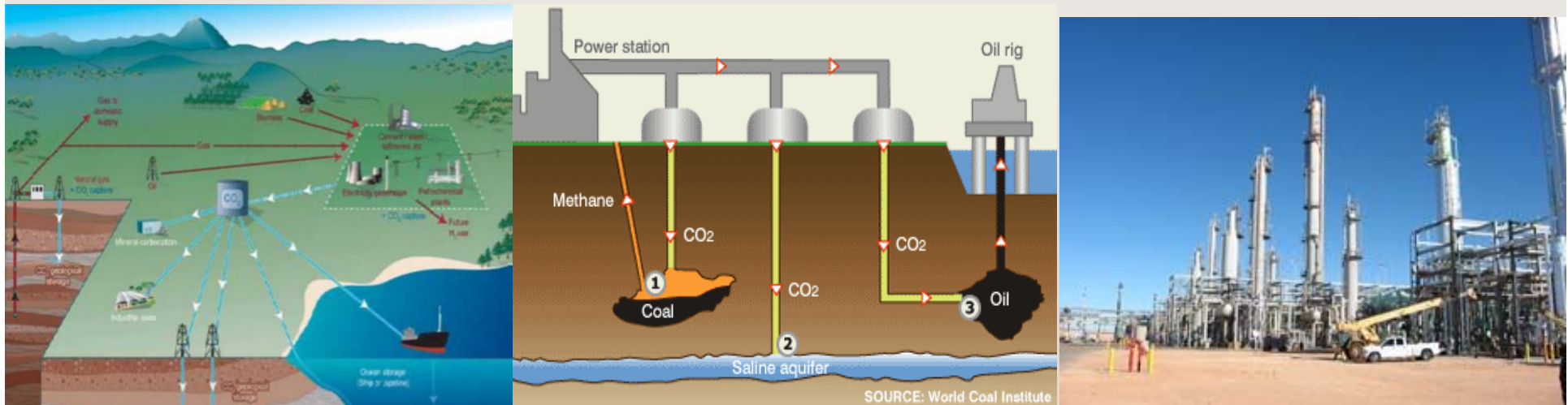


Carbon Capture and Storage After Copenhagen : an Imperative, not an Option

International collaboration for development of CCS/EOR as
early path to accelerated large scale CCS deployment

Adnan Shihab-Eldin

World Energy Congress - Montreal 2010: WEC Session 2.12

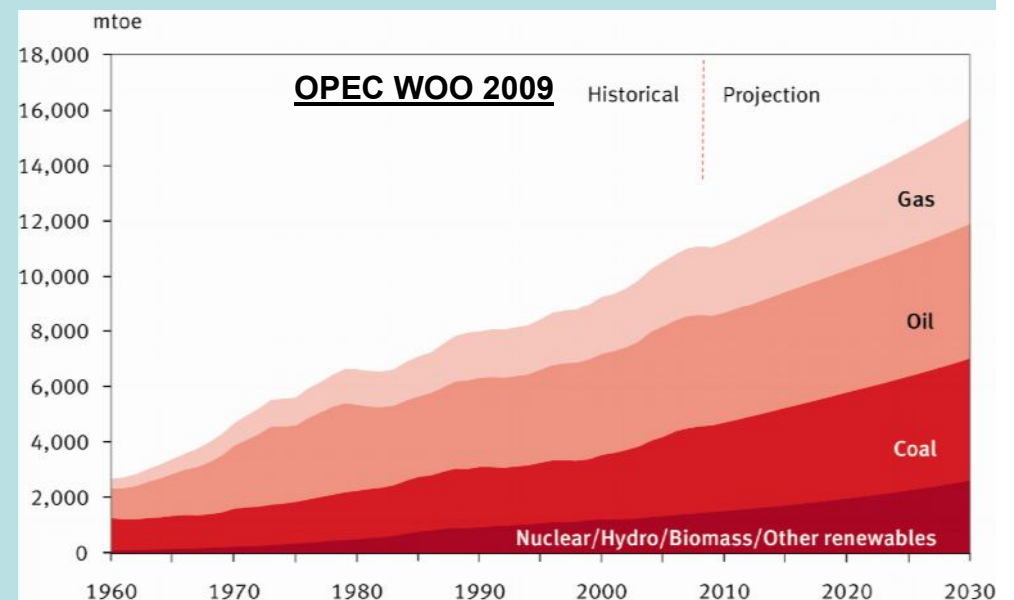
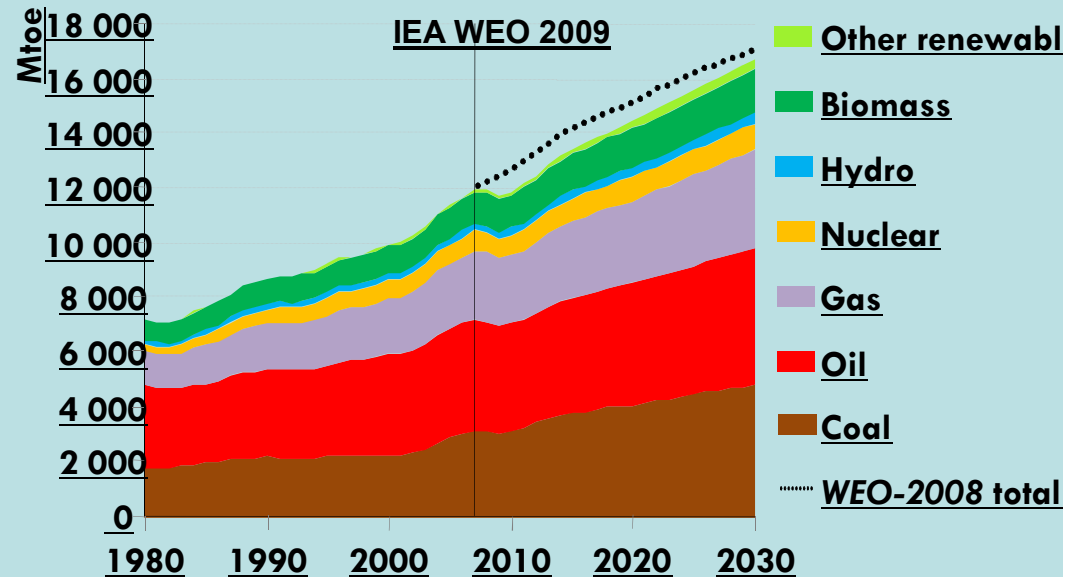


Outline

- **The critical role of CCS within the available clean energy technology options:**
 - *Can renewable & nuclear alone meet the rising DCs demand*
- **CCS with EOR:**
 - *early path to large scale commercial CCS deployment :*
- **Oil producers interests & role in CCS development**
 - *examples of what GCC/producers are doing voluntarily*
- **CCS/EOR & International Cooperation:**
 - *Indispensable for speeding up development & deployment*
 - *partnership with O&G producers*
- **Concluding remarks**

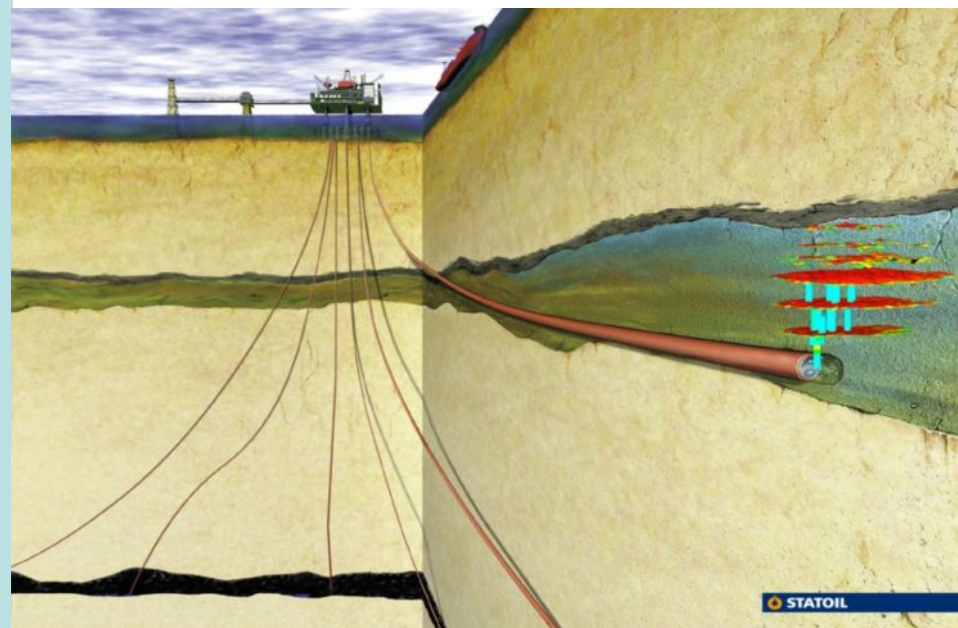
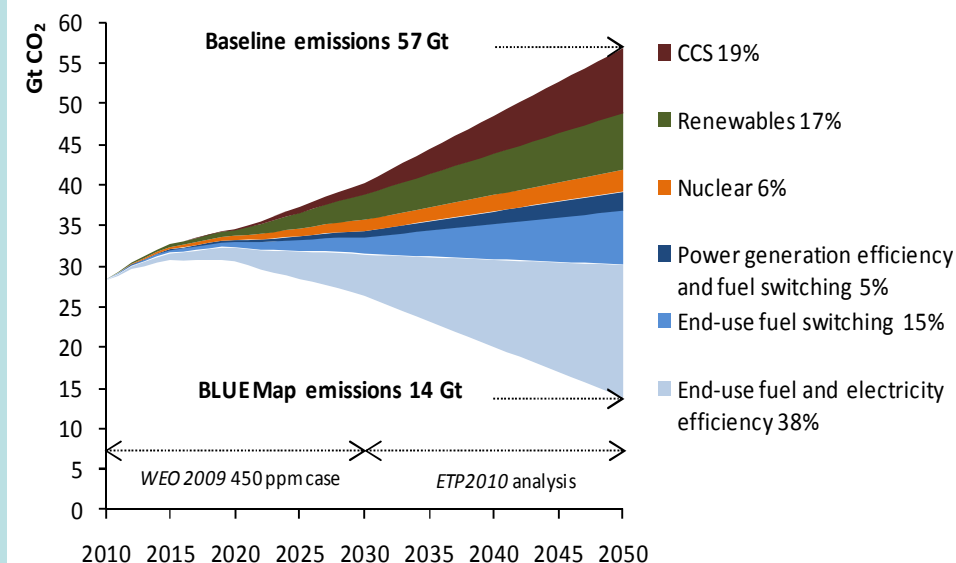
Fossil Fuel will continue to provide most of demand for energy for decades to come

- **Most scenarios**, continue to project **demand for fossil fuels are to grow** & account for ~ 80% of energy demand by 2030,
- **Energy Security & Climate Change** drivers are being advocated too strongly to **reduce & reverse growth** in demand for fossil fuels (oil).
- While **all energy** technology options need be developed, it is **unwarranted** to press for too **expensive & risky** scenarios of only/mostly **renewable**



The dual Challenge facing continued and expanded use of fossil fuels

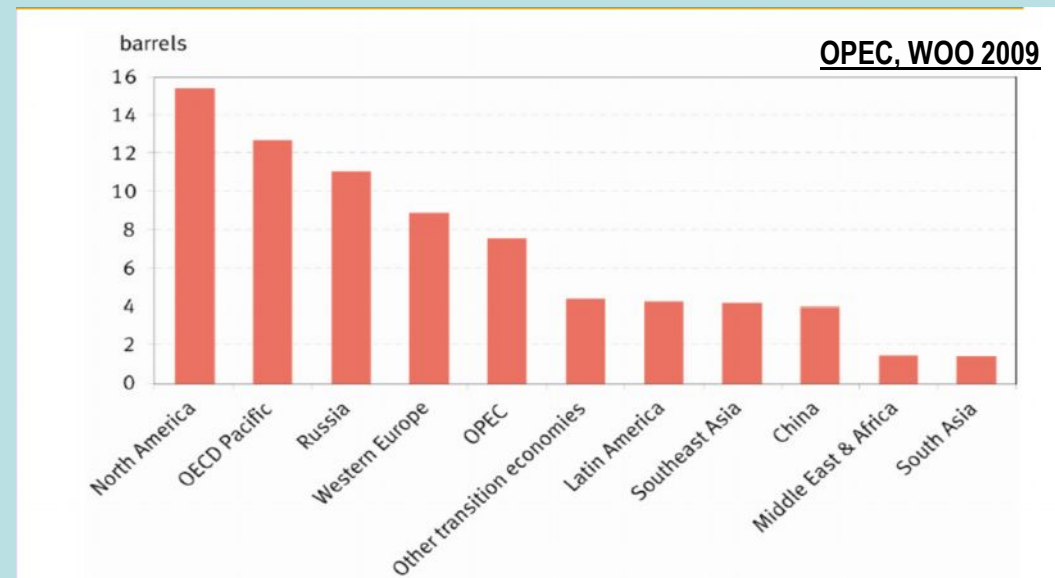
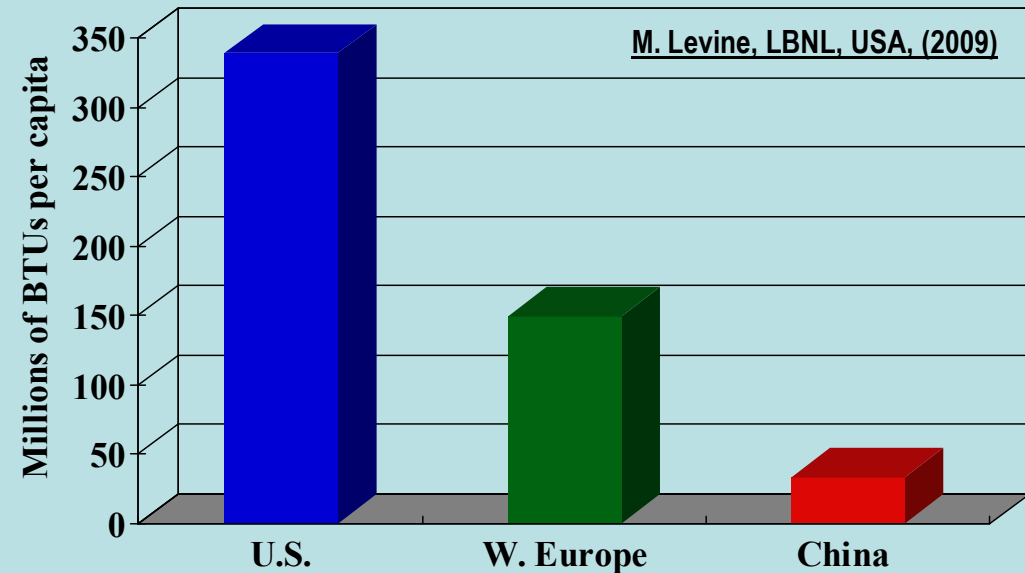
- The **trend** that has been building up **against expanded use fossil fuels**, on **energy security** grounds), has gained additional **momentum** from **climate change** concerns
- **Fortunately, CCS** is one of the key technology options to reduce CO₂ emissions
- **It allows continued use** of cheap **fossil resources** for **economic growth** (especially for **DC**) while ensuring, (with other options) **reduced net CO₂ emissions** from their use



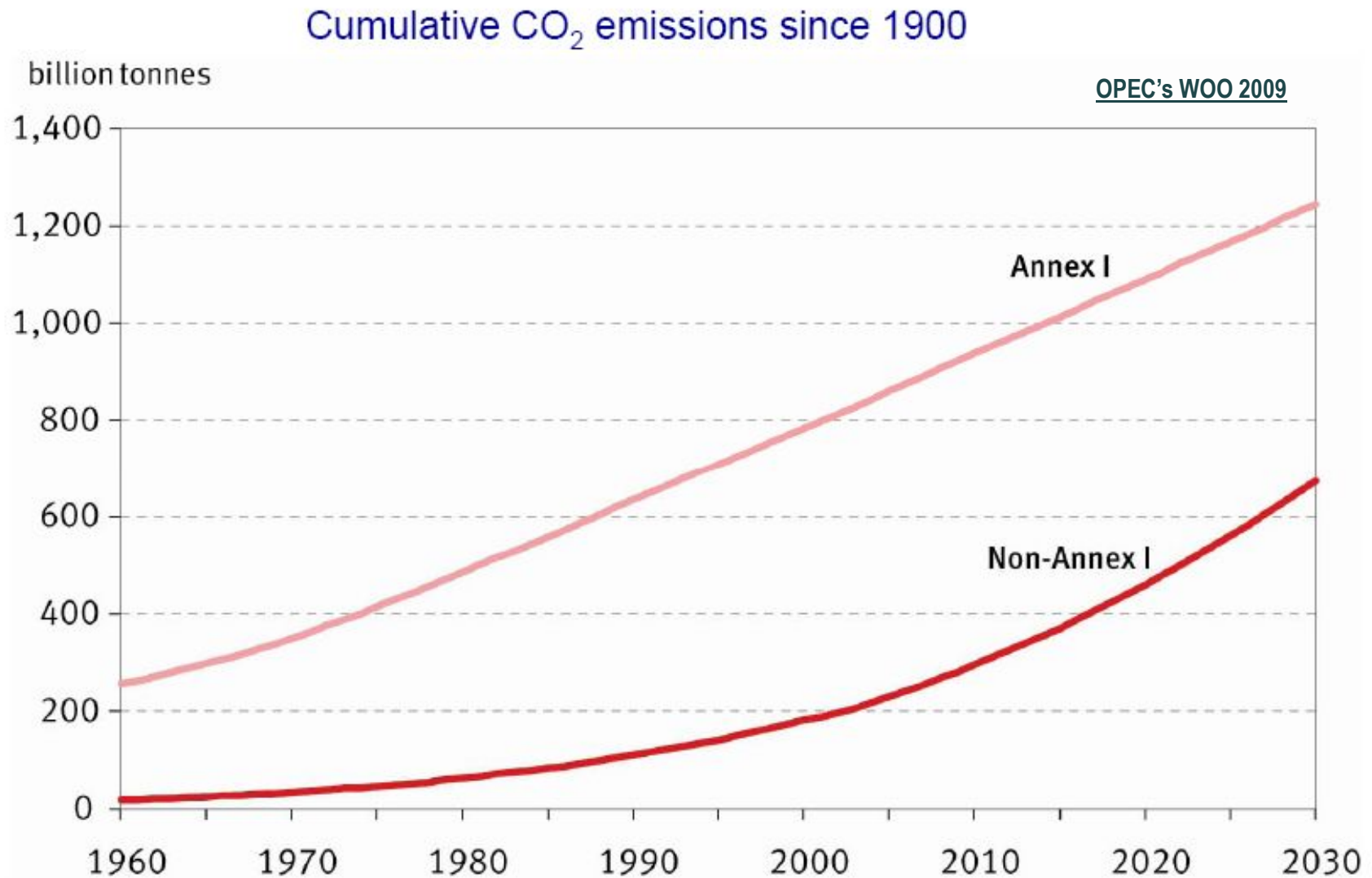
Myths & Realities about China's & other DCs rising energy consumptions & emissions

- **Myth:** China is profligate in its use of energy and becoming more so
- **Reality:** Per capita energy use in China in 2008 was only 1/8 U.S. & 1/4 EU

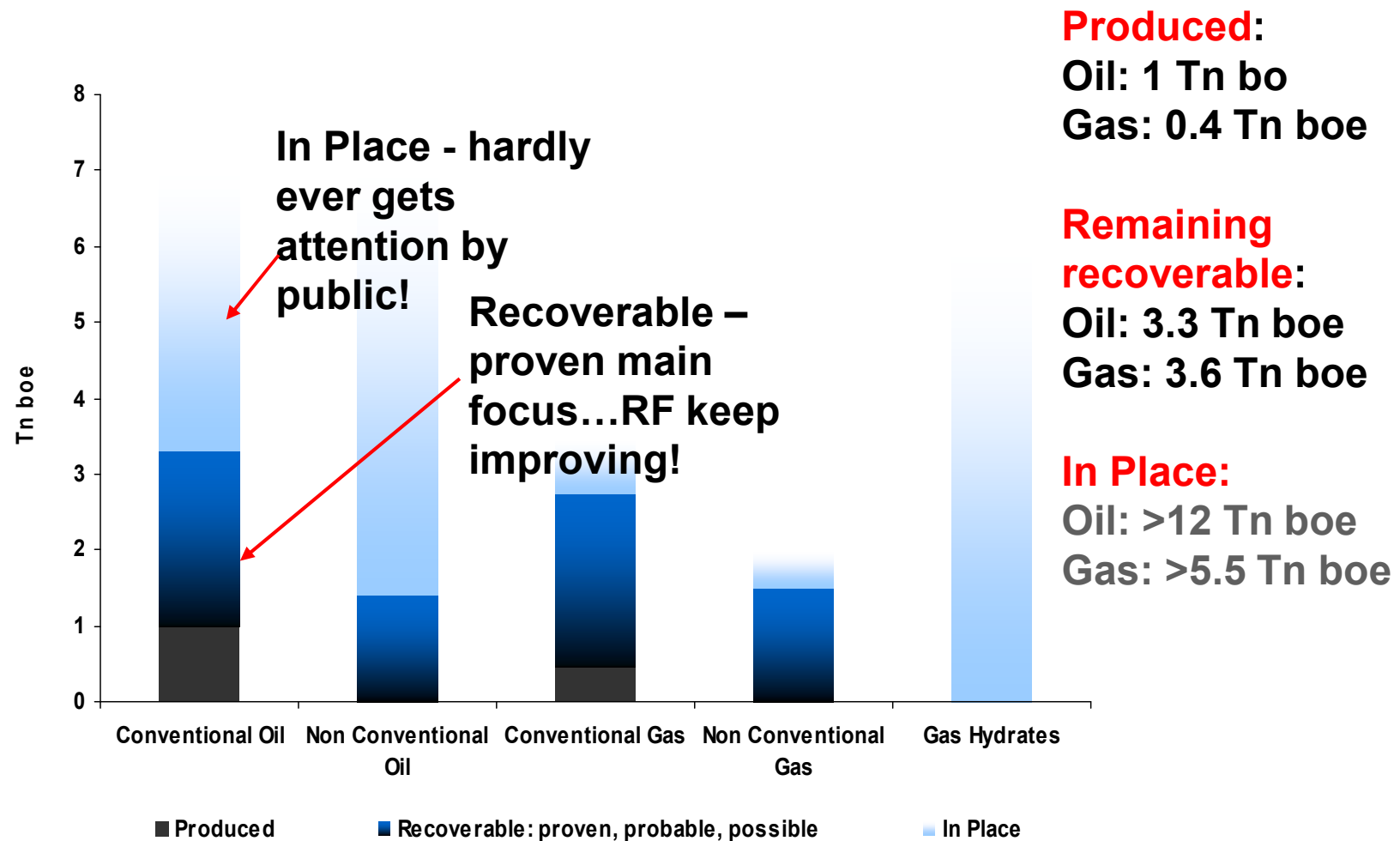
- Projected **China's** and other DCs **per capita oil use** (and emissions) in **2030** will still be far below those of DC
- → per capita **US & other OECD** energy use and emissions have room to **go down further** while **DC** energy use and emissions **may still grow** → **meet in the Middle!!**



Cumulative CO₂ emissions: historical responsibility of developed industrial countries



Oil & gas resources are huge: Resource/Supply peak not in sight

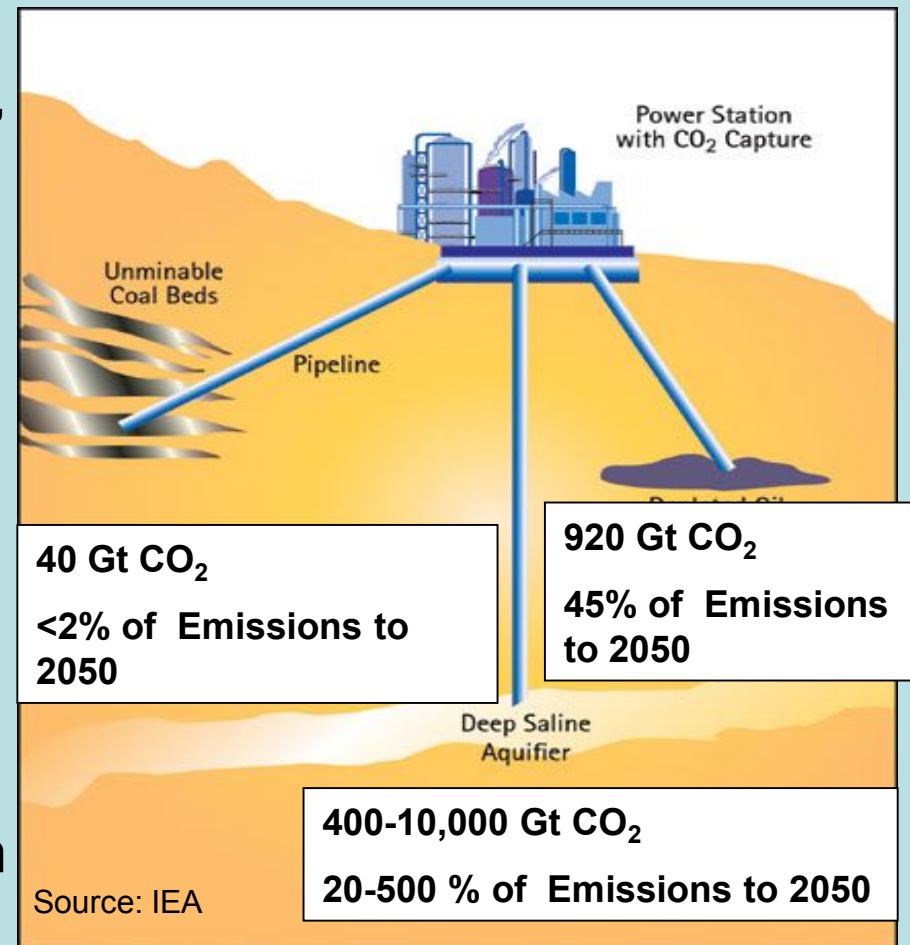


Source: Ivan Sandrea , Statoil, (IEA, IHS and USGS)

CCS potential, technology, challenges & requirements for large scale deployments

- **Technologies** involved in CCS have been tested, **proven** & **used** independently (e.g. EOR & EGR);
- **Barriers** to large scale deployment **remain** but **manageable**: technical, economic, legal, public acceptance
- **The Challenge**: **integration** that is safe, at a reasonable cost and on a large enough scale to make a meaningful dent in global CO₂ emissions → **Government support**
- **International cooperation** and government-industry collaboration are **prerequisites** to the acceleration of CCS deployment on commercial scale

potential for geologic storage is huge

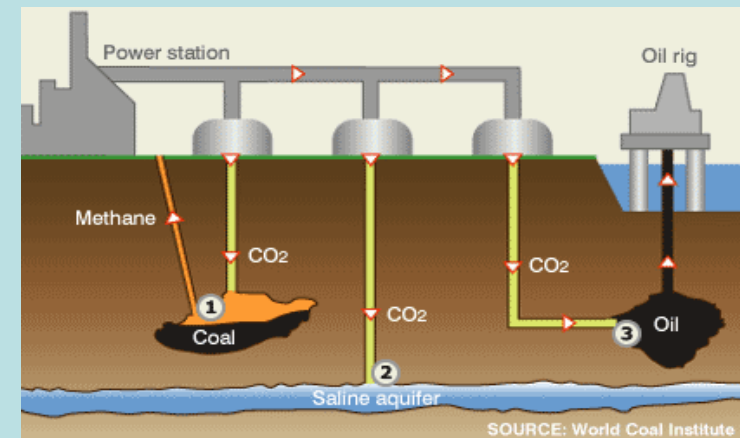


CCS & EOR: Early path to fast-track realization of CCS large potential

- “**Enhanced oil and gas recovery** offer cost-effective opportunities for CCS demonstration, **and should be pursued as an early opportunity**”. (IEA)
- Potential for **reduction** of CO₂ from CCS/EOR has been estimated to be very large, (**45%** of emissions through 2050!)
- **CCS/EOR** Technology is **available commercially** today in **certain cases**, but **further RDD** is necessary to reduce costs, localize the technology & increase confidence in the long-term viability of geologic storage

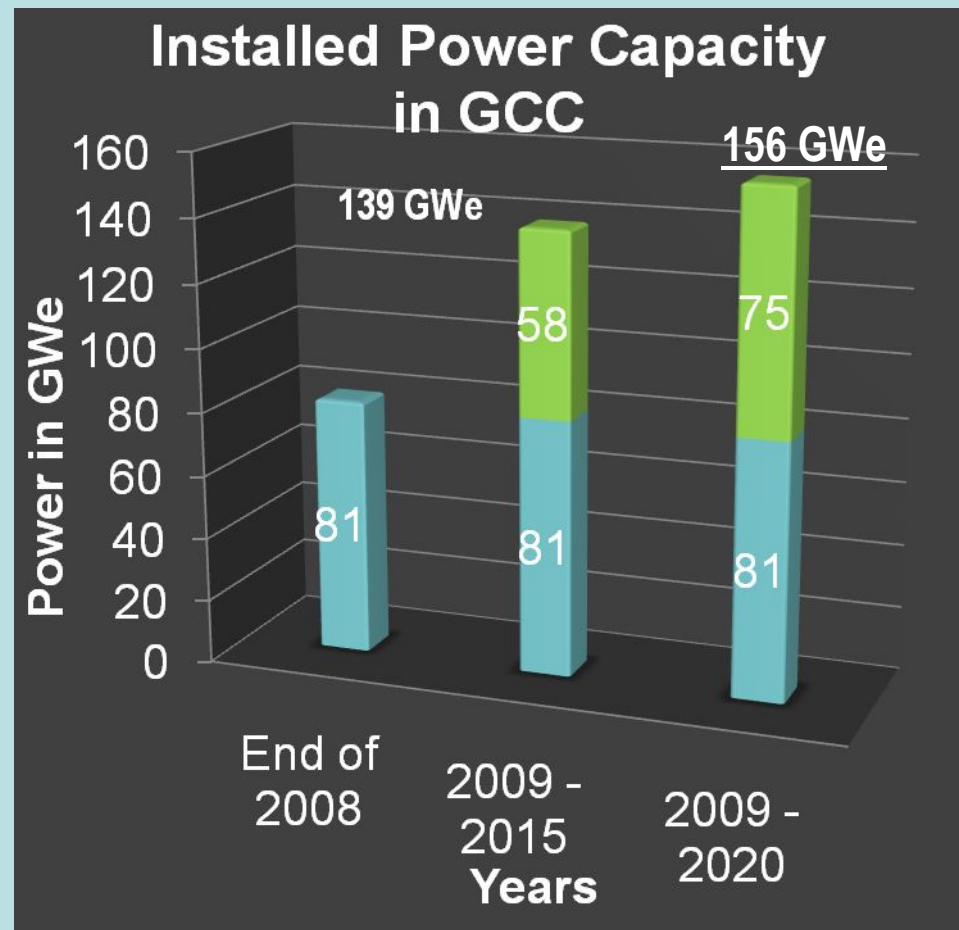
CCS & EOR: Early path to fast-track realization of CCS large potential - II

- CCS/EOR provides an “**early action pathway**” for **overcoming** the initial **barriers**:
 - Regulatory
 - Public Acceptance
 - Long-term Liability
 - Ownership (Pore space)
to Geological Storage of CO₂
- It can also **provide** offsetting **revenues** if a price for CO₂ is established.
 - **Win-Win** solution **globally** when large scale commercial plants are deployed worldwide.
 - CO₂ storage in depleting oil reservoirs **can increase recovery** through an EOR process, potential of adding ~ **500 – 1000** billion barrels and possibly much more (recent estimates for **US** → **100- 400** billion barrels to proven oil & gas reserves



Advantage of CCS/EOR in case of GCC

- **Source of large CO₂ streams close to storage:**
 - separated CO₂ streams from **sour** gas streams before exports
 - from near by **power plants**
- **High level of power consumptions and high growth rate: more than**
 - > **150 GWe is to be added** over the next 20-25 years; → no need for retrofitting
- **Large steady CO₂ streams** can be brought in by ships from **Western shores of Indian** subcontinent.
- **Capacity** of GCC oil and gas reservoirs, is **~ 40% world's** (O&G reservoirs) total sequestration capacity



Carbon storage through Peridotite?

- A rock found in Oman, UAE and Southern Saudi Arabia:
- contact between carbon dioxide and peridotite causes a chemical reaction which, over time, converts them into minerals such as calcite
- Resources on the Arabian Peninsula could suffice for capturing 10% of total human CO₂ emissions/year
- Would involve large-scale project work → 400 x windmill power of equal X section



But Developing O&G producers are not Annex I countries

- **GCC & most producing countries not part of ANNEX 1.**
 - are doing it on **voluntary** basis.
- Given the **size** of their **resources** &:
 - relatively **low production cost**, **high cost of CCS technology development**, to be mastered through expensive pilot and demonstration projects,
 - there is **no urgency** for producer to do it on their own;
- But: through **partnership & support** (technically & financially) from Major OECD and emerging economies):
 - **Producers** modest **RDD** efforts may be **significantly enhanced** & large scale **deployment accelerated** for the benefit of Annex I (realizing the potential of the easiest CCS deployment opportunities in oil & gas fields (depleting & for EOR), through **CDM** or the **newly promised** “Copenhagen Green Climate Fund” or **alternatives** (Bilateral, etc.. – after all CA was **outside UNFCCC!!**

Additional/alternative funding mechanisms

- several suggestions have been mentioned of how to do so beyond/ in addition to CDM & CGCF,:
 - Taxing emissions so that it is cheaper to store the CO² than emit (this worked in the Sleipner project); **taxing at the source?**
 - Develop cap-and-trade emissions programs that recognize stored CO² as non-emitted (EU Emission Trading System,
 - Offer direct government subsidies or funds to cover the CCS installation costs.
 - **bilateral, and multilateral funding** of specific projects or programs (The Four Kings Initiative, etc...)
 - **Governments/ Industry:** **Govt.** can provide initial RDD support, long-term policy and regulatory framework that enables commercial scale deployment **while industry** can provide know-how, technology innovation and the capital needed to develop large scale projects.

Voluntary actions taken by many O&G producers

- **Algeria** realized first full-scale demonstration **CCS** project in the **In Salah gas field** (Norway's Sleipner)
- **Saudi Arabia** is an active member of the “**Four Kingdom's Initiative**” (together with the UK, Norway and the Netherlands),
- **OPEC** has joined the IEA' **IEAGHG** Programme.
- **CCS** is also an important part of the **EU-OPEC** dialogue & **GCC-EU** dialogue



Highlights of GCC proactive interest in development of CCS(EOR)

- **Pledged** US\$ 750 million to clean energy technology development (OPEC Summit 3)
- **Flurry** of national, regional & international workshops, meetings & conferences
- **UAE**
 - MASDAR integrated power/CCS/EOR (2\$ billion)
 - ADFEC awarded contract to inject power plant CO² into oil fields (EOR)
- **Qatar**
 - 10 year joint RD program QP/Imperial College, Shell (70 million US\$) &..
- **KSA**
 - **KAPSARC** & ARAMCO; Master Planning: & RDD
 - first CCS/EOR **pilot** start 2013 (Ghawar)
- **Kuwait:** (KPC/KOC/KISR)
 - RD & developing master plan
 - selecting of 1st Pilot target for 1st pilot, ready after 3 y
- **Oman:**
 - Exploring CCS project as well direct extraction & sequestration

CCS access to CDM: why the failure so far?

- One source to accelerate deployment in developing countries is CDM, under the Kyoto Protocol, if CCS projects had access to it.
- This question has been debated in climate change negotiations since 2006, most recently in the UNFCCC 15 COP in December 2009 in Copenhagen.
- With G20, IEA, OPEC & other major economies behind, it was expected to be approved, but the decision was deferred to the next UNFCCC - to be held in Mexico in December 2010 - lack of consensus.
- A **small number** of parties (& NGOs) remain **opposed** to the inclusion of CCS in the CDM and have **cited** concerns around storage safety, as well as legal and accounting issues.
- Some argue that it **would divert investments away from energy efficiency and renewable** energy. A coordinated approach by proponent governments (including non Annex 1 countries) would be required to address CCS inclusion.

CCS within the UNFCCC

- While the potential for CCS has been known by scientists/engineers for a long time, it took a long time before it has been recognized by policy and decision makers as a serious mainstream technology option to reduce. (OPEC 2004 CCS workshop)
- It took some negotiation at UNFCCC/COP meetings to recognize and explore its potential. WEC is one of the early organizations to take note, explore, encourage, etc..
- There continues to be a bias against fossil fuels in general & oil in particular from many parties to COPs, NGOs
- It is high time now to get serious, if the climate change concerns are serious, support in a balanced & rational way all viable clean energy options.

Summary & Conclusions

- **All** promising clean energy options need to be pursued, **CCS amongst them**. This is **an imperative**
- Not clear what the future energy mix will look like **precisely** in 20 or 50 years, but for sure fossil fuels will continue to be a major part, **at least for DCs**
- **CCS/EOR** , by all accounts, is part of **way forward** in the early part of the path towards CCS promise
 - already **commercial under certain conditions** → need **RDD**
- International collaboration needed for **CCS, CCS/EOR (pilot & demo)**, as per UNFCCC principles,
- **CDM, CGCF & other international/multilateral, funding arrangements must be made available to CCS (& CCS/EOR)**

*Air Extraction can
compensate for CO₂
emissions anywhere*

400 times the power of a zero-emission
wind mill of equal X section



THANK YOU

Art Courtesy Stonehaven CCS, Montreal

Source: GROCC
Columbia Univers