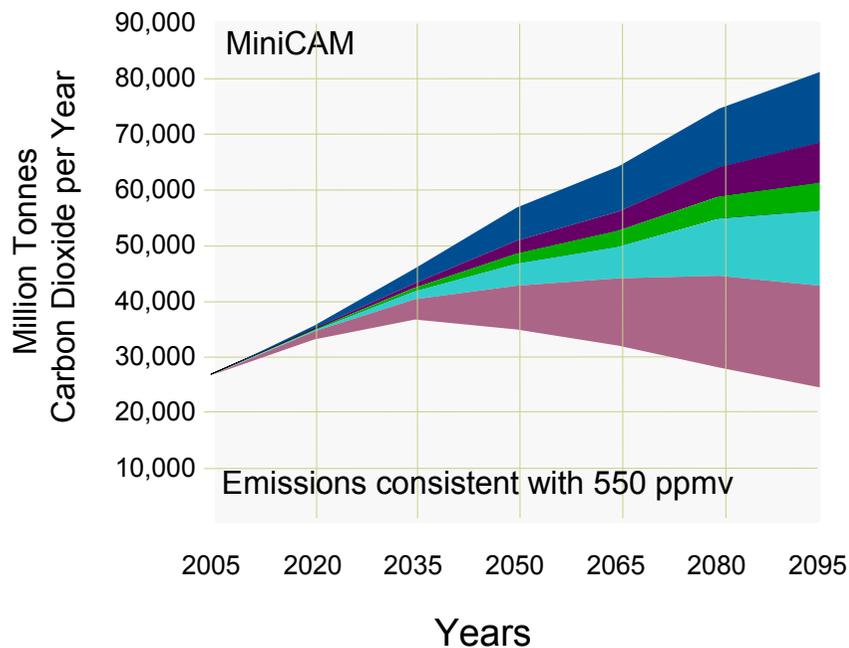


CO₂ STORAGE



CCS CAPACITY IS SIGNIFICANT

- Technical potential likely to exceed 2000 GtCO₂
- In most scenarios CCS contributes between 220 and 2200 GtCO₂ to achieve stabilisation between 450 and 750 ppm CO₂



IS IT SAFE?

According to IPCC SRCSS fraction retained in appropriately selected and managed geological reservoirs is

- very likely to exceed 99% over 100 years, and
- is likely to exceed 99% over 1,000 years.

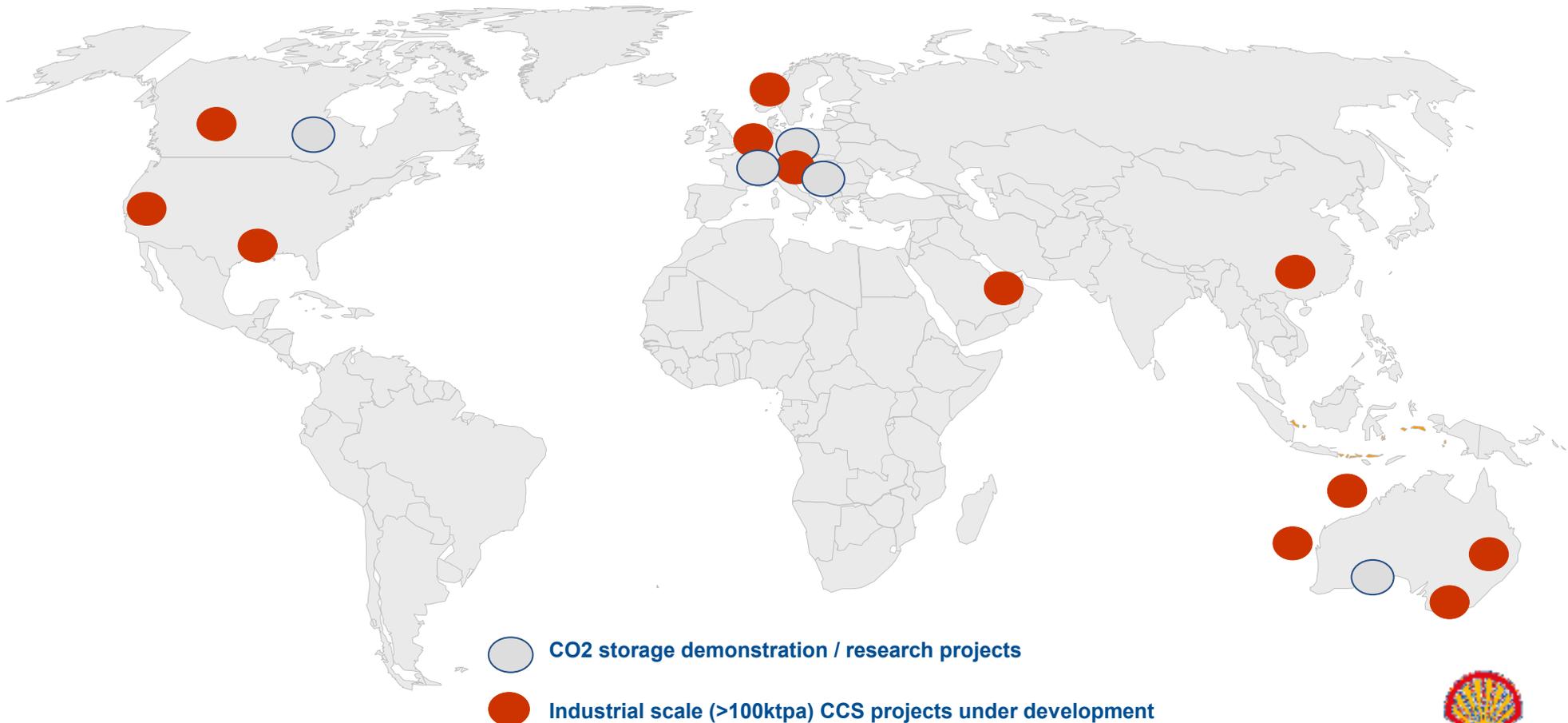
"Likely" is a probability between 66 and 90%, "very likely" of 90 to 99%

Local risk of geological storage can be comparable to risks of current activities

- Natural gas storage, EOR



CCS DEMO PROJECTS & DEVELOPING INDUSTRIAL SCALE PROJECTS



CARBON CAPTURE & STORAGE

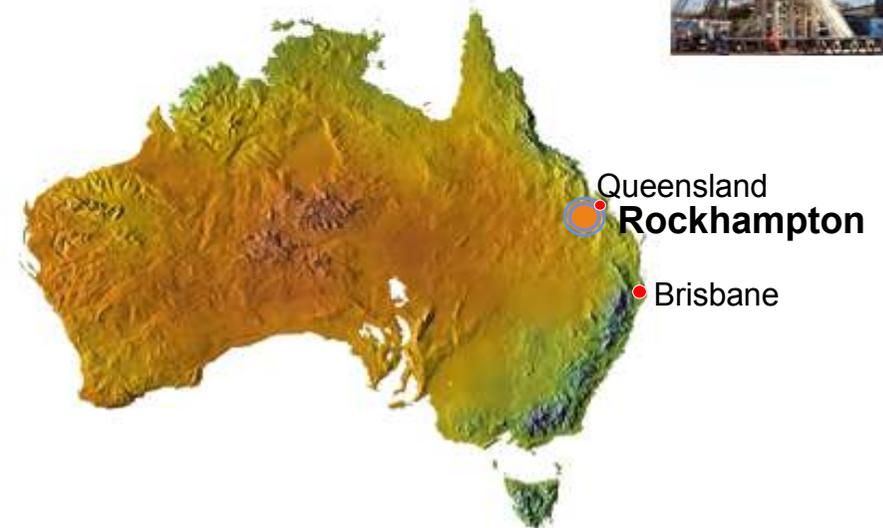
ZeroGEN PROJECT, AUSTRALIA

Project description

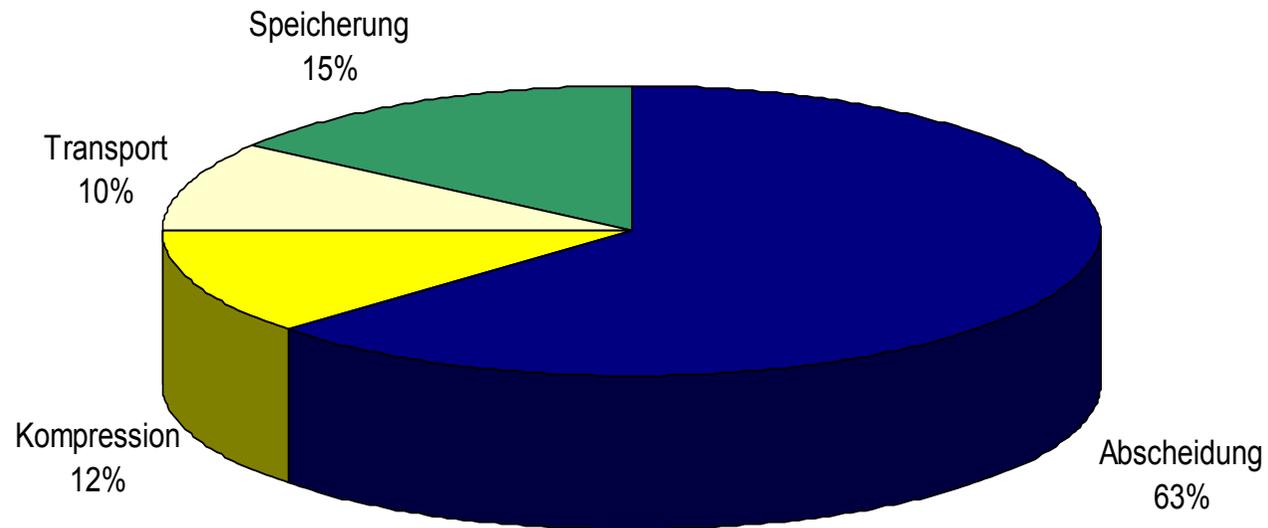
- World's first CO₂ capture and storage coal power project in design
- Integrated coal-based gasification plant, Rockhampton
- 200-km CO₂ pipeline
- CO₂ storage in reservoir ~2km below surface
- Resulting in low CO₂ base-load electricity

Project status

- Shell and Stanwell agreement
- Feasibility work ongoing



CCS COST

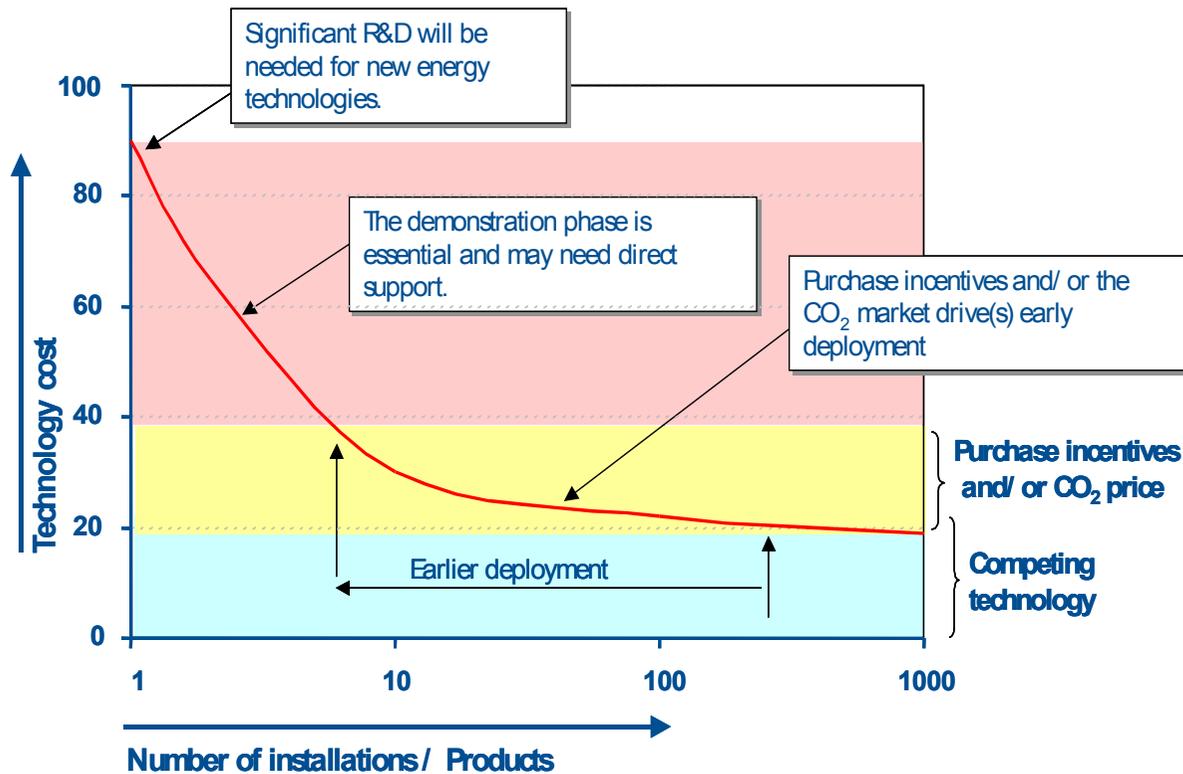


Total cost 2008: 80-100 €/t

Quelle: Wuppertal Institut (2007) -
Geologische CO₂-Speicherung als klimapolitische Handlungsoption
Technologien, Konzepte, Perspektiven



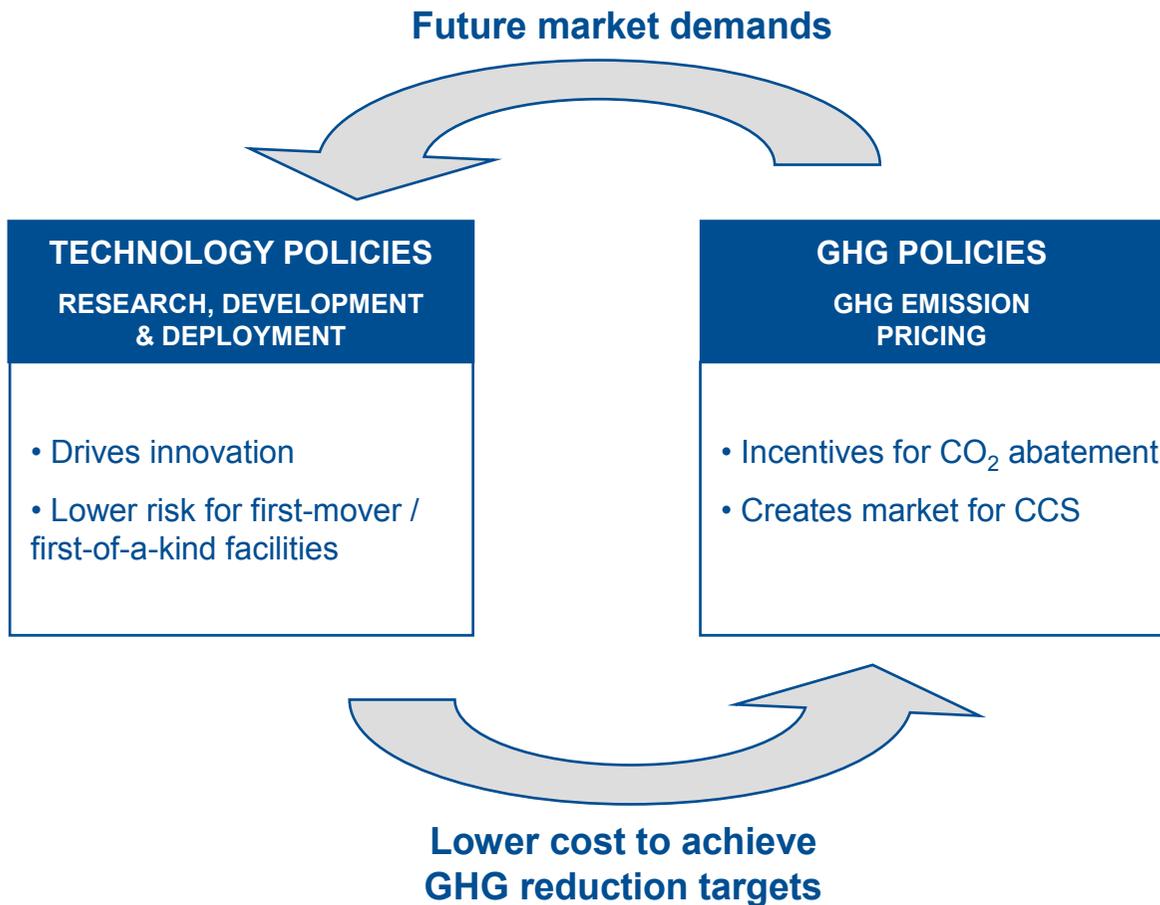
TECHNOLOGY DEVELOPMENT AND DEPLOYMENT



- Future policy must focus on both the **development** and **demonstration** of new technology and the rapid **deployment** of both new and existing technology
- A hybrid regulatory environment is required to timely deploy CCS technology:
 - **Direct support** to bring the technology cost down; and
 - **CO₂ Market** to set the incentives to mitigate CO₂ at large scale



DEPLOYMENT OF CCS NEEDS BOTH TECHNOLOGY AND GREENHOUSE GAS (GHG) POLICIES



- GHG policies in effect create market(s) for GHG emissions and GHG abatement measures, including CCS
- Future market demands require technological innovation to achieve the GHG reduction at lower cost
- Technology policies to support research, development, and deployment lower the risks for early actions / first movers



FORTHCOMING EUROPEAN CCS LEGISLATIONS

PROPOSED CCS DIRECTIVE

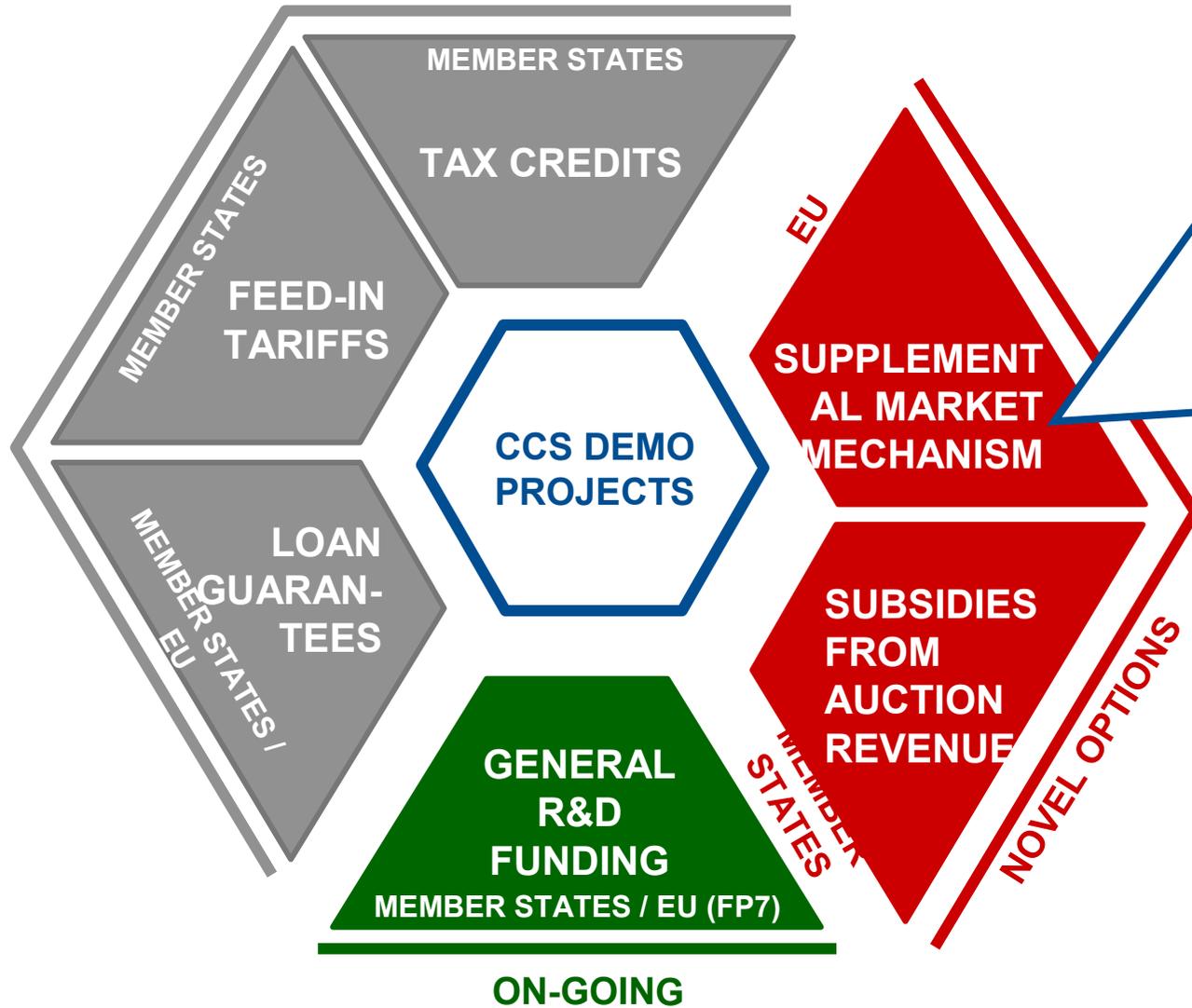
- Provides basis for Monitoring, Reporting, Verification (MRV) + “offsetting” any emissions
- Confer Environmental Impact Assessment (EIA) Directive onto CCS: provides basis for planning authorisations and public consultation
- Confer Environmental Liability Directive: provides basis to local environmental damages
- Disapply waste and derogate water laws
- Develop free-standing legislation covering site selection criteria and process, risk assessment, and monitoring

PROPOSED EMISSION TRADING SCHEME DIRECTIVE

- An EU wide cap to reach 21% below 2005 by 2020
- Include CCS in the EU ETS
- No need to surrender allowances for CO₂ stored, no free allocation for CCS
- Full auctioning for the power sector from 2013
- The allocation process shifts from free allocation plus some auctioning, to auctioning with some free allocation
- Other sectors: gradual move from 20% auctioning in 2013 towards full auctioning in 2020, including the aviation sector and refineries



POLICY SUPPORT FOR EU CCS DEMO PROJECTS



SUPPLEMENTAL MARKET MECHANISM

- Allows CCS projects to tap funds directly from the market
- Establish an EU “CCS Demonstration Project Mechanism” that mimics Clean Development Mechanism in structure and process
- The Mechanism generates “Capture and Storage Reduction Units” or “CSRs” to early CCS demo projects in EU
- CSR would be tradable in the EU ETS



CONCLUSIONS

- Fossil fuels will be needed for much of this century.
- CO₂ emissions must be managed.
- Many new zero-CO₂ energy technologies are far from commercial.
- CCS is an important and safe option for CO₂ mitigation.
- A policy framework will be needed to deliver CCS projects.
- CCS demonstration projects are needed to drive down the cost and provide learning-by-doing.
- Urgent action is needed to fund large-scale demonstration projects for timely deployment of CCS.

