CARBON CAPTURE AND STORAGE

International Energy Agency

Potential for EOR to kick-start early projects CCS projects

Committee on Energy Research and Technology
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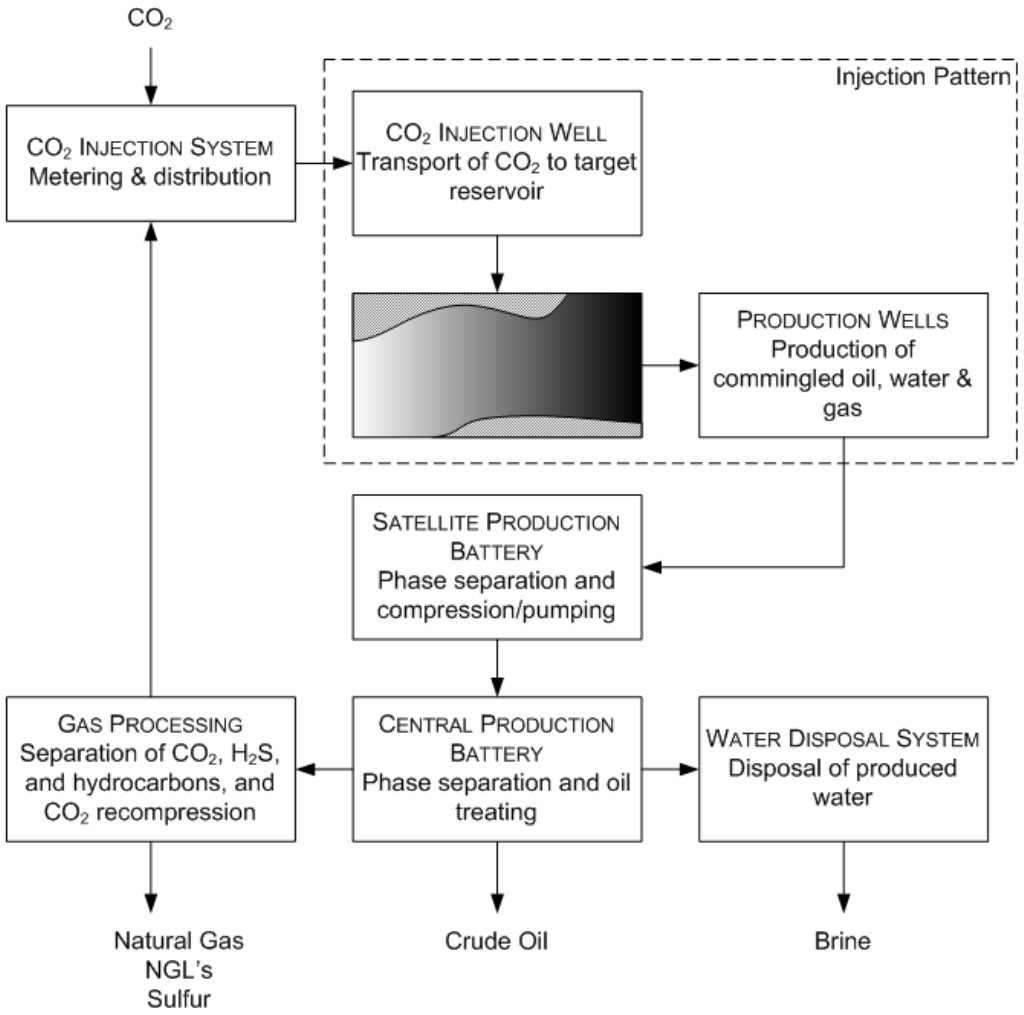
Three key messages

1. CO_2-flood enhanced oil recovery (CO_2-EOR) is a technically proven and well understood process that is applied commercially today
2. CO_2-EOR results in storage of CO_2, however the emissions reduction benefit is dependent on design of the project and the policy environment
3. There are barriers to designing and operating a CO_2-EOR project as part of a CCS project that need to be resolved for CO_2-EOR to play a role in reducing emissions

CO_2-EOR: Using CO_2 to improve oil recovery



Source: McCoy, 2008

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How does CO_2 improve oil recovery?

- Two types of CO_2-EOR processes exist:
  - *Immiscible*: injected CO_2 displaces oil from the reservoir and drives it towards production wells
  - *Miscible*: injected CO_2 forms a single-phase mixture with the oil, effectively reducing the density and viscosity of the oil, improving ability of the oil to flow
- *Miscible* CO_2-EOR tends to recover more oil than *immiscible*, but uses less CO_2 per barrel
  - The type of CO_2-EOR process depends on reservoir pressure and oil composition (MMP)
- Majority of projects are *miscible* CO_2-EOR projects

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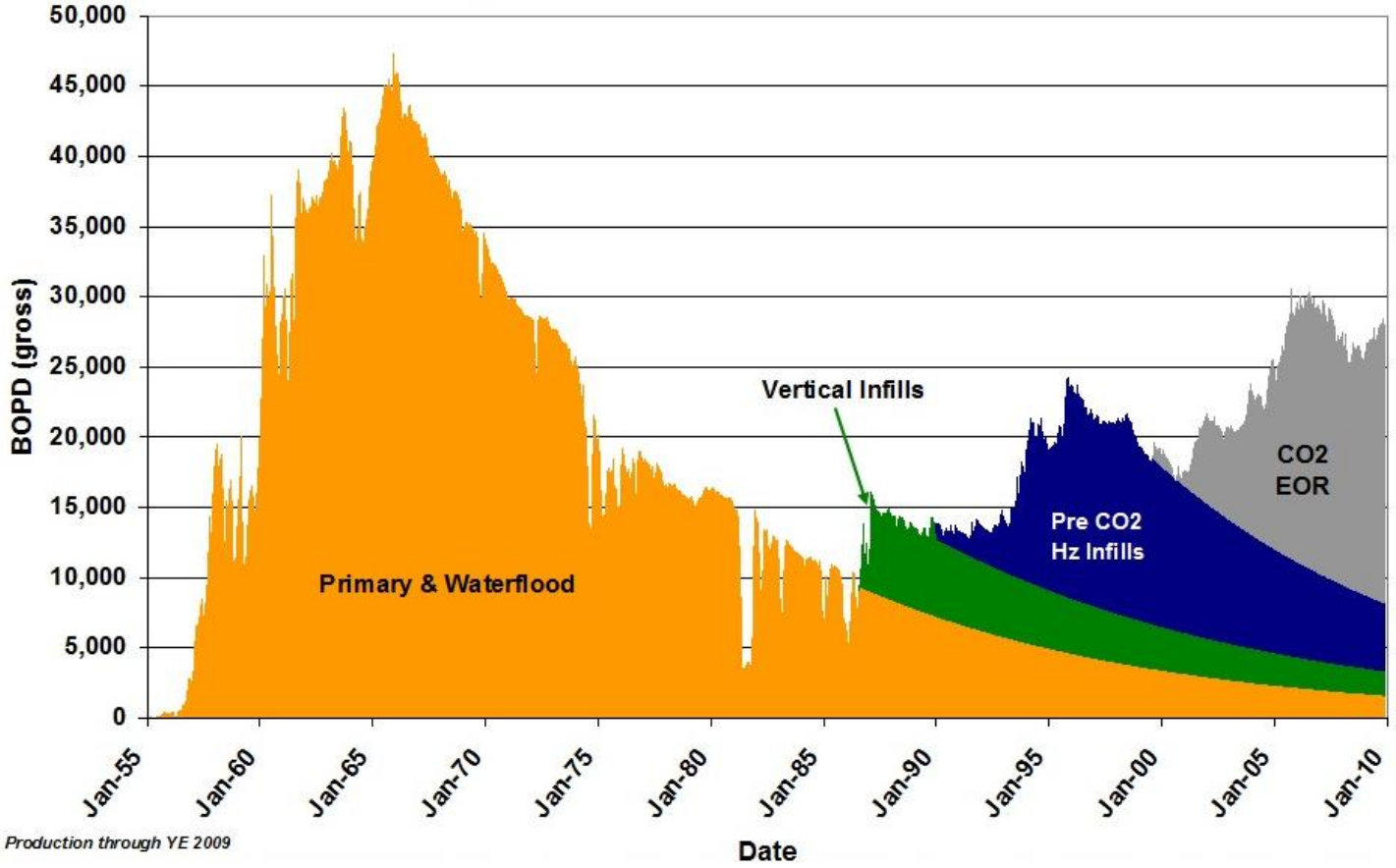
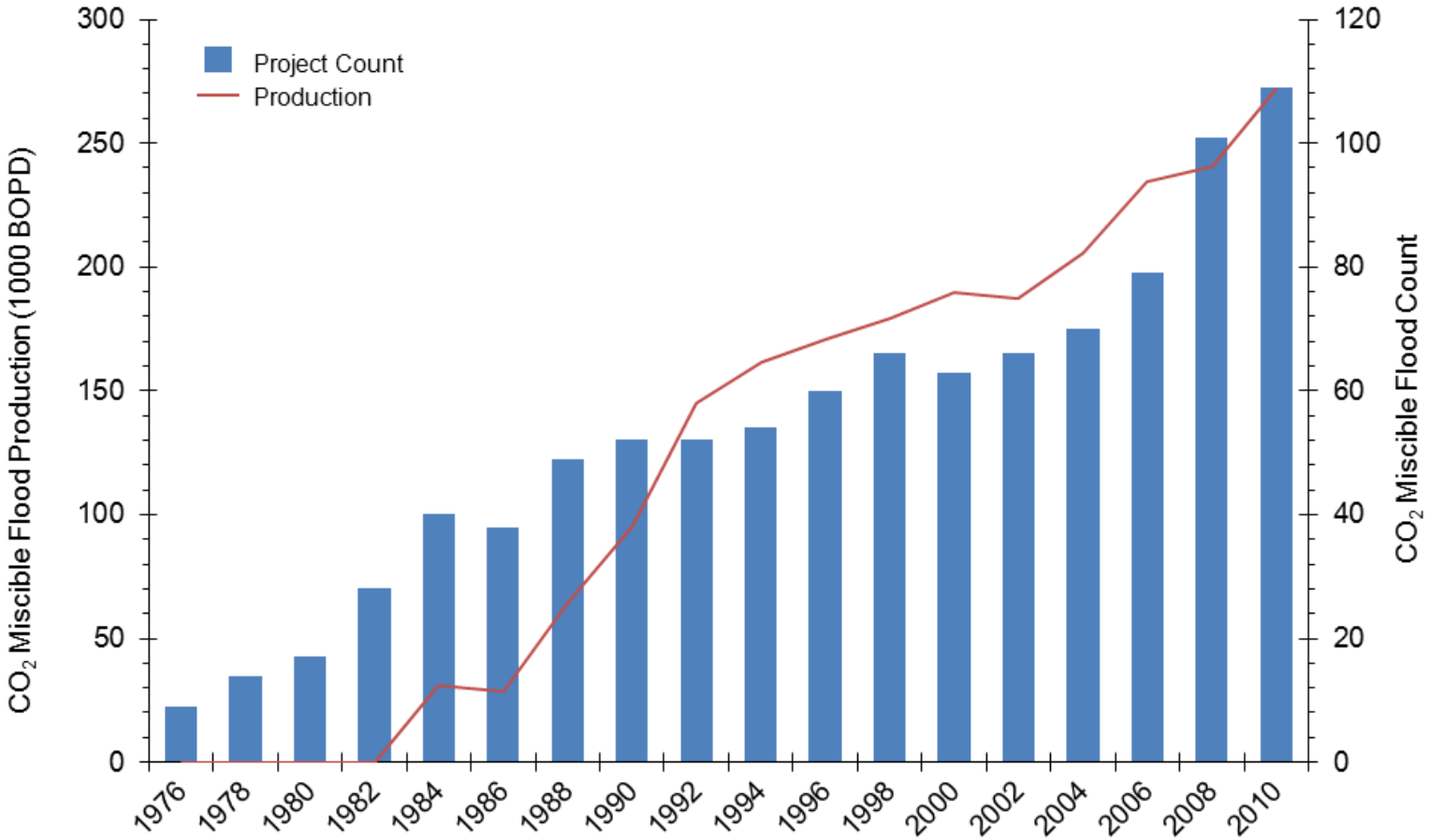
Increased oil production from the Weyburn Unit under miscible CO_2-EOR



Around 30,000 bbl/day total production, over 20,000 bbl/d due to CO_2-EOR

Figure: Cenovus Energy/Malcolm Wilson, PTRC

An upwards trend for US miscible projects and production from CO_2-EOR



Data: Oil & Gas Journal, 2010

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The boundaries used to assess emissions from CO_2-EOR matter

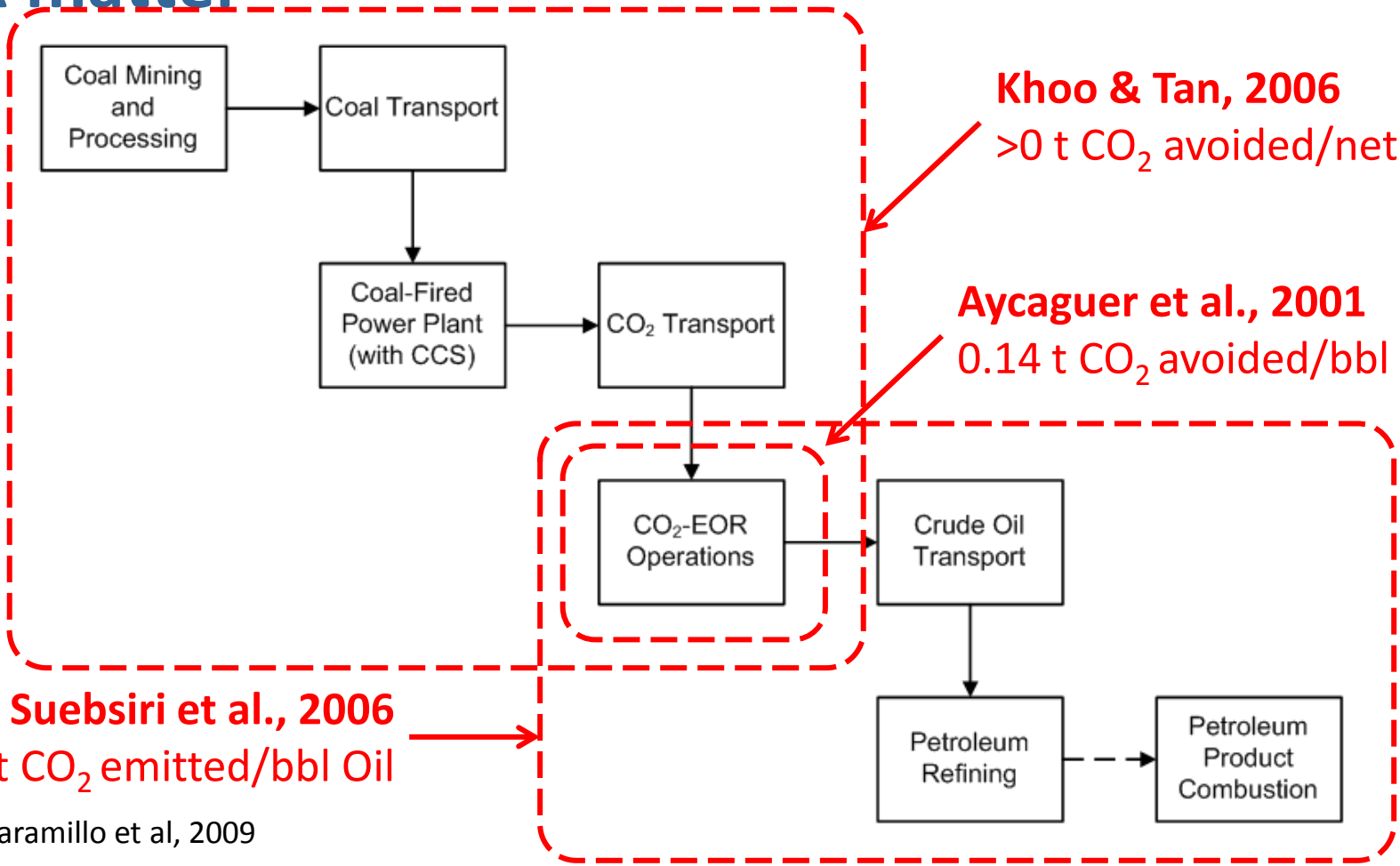
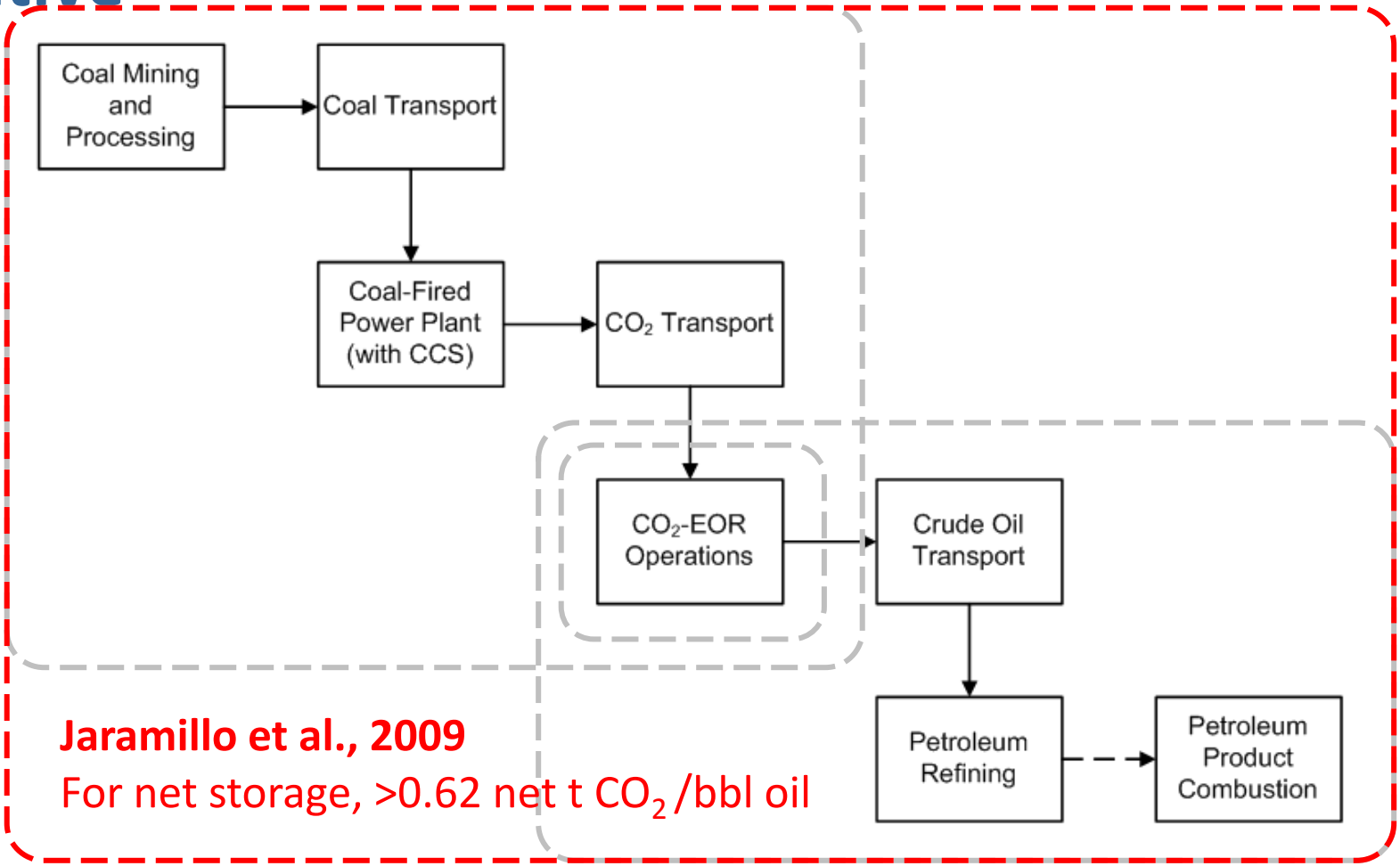


Figure: Jaramillo et al, 2009

Cradle-to-grave emissions from CO_2-EOR are positive



Emissions can be reduced through displacement

Marginal Barrel Displaced (kg CO_2e/bbl)	Marginal Generation Displaced (kg CO_2e/MWh)	Emissions Reduction Efficiency			
		Project 1	Project 2	Project 3	Project 4
Current Average Consumption-USA (529)	Current Average Generation-USA (652)	71%	68%	70%	73%
Canadian In-Situ SCO (600)	Uncontrolled IGCC (894)	140%	128%	137%	145%
	NGCC (425)	87%	75%	83%	92%
Saudi Arabian Light (521)	Uncontrolled IGCC (894)	94%	92%	93%	95%
	NGCC (425)	41%	38%	40%	42%
	Carbon-free Electricity (0)	-8%	-10%	-8%	-7%

McCoy et al, 2010

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Important observations from past life-cycle assessment research

1. Emissions **depend on boundaries**:
   a) Including emissions from oil production makes business-as-usual (BAU) CO_2-EOR a net emitter
   b) Changes to design and operation of BAU CO_2-EOR could decrease the CO_2 footprint
2. **If** energy-related emissions that **would otherwise be produced** from an equivalent system are displaced, CO_2-EOR reduces emissions
3. Emissions reduction efficiency is **a function of energy displacement and CO_2 utilization**
   a) Displacement of CO_2-intensive power and oil results in a larger emissions reduction than would otherwise occur

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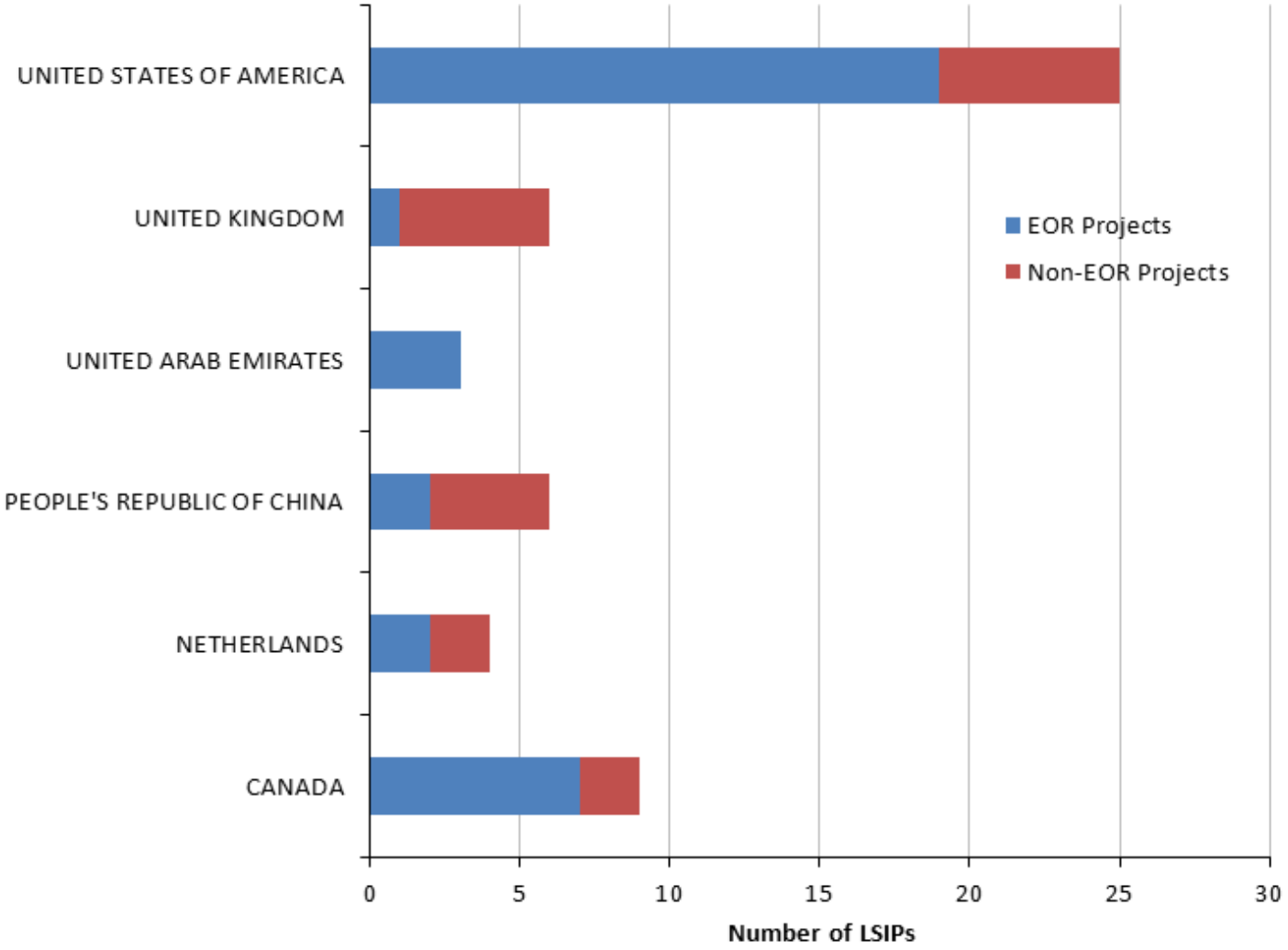
Attributes of CO_2-EOR operations necessary for qualification as storage

Technology	Energy Policy	Climate Policy
• Increase net CO_2 utilization through changes to design and operation (?) • Monitoring, measurement, and verification of similar stringency to that applied to saline aquifers • Abandonment to ensure long-term retention of stored CO_2	• Law and regulation to enable CO_2-EOR as a oil recovery process • Regulation to ensure that CO_2-EOR is undertaken safely for humans and the environment	• Measurable emissions reduction goals and accompanying policy • Laws and regulation enabling CO_2-EOR as climate change mitigation option • Accounting rules that accurately award credit for emissions avoided

Numerous planned CCS projects rely on CO_2-EOR



Data: GCCSI Project Database, 7 Nov. 2011

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Barriers to private investment in CO_2-EOR

BAU CO2-EOR	CO_2-EOR for Climate Change Mitigation
• Low valued investment option in IOC portfolios • Lack of low cost CO_2 for injection in many places • Competition with other EOR processes • Mismatch in business cases for capture versus injection	• Those for BAU CO_2-EOR, PLUS: • No return on additional cost for storage • Cost for monitoring, measurement, and verification • Cost for ensuring long-term containment

Can incentive policies address these issues?

If so, how?

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Objectives CO_2-EOR analysis at the IEA

1. A clear understanding of the global potential for CO_2-EOR to contribute to emissions reductions
2. Identification of unique considerations that need to be addressed to achieve emissions reductions
3. Identification and understanding of gaps and barriers that prevent development of projects
4. Sound recommendations for member countries to enable CO_2-EOR as climate policy option

IEA working paper on CO_2-EOR as storage

1. **A brief history of enhanced oil recovery**
2. **Objectives**
3. **Business as usual enhanced oil recovery**
   a. Process details and applicability
   b. Conventional economics
   c. Global potential for oil production
   d. The emissions balance
   e. Legal and institutional framework
4. **Enhanced oil recovery for storage**
   a. Engineering the EOR process for storage
   b. Accounting for emissions reductions from EOR
   c. Global potential for oil production and storage
   d. Legal, regulatory requirements
5. **Necessary attributes of EOR for storage**
6. **Barriers to enhanced oil recovery as storage**

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IEA-OPEC dialogue on CO_2-EOR as storage

- The Kuwait Petroleum Company hosted a joint IEA-OPEC workshop on February 7-8 in Kuwait City
- Four objectives:
  1. Review CO_2-EOR technology, its potential benefits and the technical considerations, challenges and risks for turning CO_2-EOR into CO_2 storage
  2. Share lessons learned from some of the existing CO_2-EOR projects and from past experiences
  3. Gain deeper insight into the commercial and economic aspects for CO_2-EOR as CO_2 storage
  4. Identify areas of mutual interest for a possible follow-up workshop

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Questions?

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