GLOBAL CCS INSTITUTE

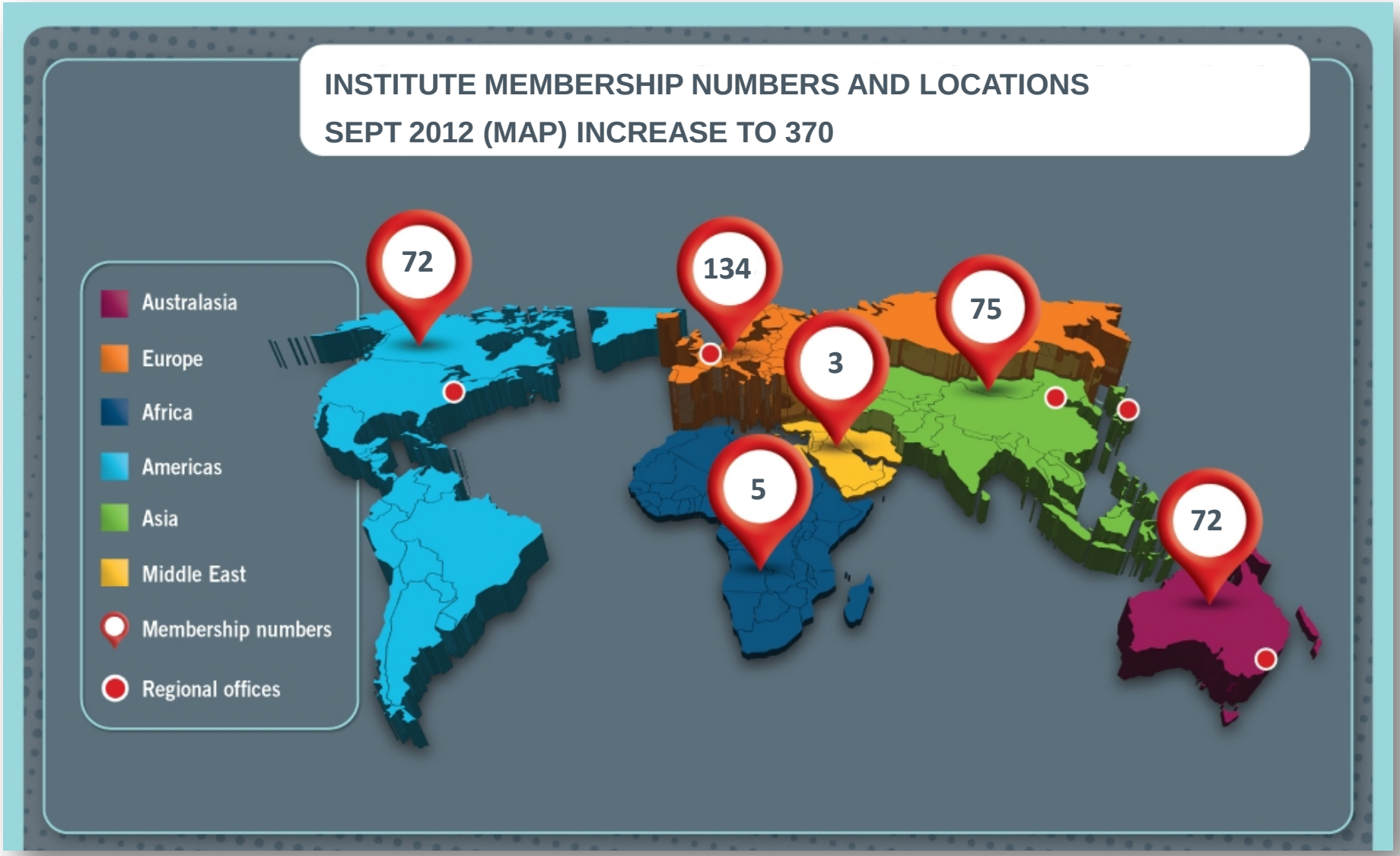
Worldwide Carbon, Capture, Utilization, and Storage

VICTOR DER – GEN MGR, AMERICAS REGION - GLOBAL CCS INSTITUTE

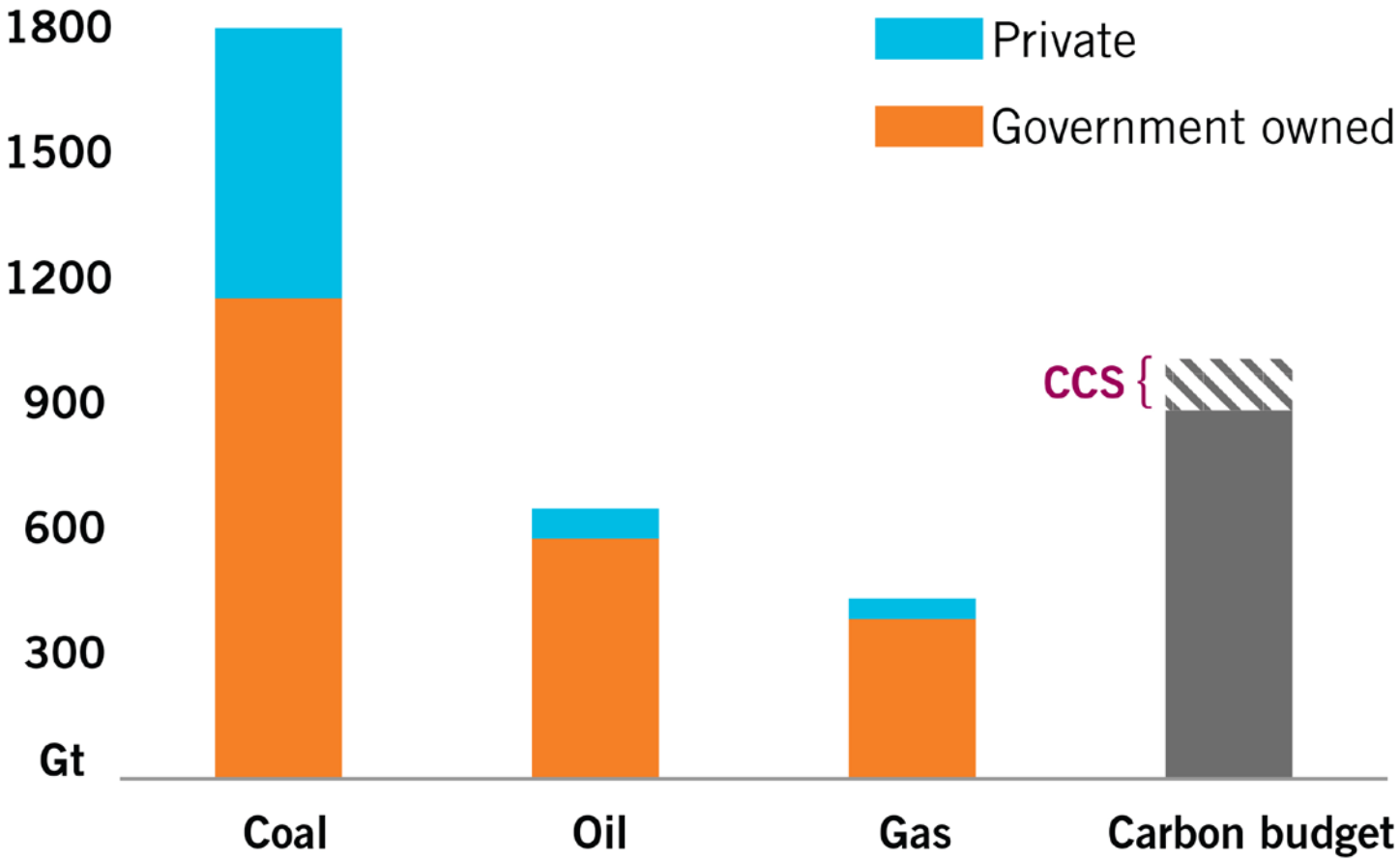
FOREIGN SERVICE OFFICERS' COAL AND POWER TRAINING COURSE

JULY 15, 2013

GLOBALLY CONNECTED MEMBERSHIP



Potential emissions by current fossil fuel reserves

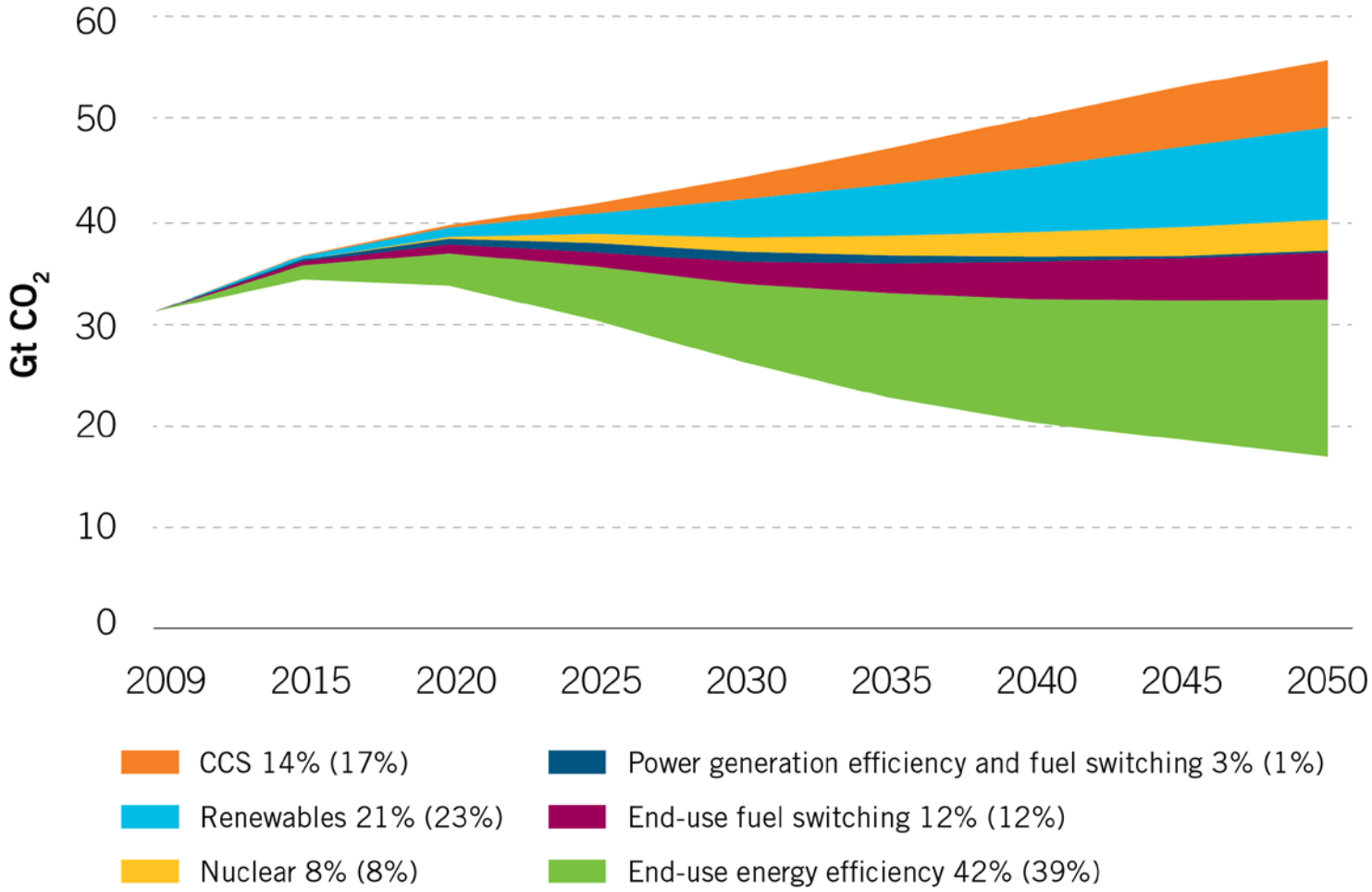


Source: International Energy Agency 2012

KEY MESSAGE

CCS ROLE IN TACKLING CLIMATE CHANGE

Energy-related CO_2 emission reductions by technology



SOURCE: IEA
NOTE: Percentages represent share of cumulative emissions reductions to 2050. Percentages in brackets represent share of emissions reductions in the year 2050.

Key Challenges to Carbon Capture and Storage

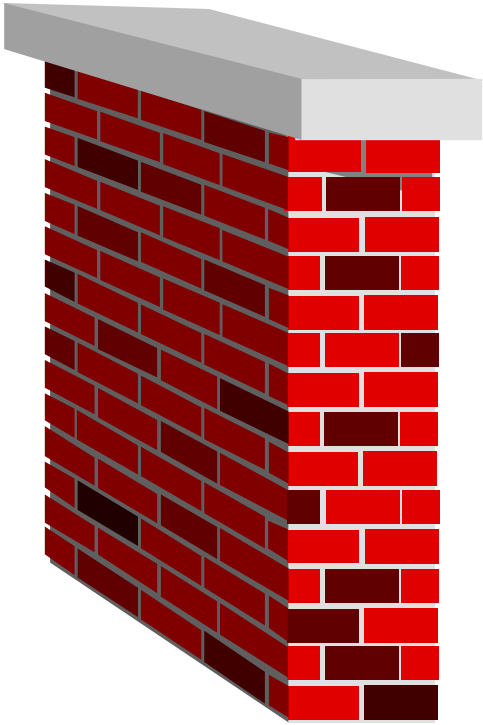
Technical Issues

- **Capture Technology**
  - Existing Plants
  - New Plants (PC)
  - IGCC
- **Cost of CCS**
- Sufficient **Storage Capacity**
- **Permanence**
- **Best Practices**
  - Storage Site Characterization
  - Monitoring/Verification
  - Modeling

Legal/Social Issues

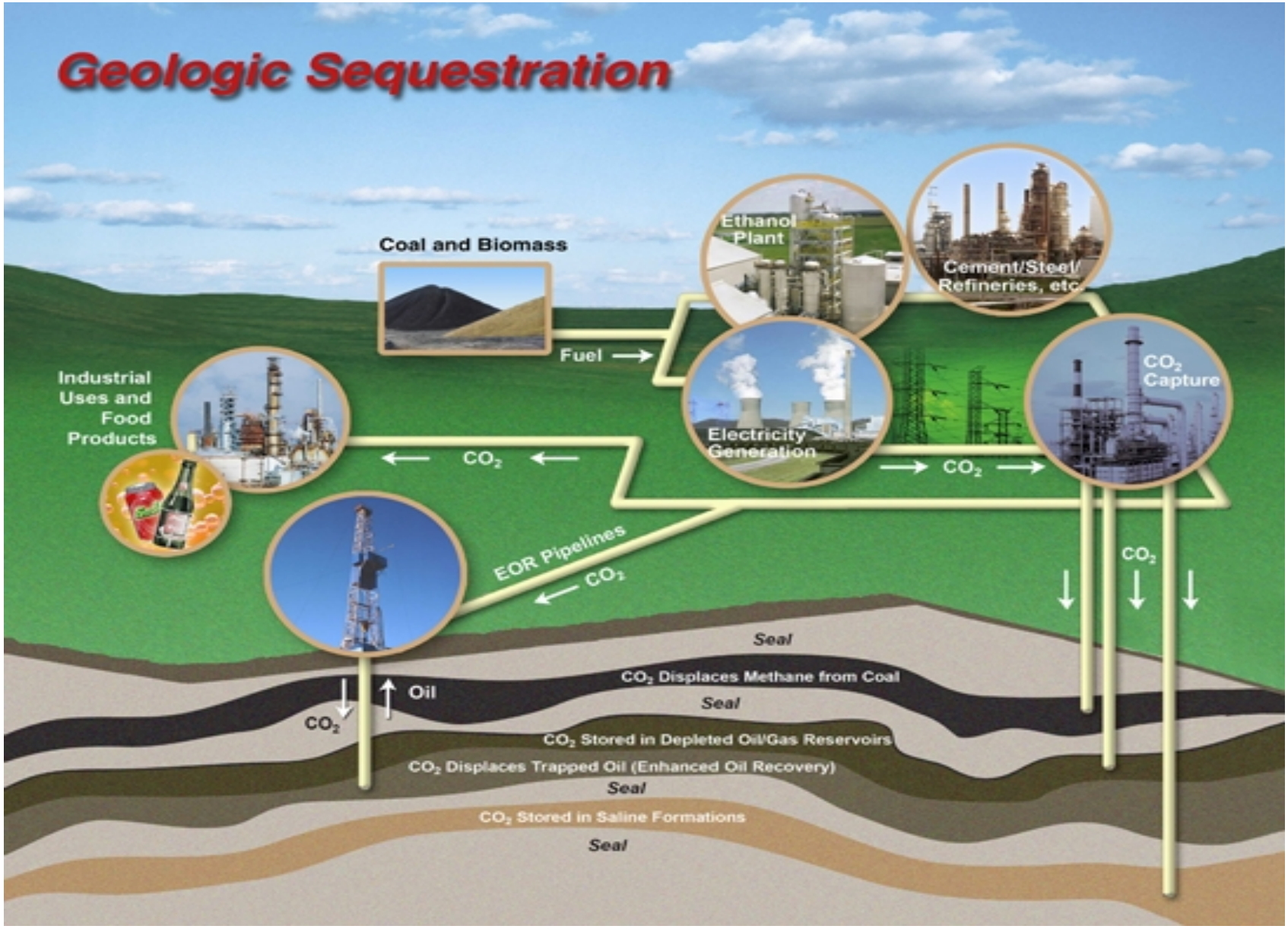
- **Regulatory Framework**
  - Permitting
  - Treatment of CO_2
- **Legal Framework**
  - Liability
  - Ownership
    - pore space
    - CO_2
- **Infrastructure**
- **Human Capital**
- **Public Acceptance**

(NIMBY → NUMBY)



Source: US Department of Energy Office of Fossil Energy

http://energy.gov/fe/science-innovation/carbon-capture-and-storage-research/overview-carbon-storage-research



What is Carbon Capture Utilization and Storage?

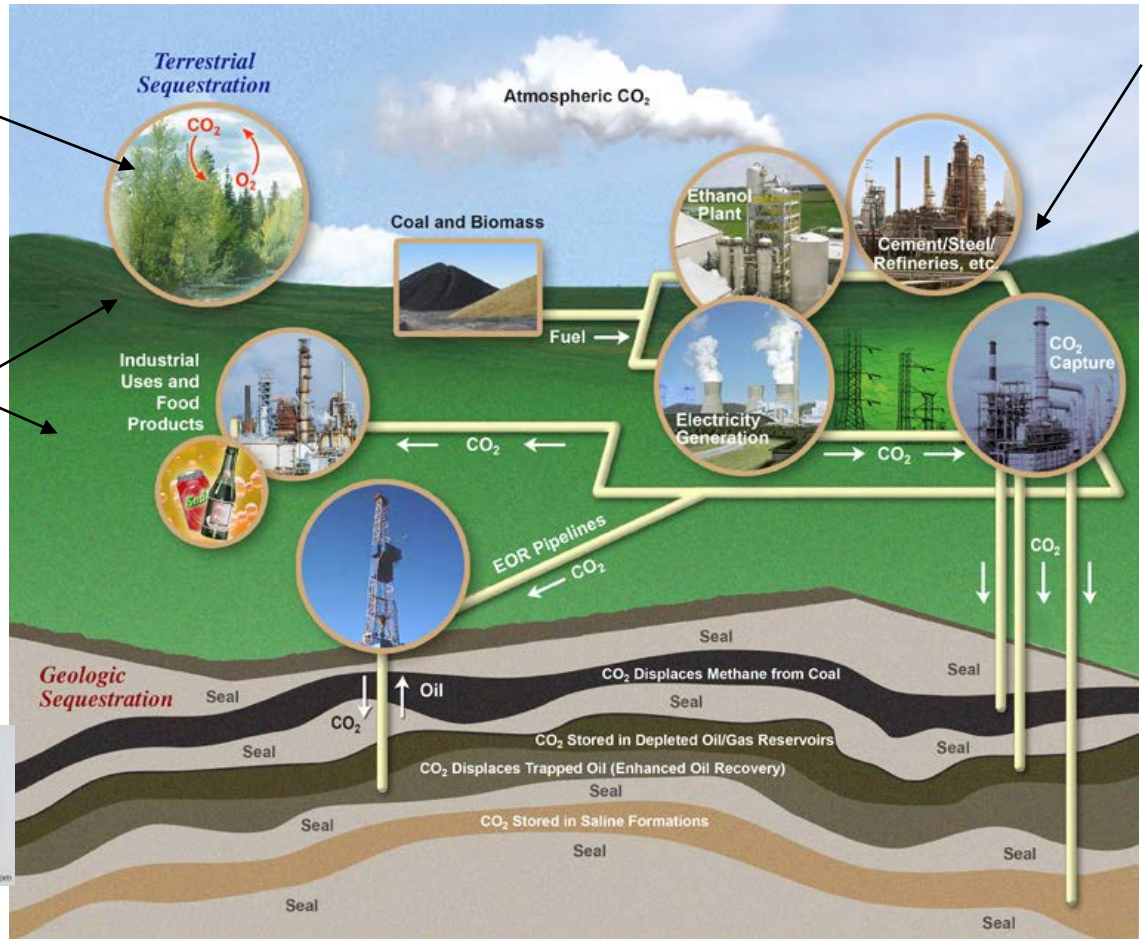
Capture, utilization and storage of CO_2 and other greenhouse gases that would otherwise be emitted to the atmosphere

Terrestrial Capture

CO_2 absorbed from air

Terrestrial Storage

Trees, grasses, soils



Sandstone

Point Source Capture

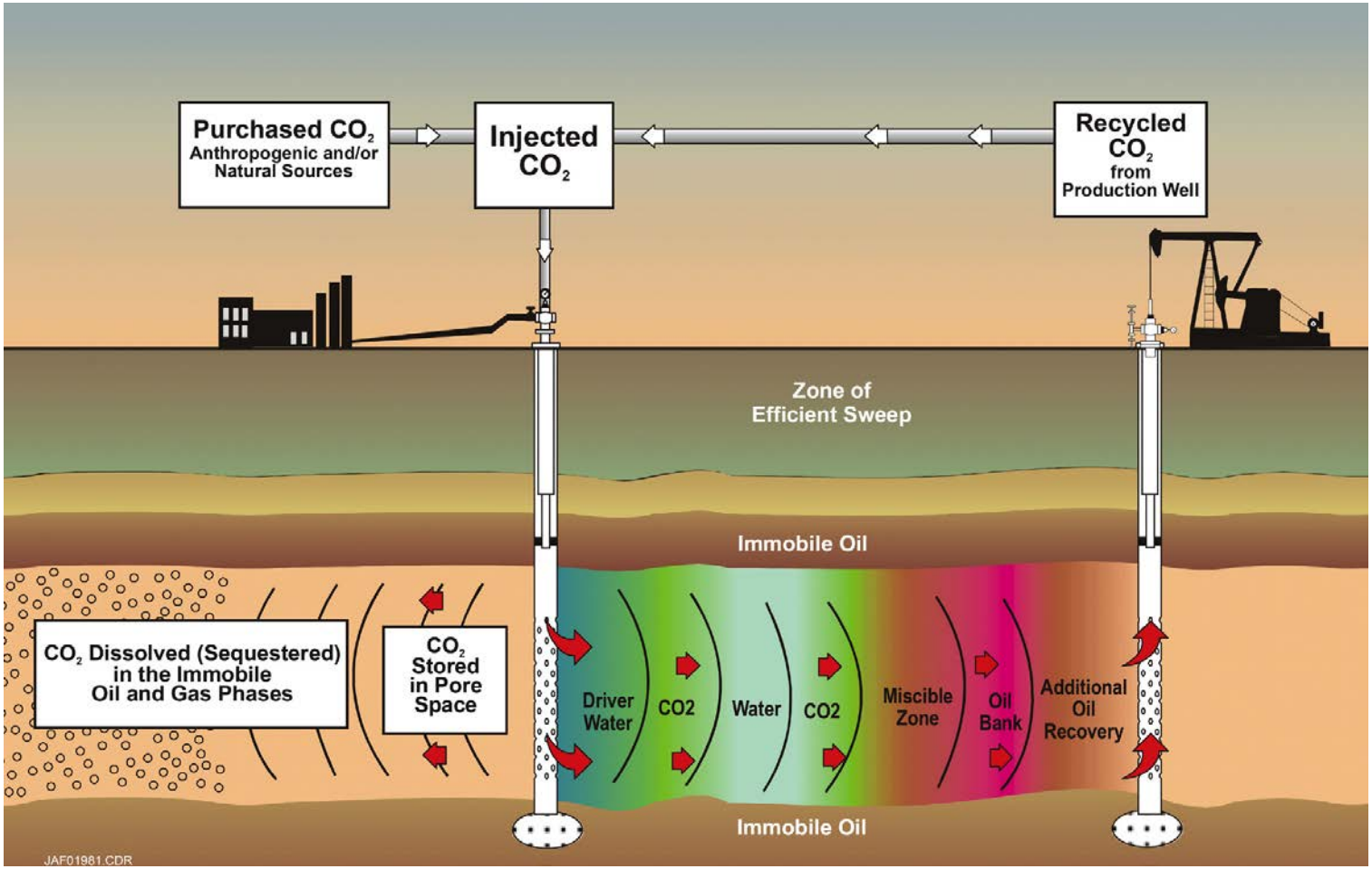
- ***Power Plants***
- ***Ethanol Plants***
- ***Cement***
- ***Steel***
- ***Refineries***
- ***Natural Gas Processing***

Geologic Storage

- ***Saline formations***
- ***Depleted oil/gas***
- ***Unmineable coal***
- ***Other: basalts, shales***

***Source*: US Department of Energy - Office of Fossil Energy**

Using *CO2 with Alternating Water Flooding EOR*



Source: ARI and Melzer Consulting (2010)

CO_2-Enhanced Oil Recovery

The "Un-Mined Gold" Story for Energy, Jobs, and Sustainability

Domestic Energy Security

- **60 billion barrels of crude production from domestic EOR resources**
- **By 2030 ~15% of U.S. crude oil consumption could be supplied by CO_2-EOR**

Economic Security

- **$3.5 trillion in reduced expenditures on imported crude oil**
- **622,000 new jobs**
- Cost of captured CO_2 in 2020: $13 - $22/tonne CO_2
- Cost of captured CO_2 in 2030 : $1/tonne CO_2

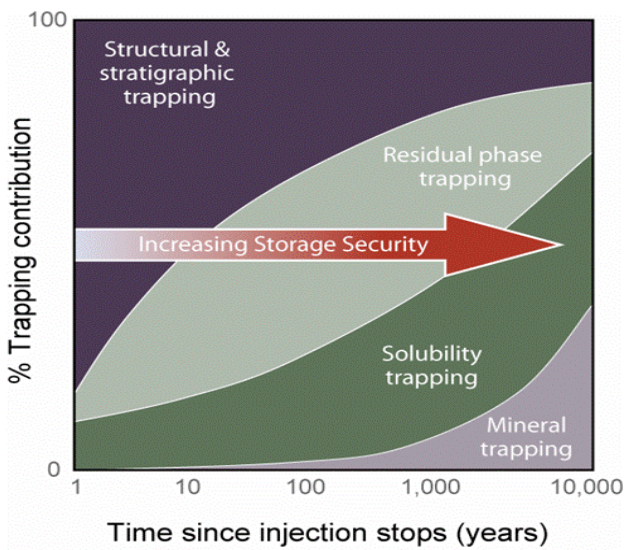
Environmental Sustainability

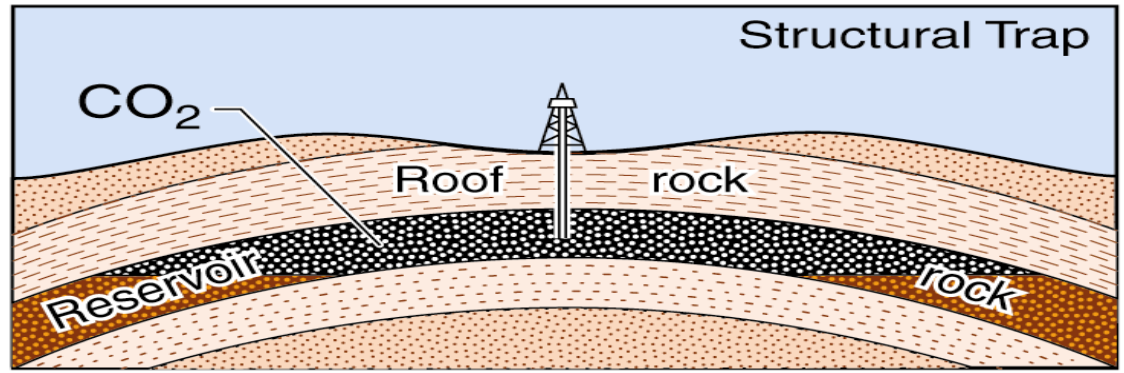
- **Meeting President's Goal: 83% reduction in GHG emissions by 2050**
- IEA: "CCS …most important technology option"
- **CO_2-EOR can spur deployment of commercial CCUS**

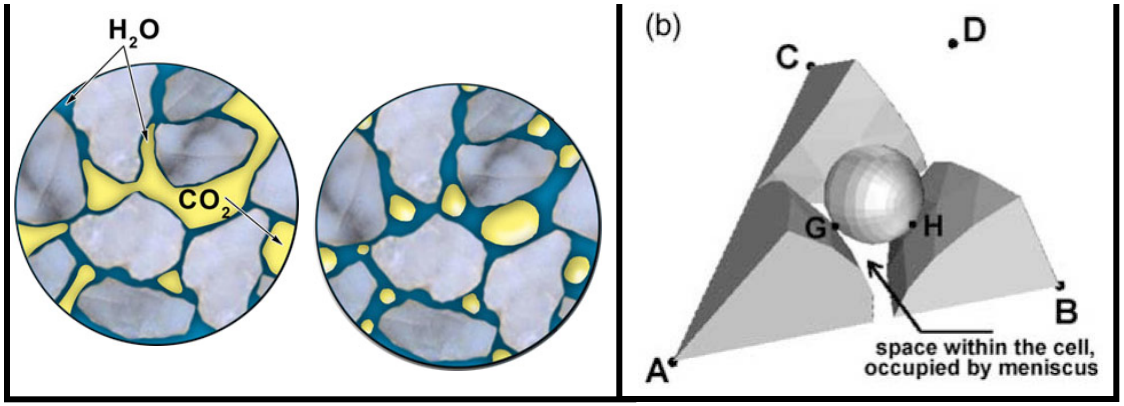
Carbon Storage – How does it work?

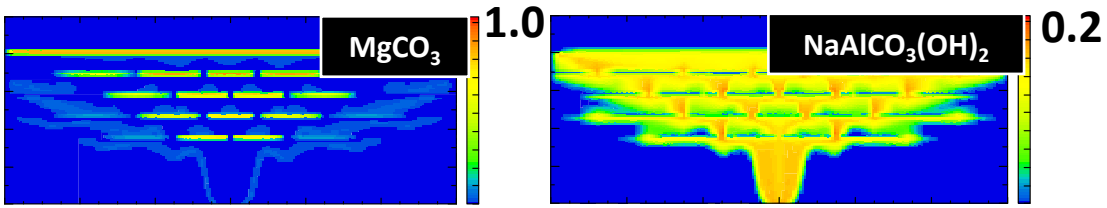
Storage mechanisms vary by target class; generally multiple processes which improve over time

- **Physical trapping**
- **Residual phase trapping**
- **Solution/Mineral Trapping**
- **Gas adsorption**
  - **For organic minerals only (coals, oil shales)**





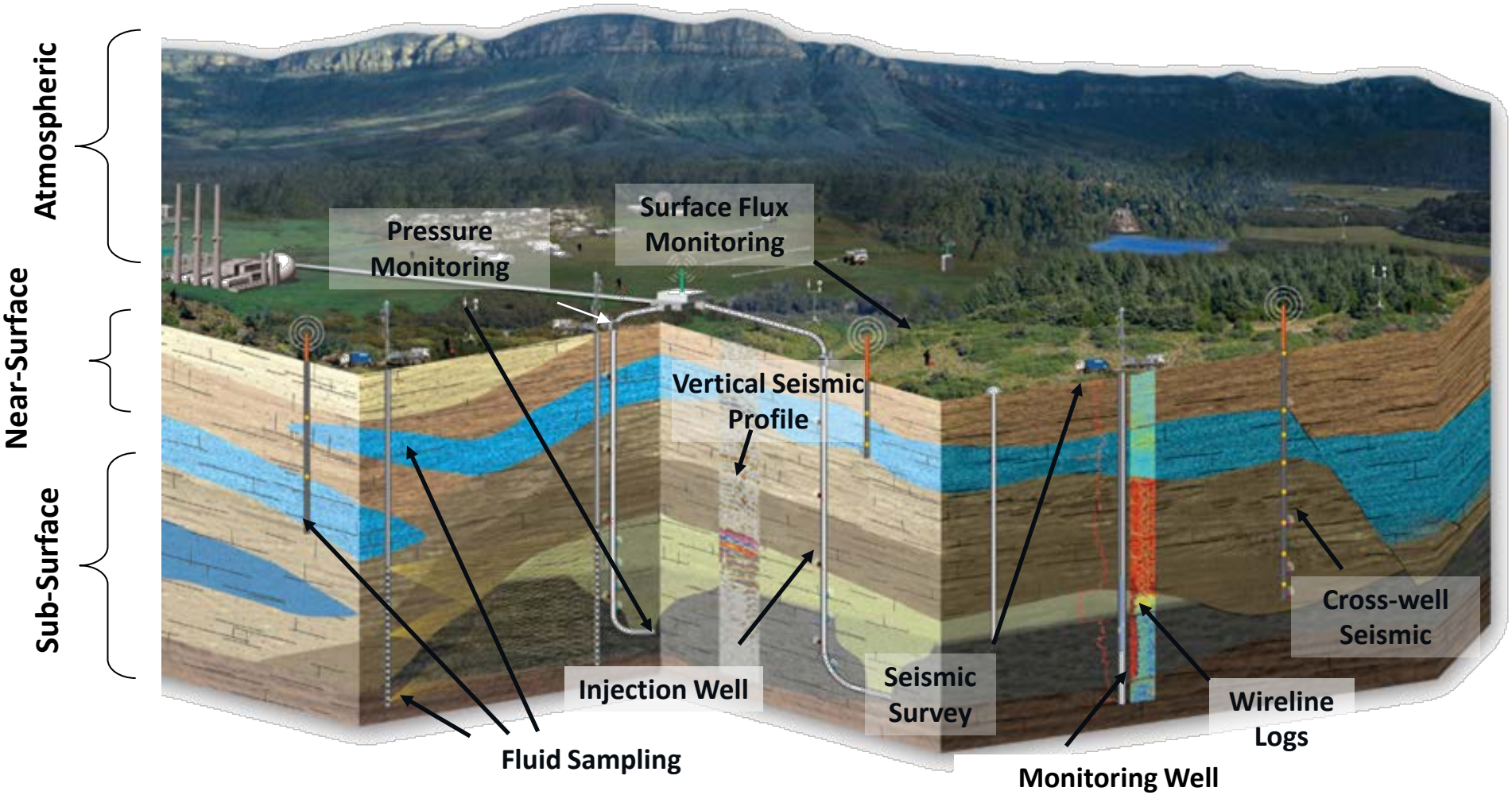




Source: S Benson, LBNL

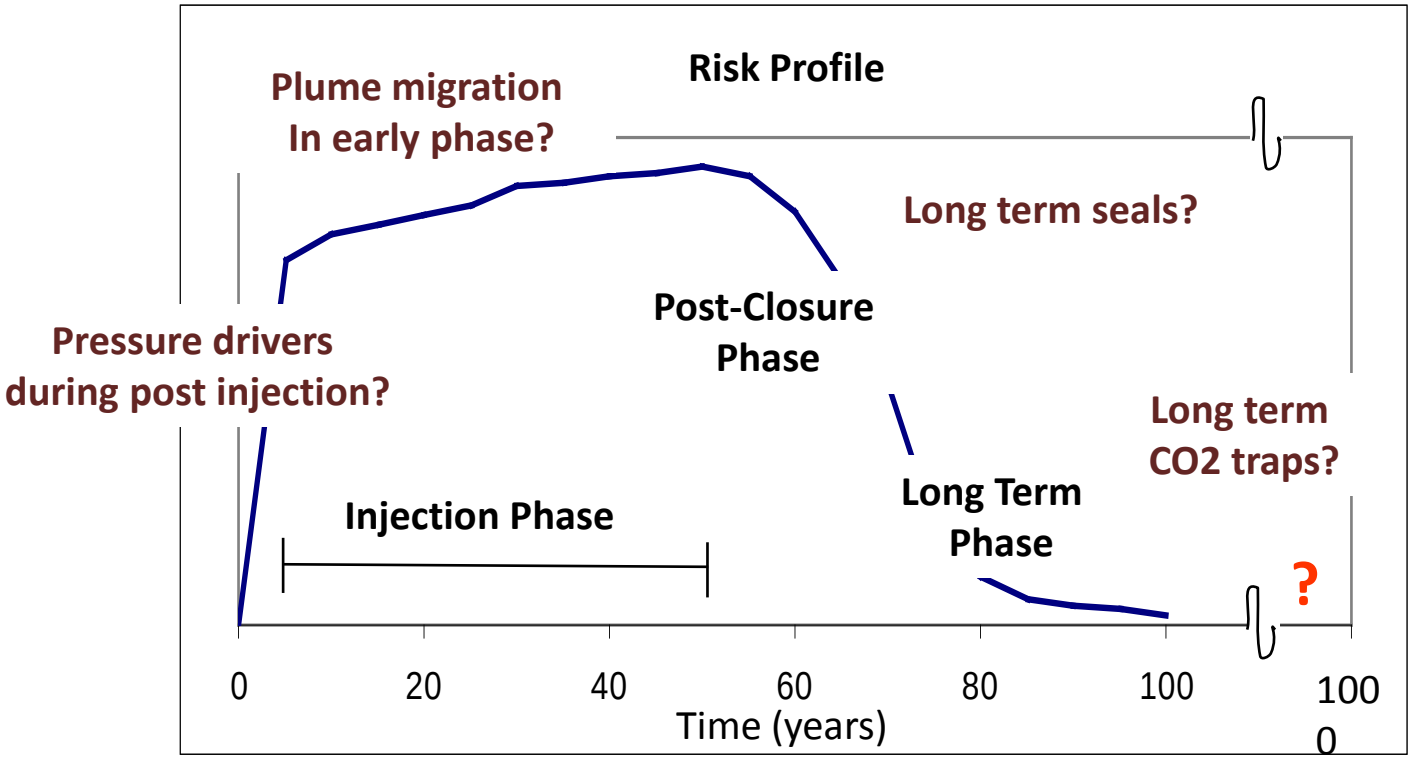
Geologic Storage

Monitoring, Verification, Accounting (MVA) Tools



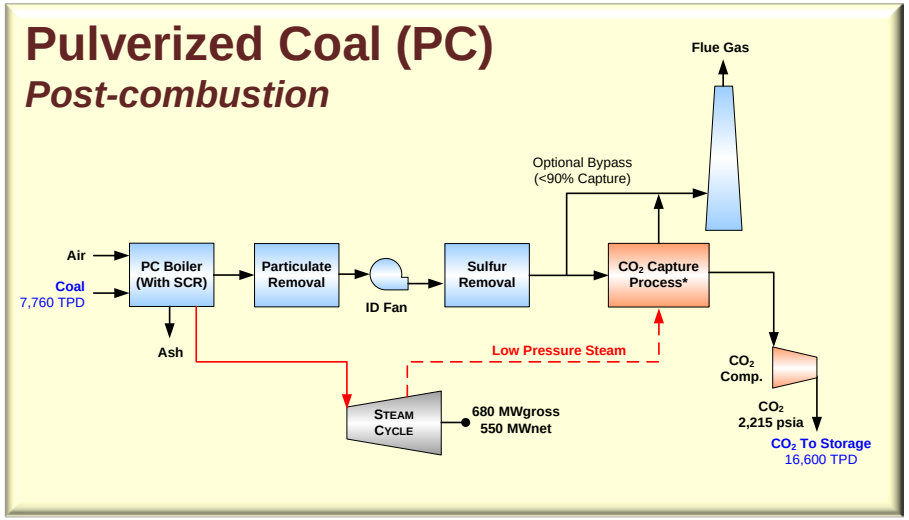
Courtesy of Schlumberger

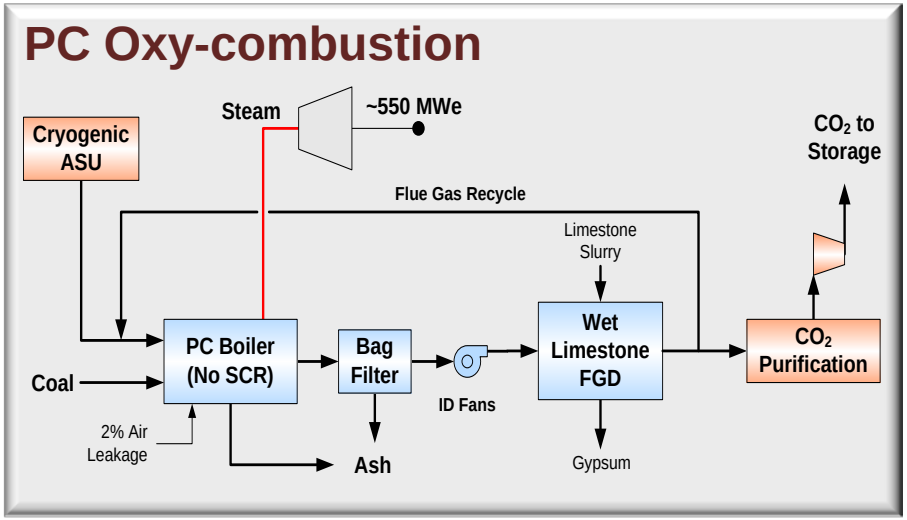
Geologic Storage
Risk Profile

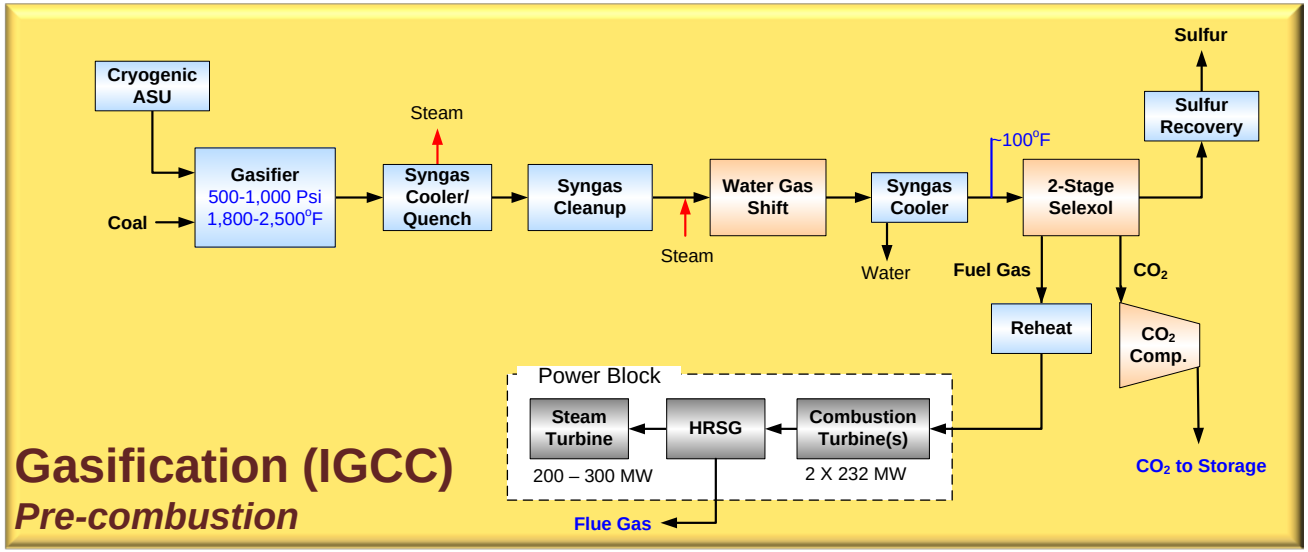


The risk timeline for leakage is heavily-laden in early times.

Fossil Energy CO_2 Capture Options





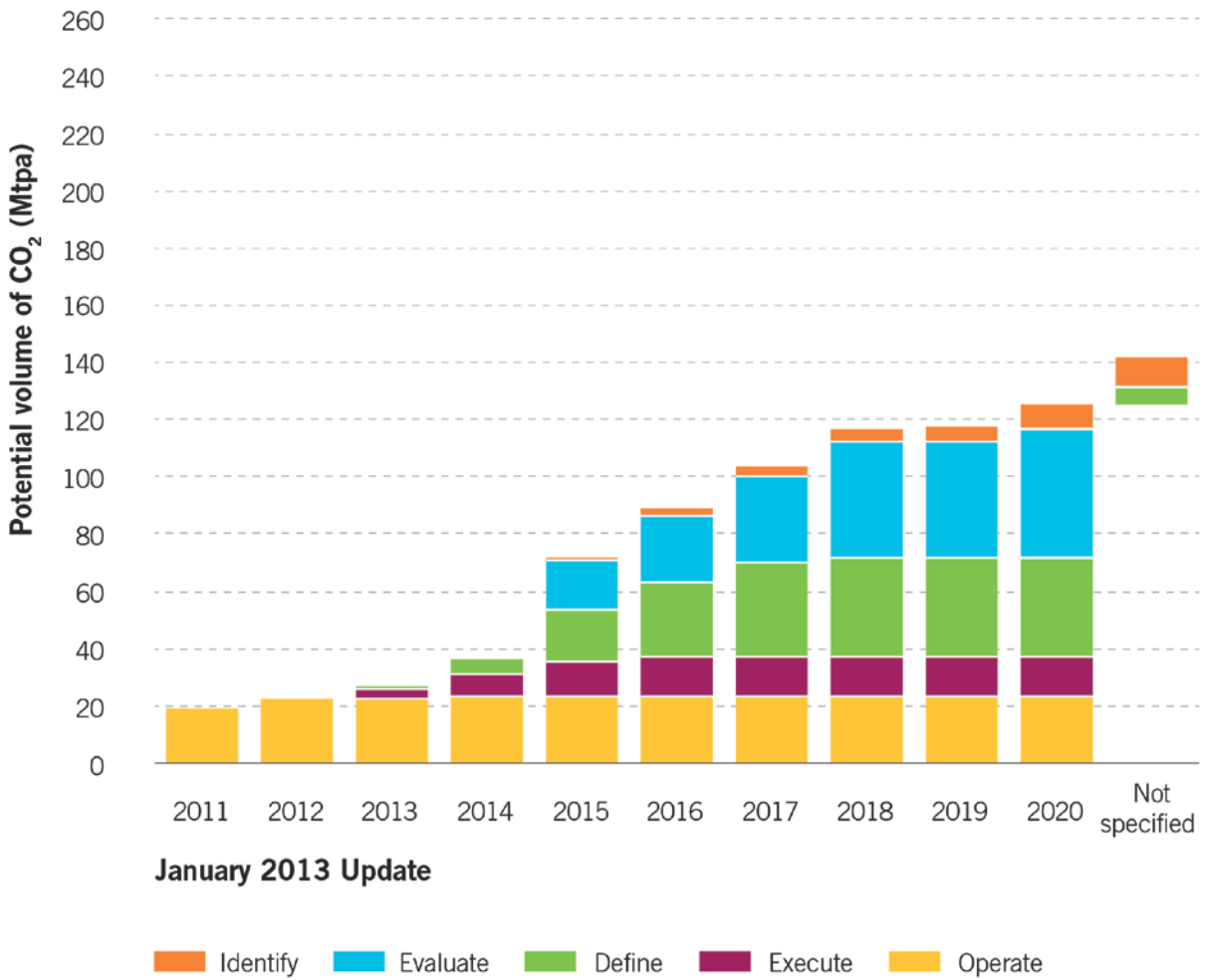


Source: Cost and Performance Baseline for Fossil Energy Power Plants study, Volume 1: Bituminous Coal and Natural Gas to Electricity; NETL, May 2007.

KEY MESSAGE

CCS PROJECTS JUST STARTING TO CONTRIBUTE TO REDUCING GHG – BUT NEED MORE PROJECTS

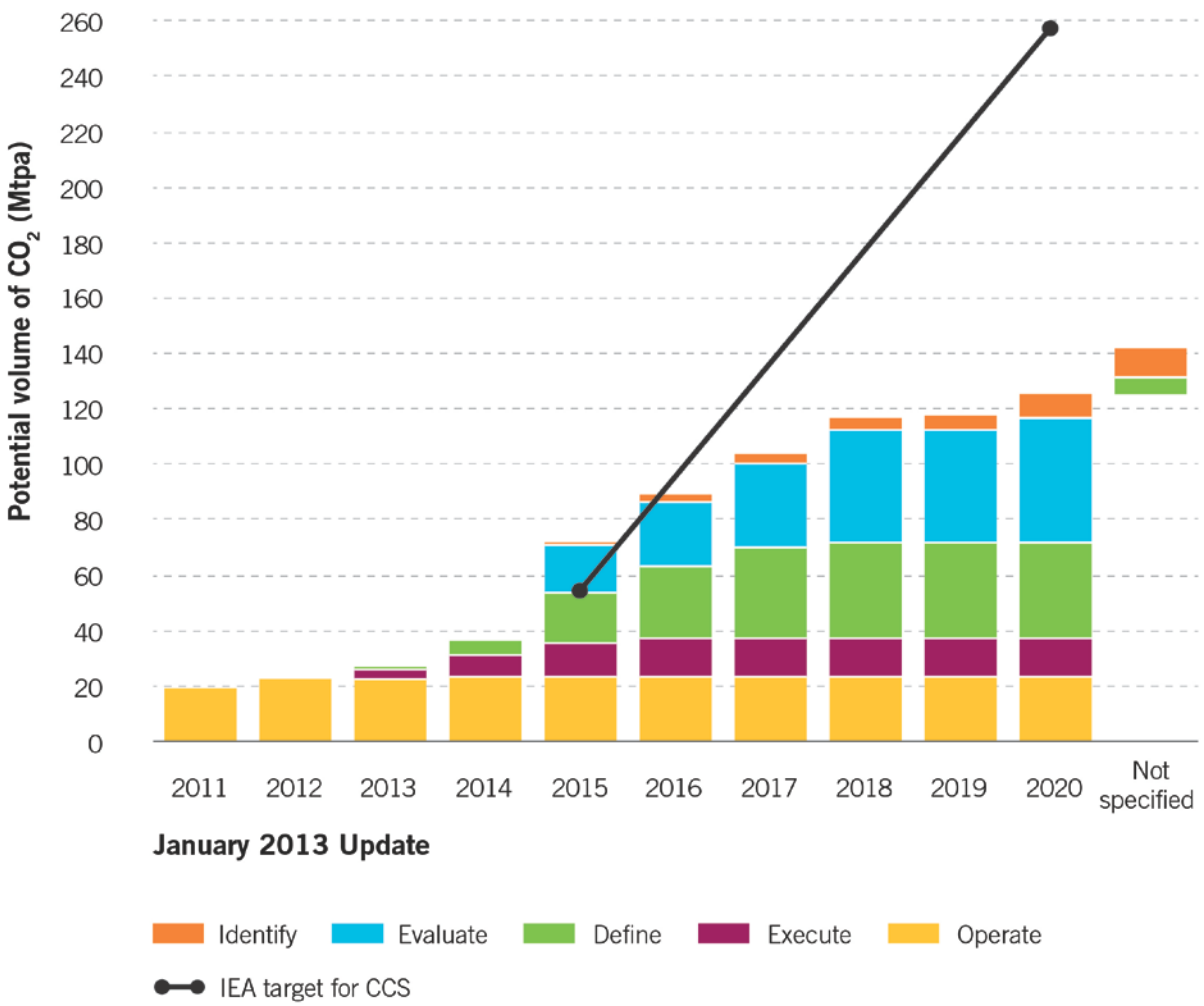
Volume of CO_2 potentially stored by large-scale integrated projects



KEY MESSAGE

PROGRESS MUST BE ACCELERATED

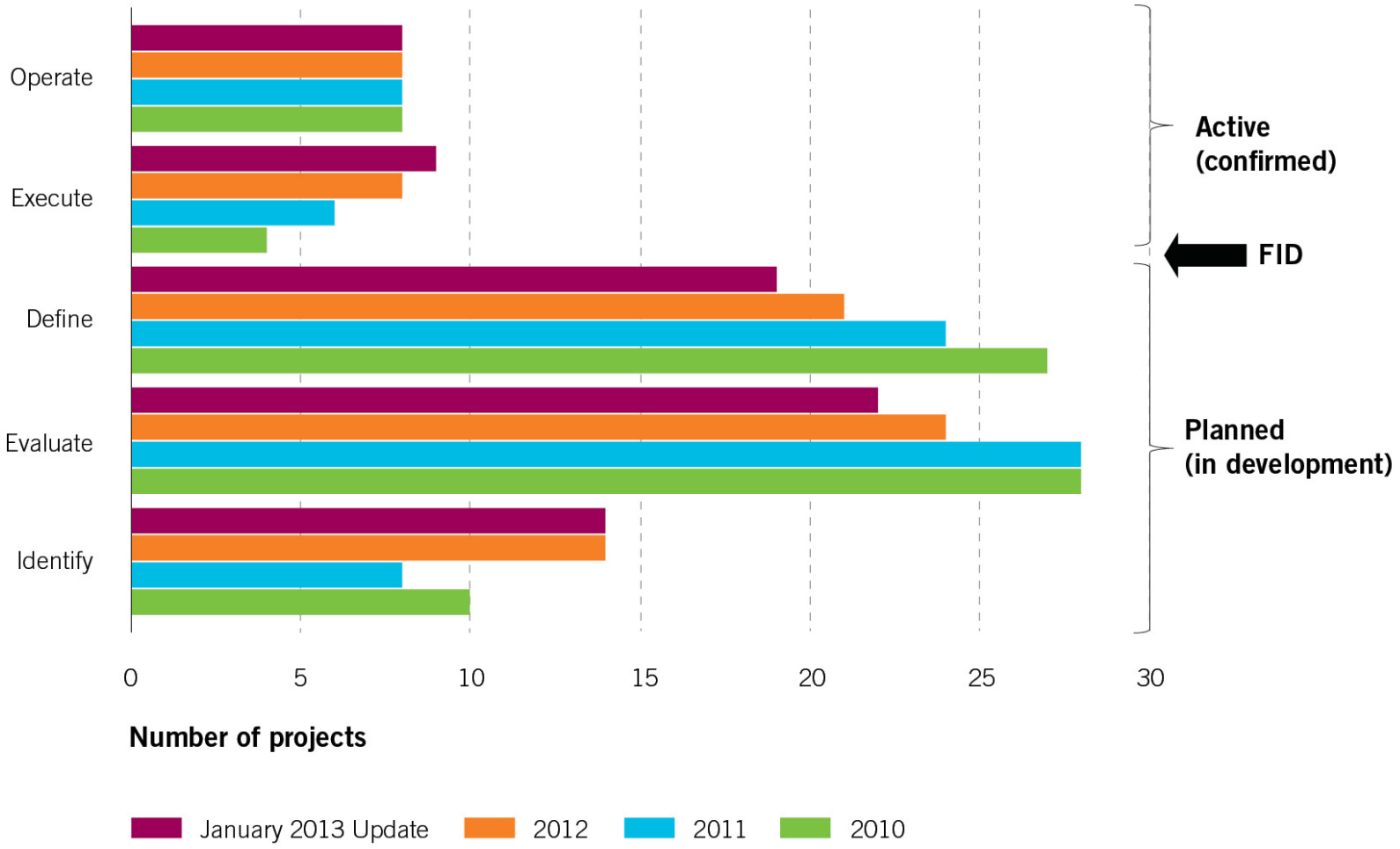
Volume of CO_2 potentially stored by large-scale integrated projects



KEY MESSAGE

STEADY PROGRESS - OVER 70 PROJECTS WORLDWIDE AT VARIOUS STAGES OF MATURITY

Large-scale integrated projects by asset lifecycle and year



KEY MESSAGE

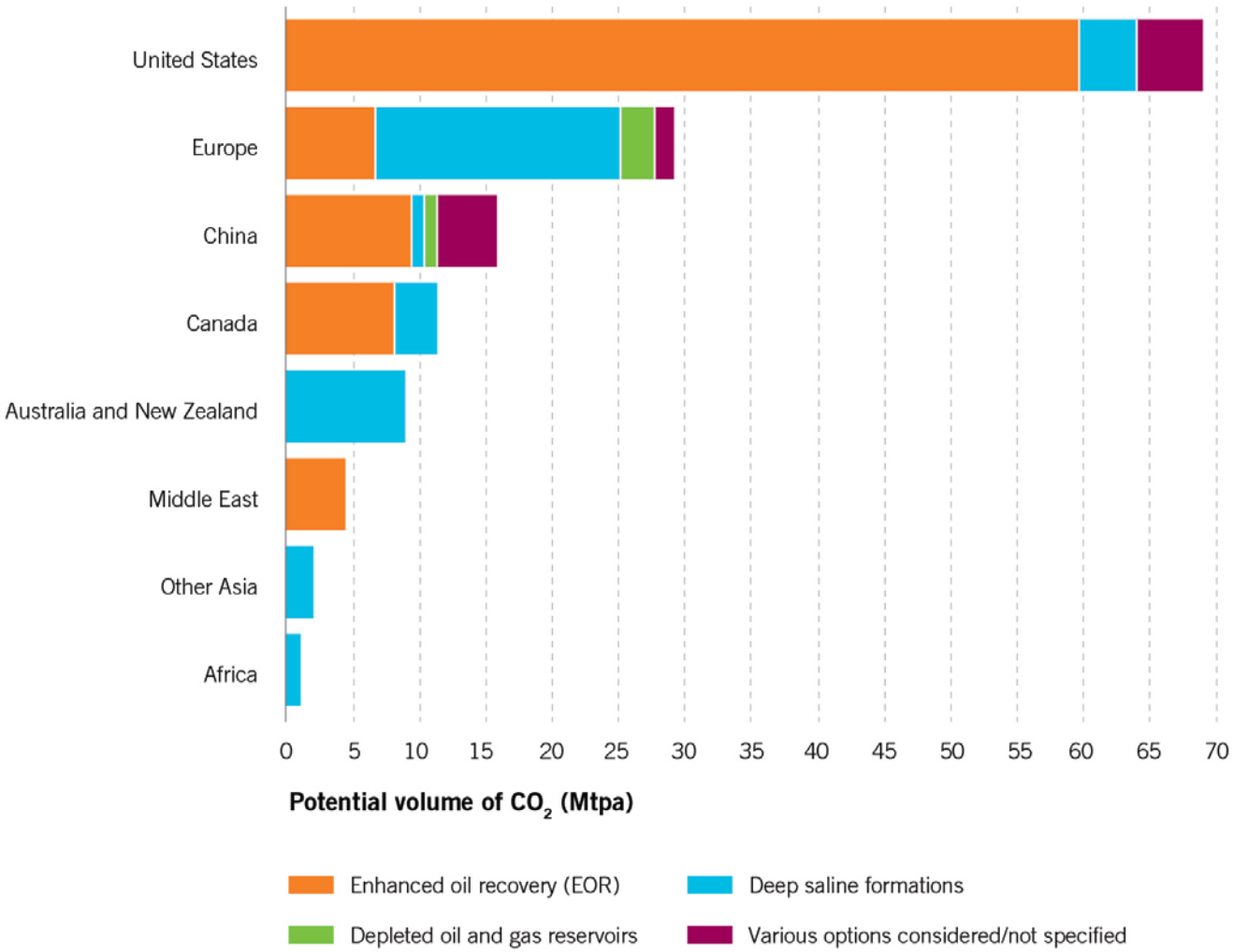
NORTH AMERICA HAS 13 OF THE 17 PROJECTS EITHER IN CONSTRUCTION OR OPERATION WORLDWIDE

North America large-scale integrated projects by asset lifecycle and year

KEY MESSAGE

VOLUME OF POTENTIAL CO_2 STORAGE REPRESENTED BY LARGE-SCALE CCS PROJECTS IN VARIOUS STAGES

Volume of CO_2 potentially stored by primary storage type and region

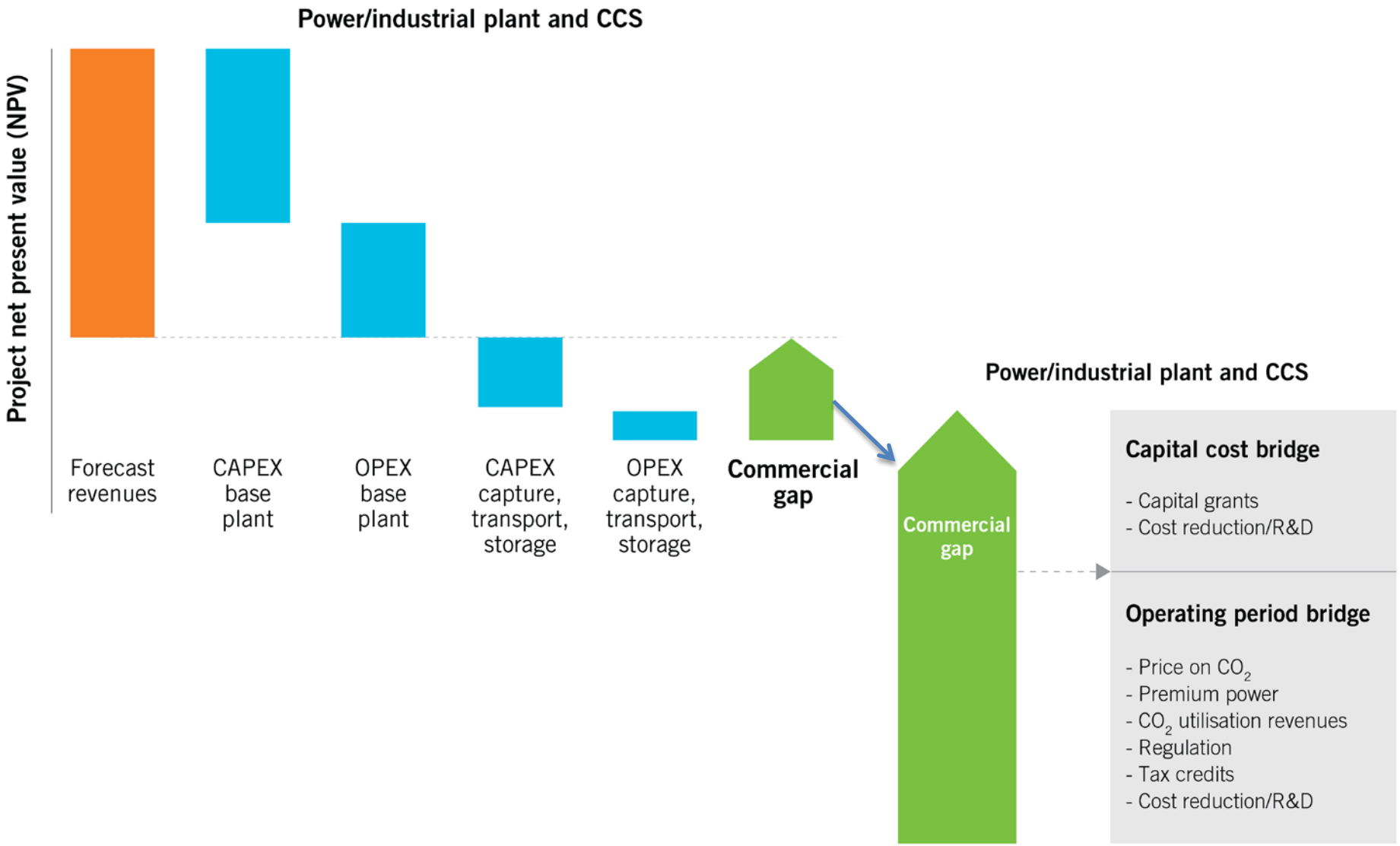


Note: Data reflects January 2013 LSIP update

CCS CHALLENGES

- **CCS is** a **capital intensive add-on with high energy penalty** on output capacity of fossil-based plants unless it is inherent to the process.
- The **cost of capture is higher than the market price** for CO_2 (e.g., EOR) absent a carbon valuation policy.
- Need to incentivize **more large-scale demonstrations** to walk down the learning curve **to reduce cost**.
- **Legal/regulatory issues, e.g., long-term liability**, **ownership** rights, need to be framed in some countries (like in US and Canada)
- Public Understanding and thus Acceptance of CCS needs to improve.

Challenges to deployment: Revenue



CCS BENEFITS FROM CCUS (AS CO2-EOR)

- **Enables CCS** technology improvement and cost reduction.
- Improves **business case for** demonstration and **early mover projects** through CO_2 revenue.
- Helps **gain** public and policymaker **acceptance**.
- Builds and sustains a **skilled CCS workforce**.
- Supports **CO_2 transportation network** development where EOR is an option.

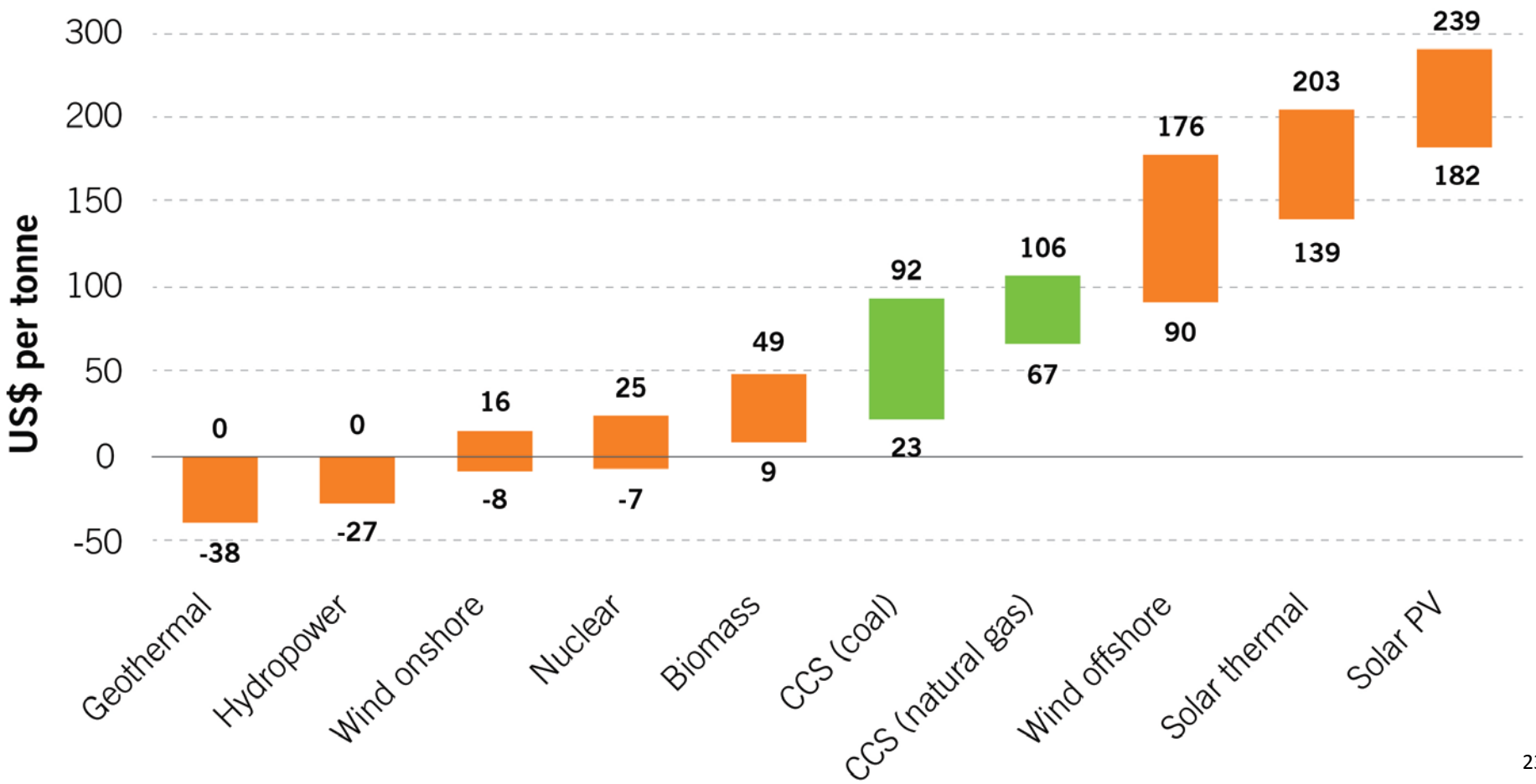
CO2-EOR AS CCUS - CHALLENGES

- CO_2-EOR as **CCUS** although important **as an enabler for CCS,** it is **geographically and capacity limited in the long run. North America is fortunate to have the opportunity.**
- **CO_2 revenue** currently alone will not bridge gap for high capture cost scenarios; more needs to be done to **narrow the gap** (**technology, policy, market**).
- Gaps exists between geologic **storage permitting** and **CO_2-EOR** regimes (**Class 2 vs Class 6 in the US**).

KEY MESSAGE

ON AN UNSUBSIDIZED BASIS CCS IS COST COMPETITIVE RELATIVE TO OTHER CLEAN LOW/NO CARBON TECHNOLOGIES

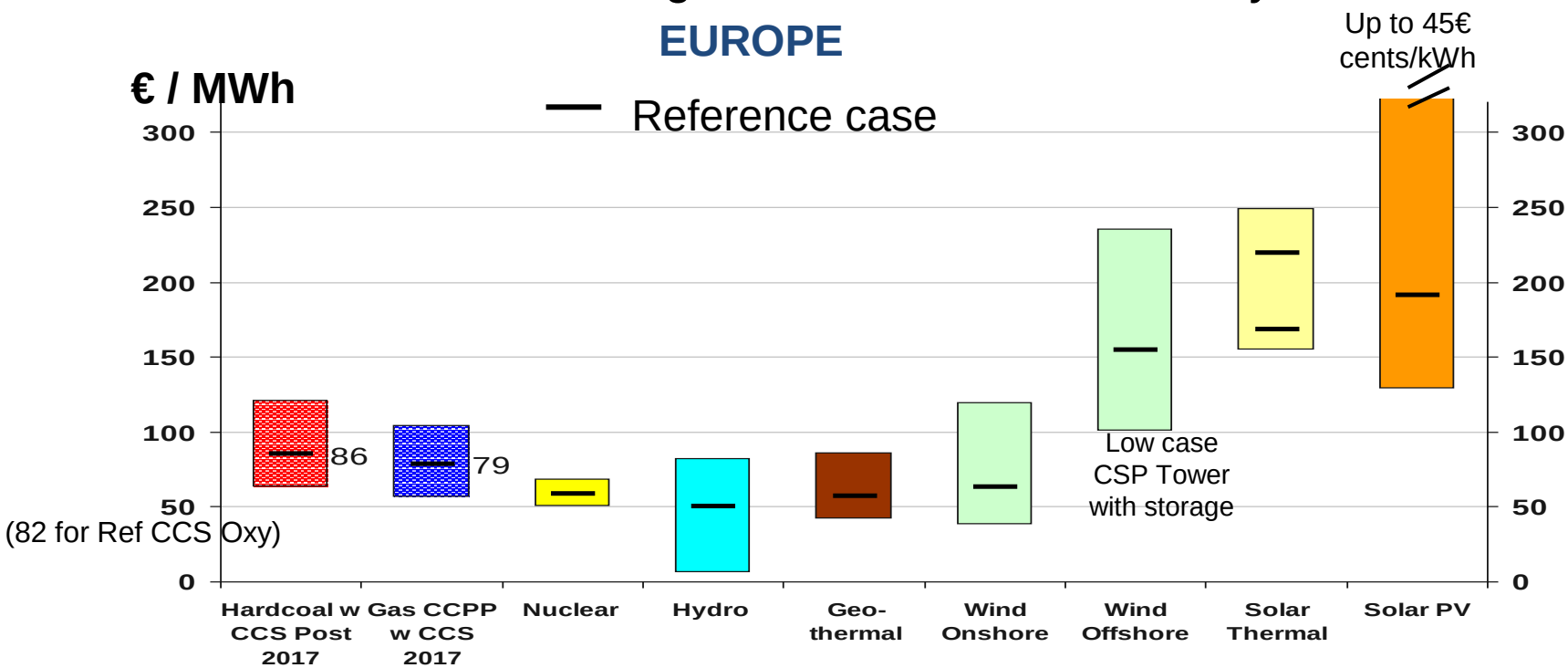
Costs of CO_2 avoided



KEY MESSAGE

CCS competitiveness against other low carbon alternatives in Europe in 2012-17

CoE Low Carbon technologies – New PP over next 5 years



Source : **Alstom analysis 2012**. CCS w Post amine 2017 costs, including on shore T&S & CO_2 price (Flue Gas Recirculation for CCS Gas CC) CoE do not include "externalities" of Intermittent power (Back-up cost, balancing cost, grid enhancement if required)

Under realistic assumptions and with a conservative variation range, CCS is already in the "mix" of low carbon alternatives

KEY MESSAGE

REDUCING THE COST OF TECHNOLOGY THROUGH DEMONSTRATION PROJECTS IS VITAL

Quest, Canada

TCM, Norway

Boundary Dam, Canada

Plant Barry, US

FINAL THOUGHTS ON IMPORTANCE AND NEED FOR CCS AS PART OF A CLIMATE AND ENERGY SECURITY PORTFOLIO

- **Fuel switching and EOR not enough to meet global targets.**
- **Absent carbon legislation, use of existing regulations not be optimum to** encourage CCS/CCUS
- Need to include **CCS** in the portfolio of clean technologies with **equitable incentives and treatment** - lowering cost of meeting reduction targets in the long run.
- **Expertise** and **learning** must be **shared to accelerate CCS progress and reduce costs-** part of GCCSI's mission to help enable
- **Need more funding and incentives for CCS projects to accelerate CCS deployment**
- **Encourage CCS capacity building in developing economies – potential sources of major future emissions**