CCS: Driving Deployment and Reducing Costs

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June 16, 2011

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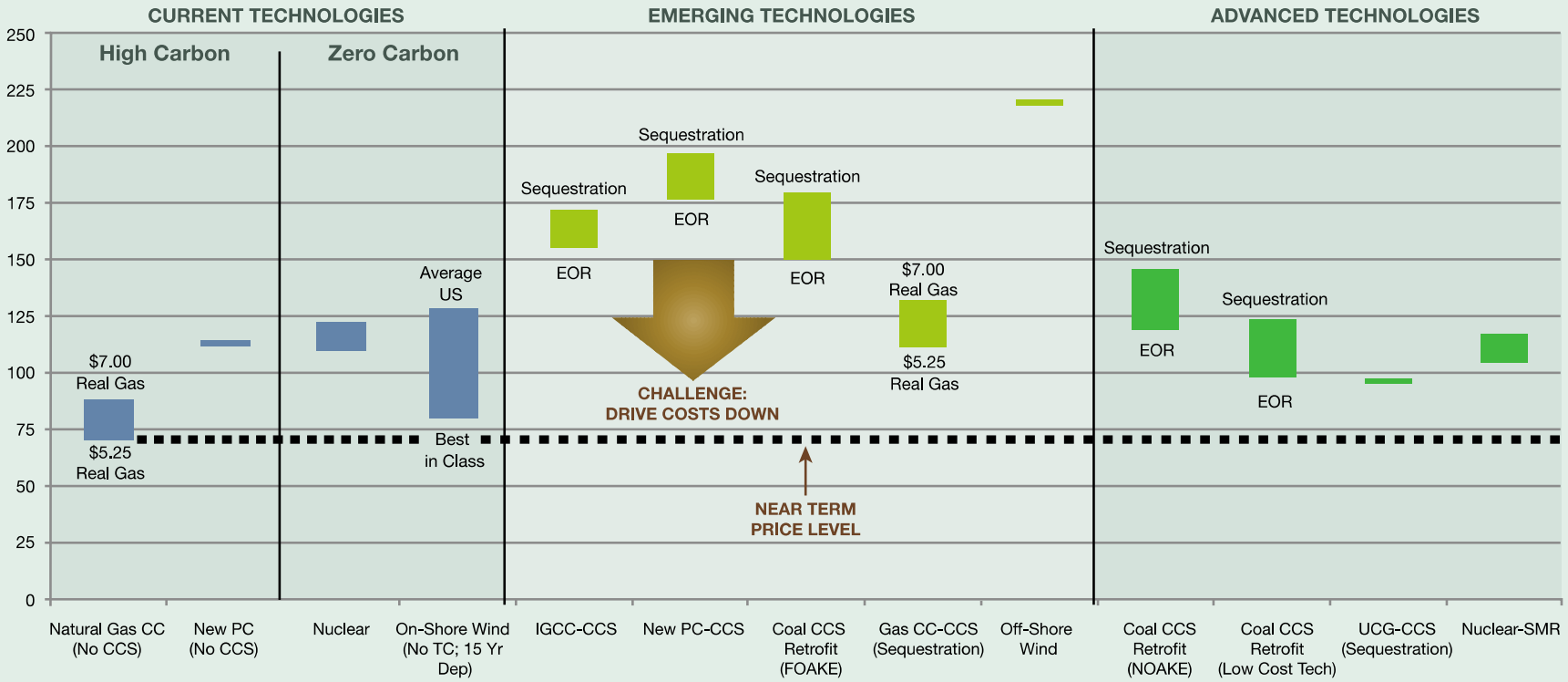
Overview

- Cost Reduction Objectives
- Enhanced Oil Recovery
- US China Collaboration

CCS Costs Too Much, Today

Technology Cost Comparison

Real Levelized $/mWh, 2018 ISD, Merchant Financing



Notes:

1. These are US costs. Absolute costs will be much lower in China, as will be the “spread” among the different technologies.
2. For intermittent technologies such as wind, no penalty is added for lower value of non-dispatchable power, or additional capacity that needs to be built to provide back up power to offset unit intermittency.

Real levelized cost metric escalates from 2018 at 2.5% annually.

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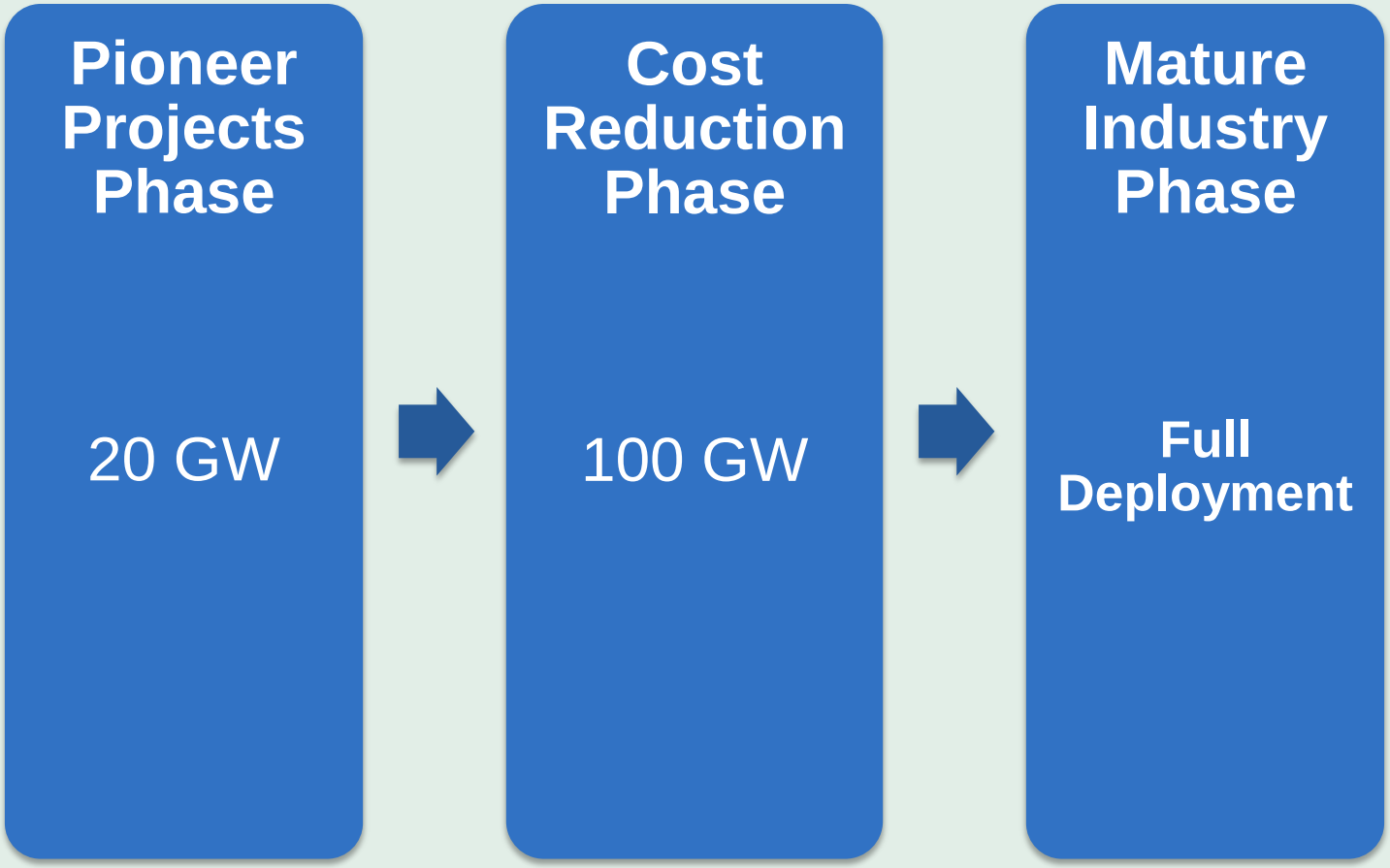
Phases of CCS Deployment



Global Objectives

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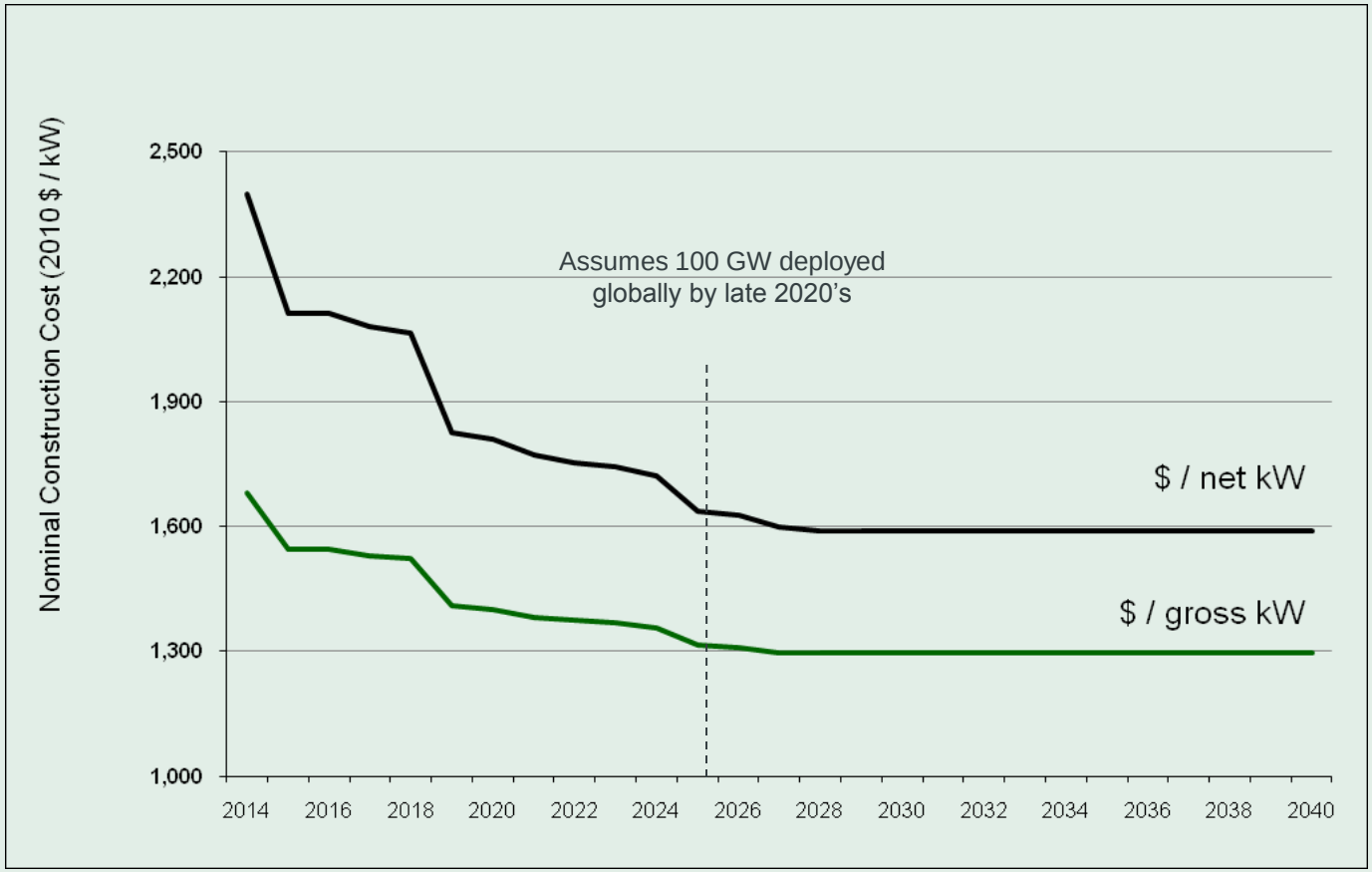
Deployment Will Drive Future Cost Savings

PCC Construction Costs Projected Drop: 30%*



*2014 cost estimate is for a scale "Nth" unit, not a first-of-a-kind demonstration project.

Source: NorthBrdige & Associates

Reducing CCS Costs

GOALS

Cost Reduction

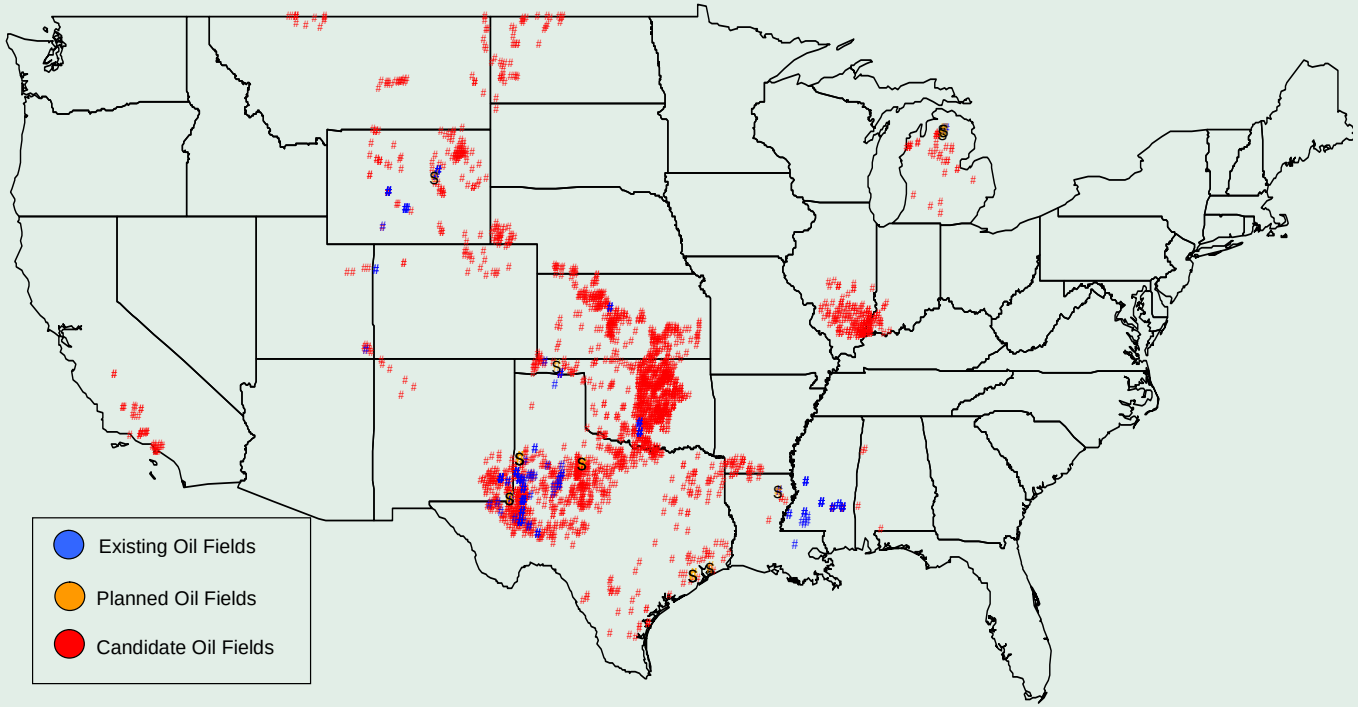
Deployment

TOOLS

Enhanced Oil Recovery

Collaborations with China

The EOR Opportunity



- 27-35 billion barrels = $3 to $4 trillion
- 9 – 11 billion tons = 50 to 61 GW of 90% CCS

Source: EIA, ARI 2010

With ROZs and Advanced flooding, demand could be as high as 19.5 billion tons of CO2

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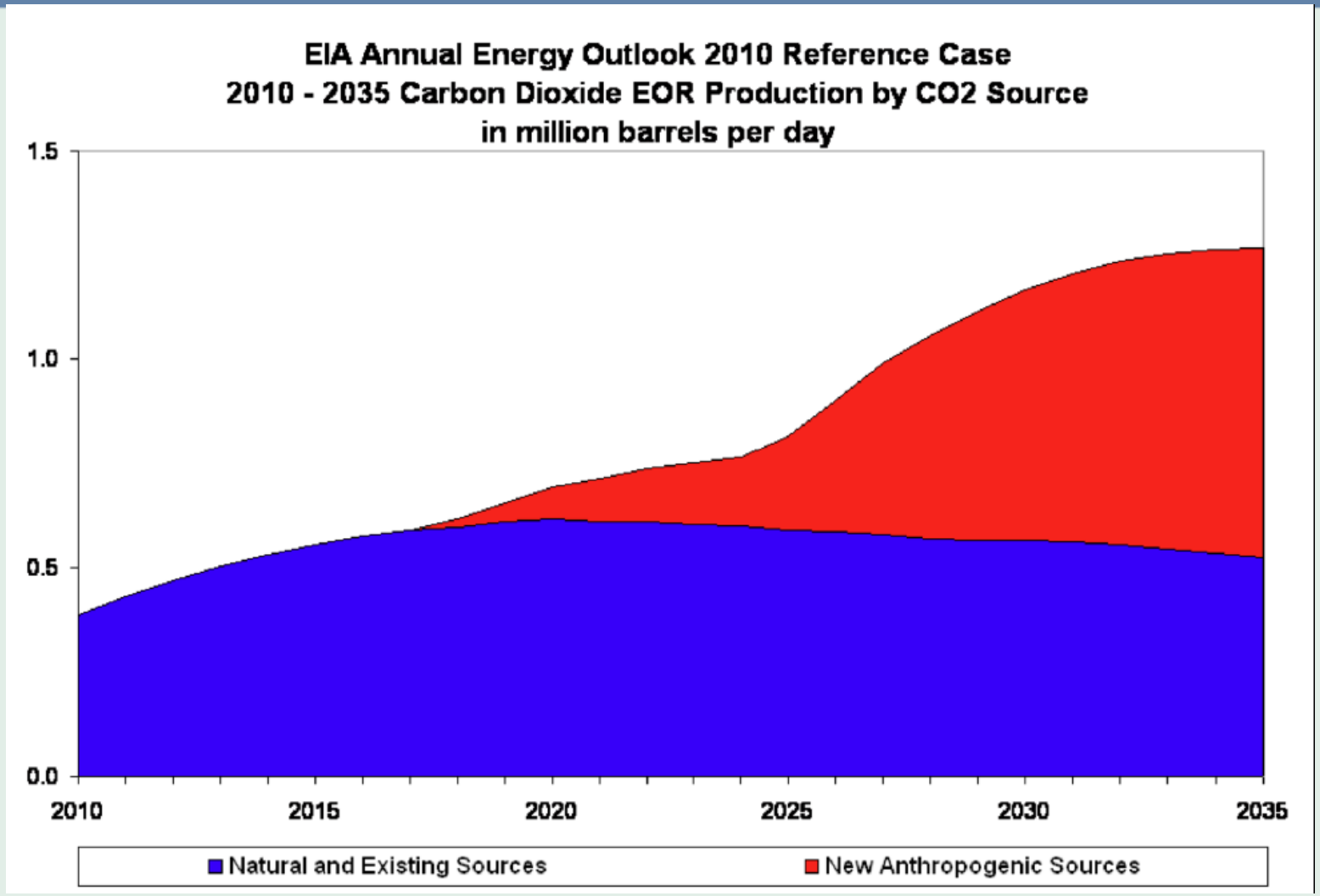
More CO2 is needed for future EOR



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The CO_2-EOR barrel

3 tons CO_2 Injection

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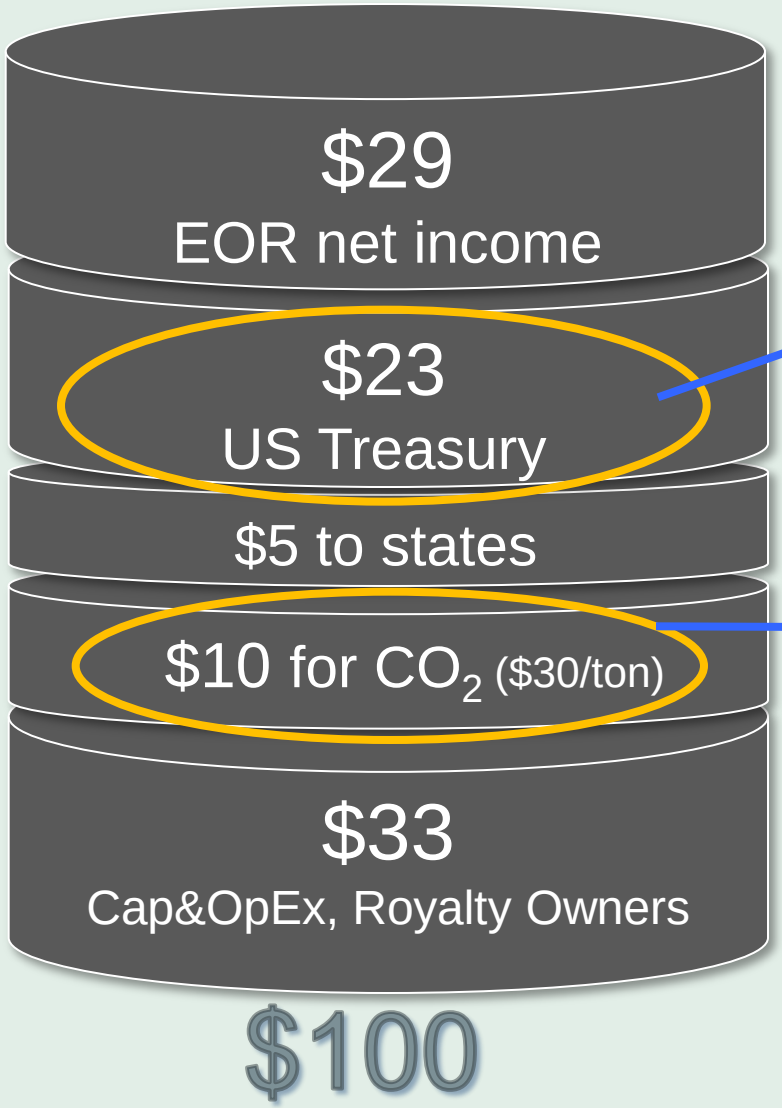
Source: EIA, ARI 2010

The CO_2-EOR barrel

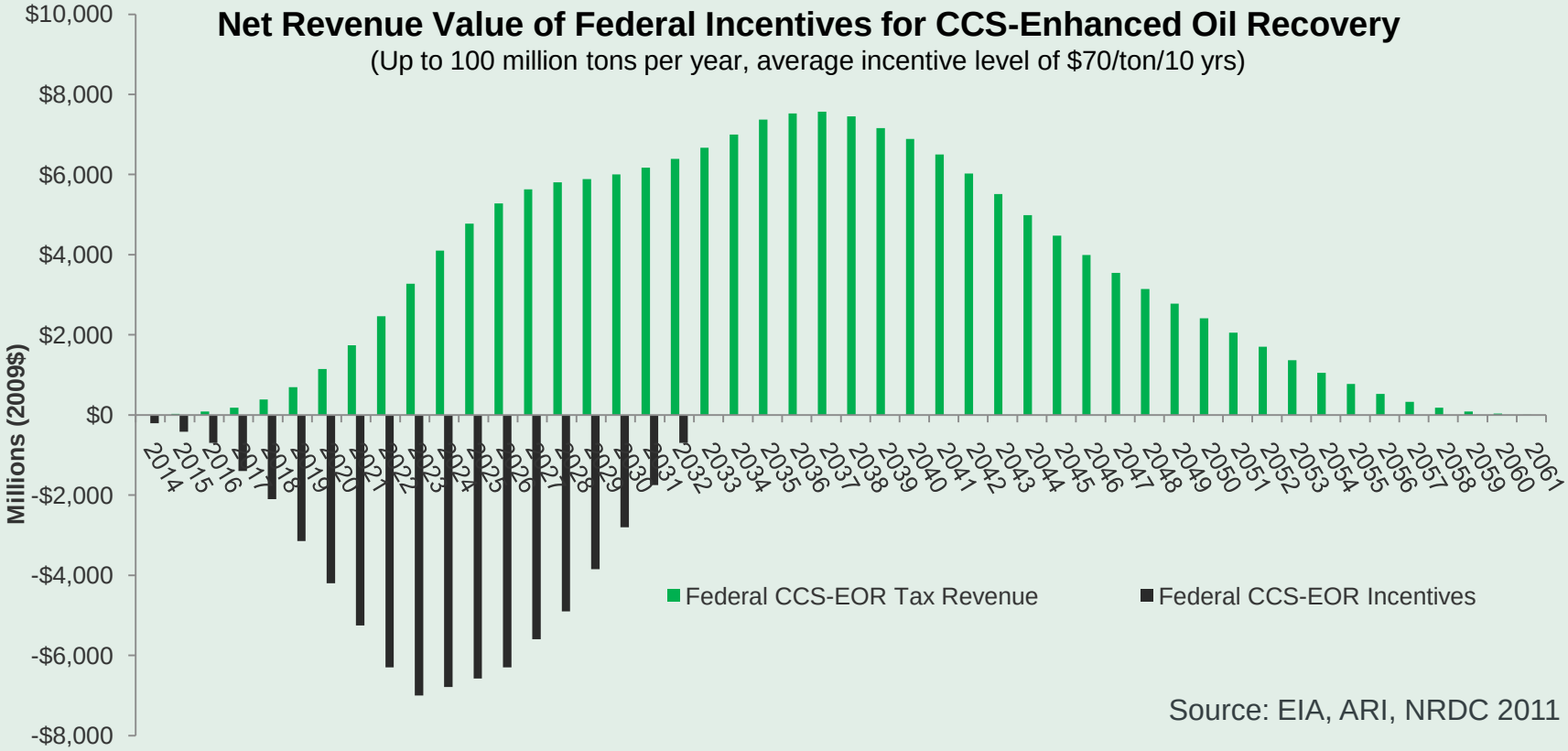


Fed Tax revenue: $69 per ton of CO2

CO2 Revenue: $30 per ton

Source: ARI ,NRDC

Potential Net Federal revenue from CCS-EOR



Source: EIA, ARI, NRDC 2011

CO_2 sequestered = 3 billion tons
Oil produced = 9 billion barrels
Total oil value = $1.05 Trillion

CCS incentives = $70 billion
EOR revenue = $180 billion
NPV (3.5% DR) = $40 billion

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The China Opportunity

China

Low Cost PCC manufacturing

Speed of Construction

+

US

EOR depth

Innovation strength

=

Potential Benefits

- Large CCS deployment in China where fossil growth is occurring
- Technical uncertainty eliminated.
- Lower CCS costs in West due to “Nth” plant
- Faster CCS deployment and innovation worldwide

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China Opportunity: CCS-EOR is economic with little subsidy

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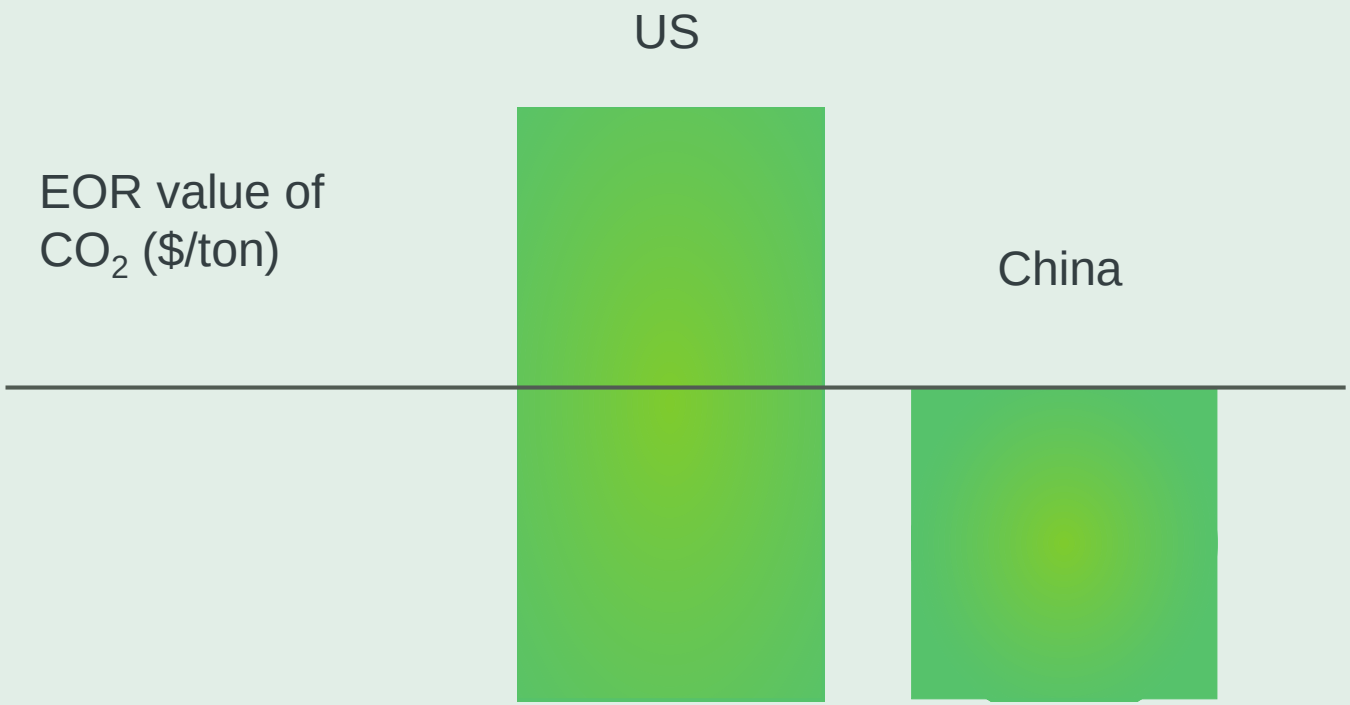

CO_2 capture and compression costs from fossil-fueled power plant in $/ton

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China's CCS Innovation

Leveraging China's market to accelerate US advances

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Capture and compression advances and innovation from China

CCS project costs to be lowered in US and China

Policy Goals

DESIGN STATE CCS POLICY AS A DRIVER FOR FEDERAL POLICY

- Expand domestic oil production by 900 million barrels through EOR
- Establish CO2 capture from power plants as a mature technology through wide application
- Establish early saline injection projects

Takeaways

- For EOR:
  - Near-term incentives (tax credits, rate recovery)
  - Can produce long term benefits (revenue, lower rates)

- US China Collaboration Benefits:
  - Accelerates US tech commercialization
  - Access to lower cost China innovation
  - China investment and learning on CO2 EOR/Sequestration