WHY PURSUE CO_2 SEQUESTRATION USING ENHANCED COALBED METHANE RECOVERY (ECBM)?

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OUTLINE

1. Status of U.S. Coalbed Methane Industry
2. CO_2 Sequestration and ECBM
3. Essential Next Steps

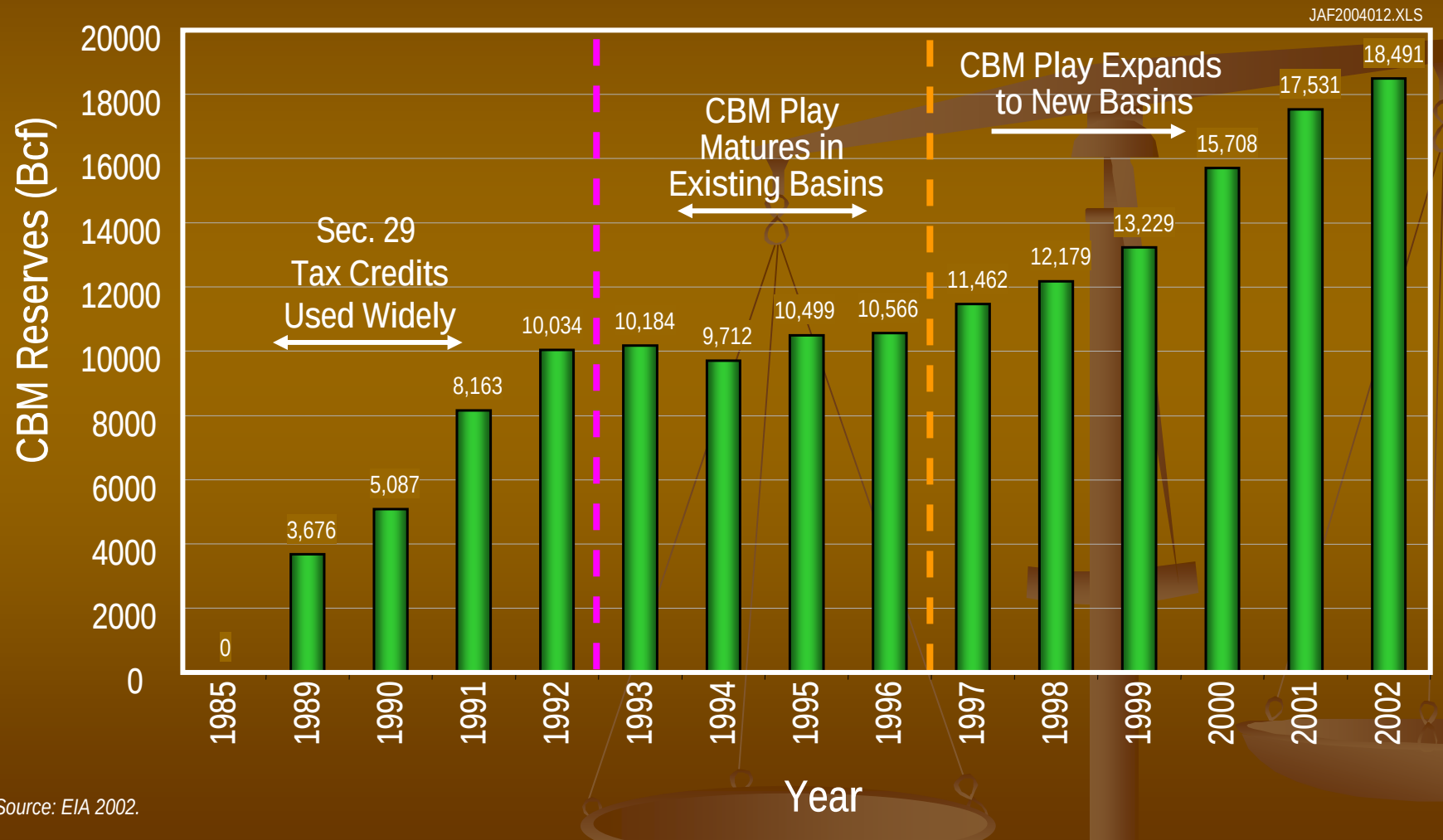
1. STATUS OF U.S. COALBED METHANE INDUSTRY

STATUS OF THE U.S. COALBED METHANE INDUSTRY

1. **Coalbed methane is becoming an increasingly important part of U.S. natural gas supply:**
   - CBM Production reached 1.6 Tcf (4.4 Bcf per day) in 2002, equal to 8% of total U.S. natural gas production.
   - Proved reserves reached 18.5 Tcf in 2002, equal to 10% of total U.S. natural gas proved reserves.

2. **In the right settings, coalbed methane can be a reliable, low cost resource:**
   - High success rates, generally greater than 90% once the nature of the basic play is understood.
   - Low finding and development costs, due to low well drilling and completion costs, in favorable coal reservoir quality areas.
   - Lower F&D costs may be countered by higher O&M costs, mainly for water handling and disposal.

PROVED RESERVES



Source: EIA 2002.

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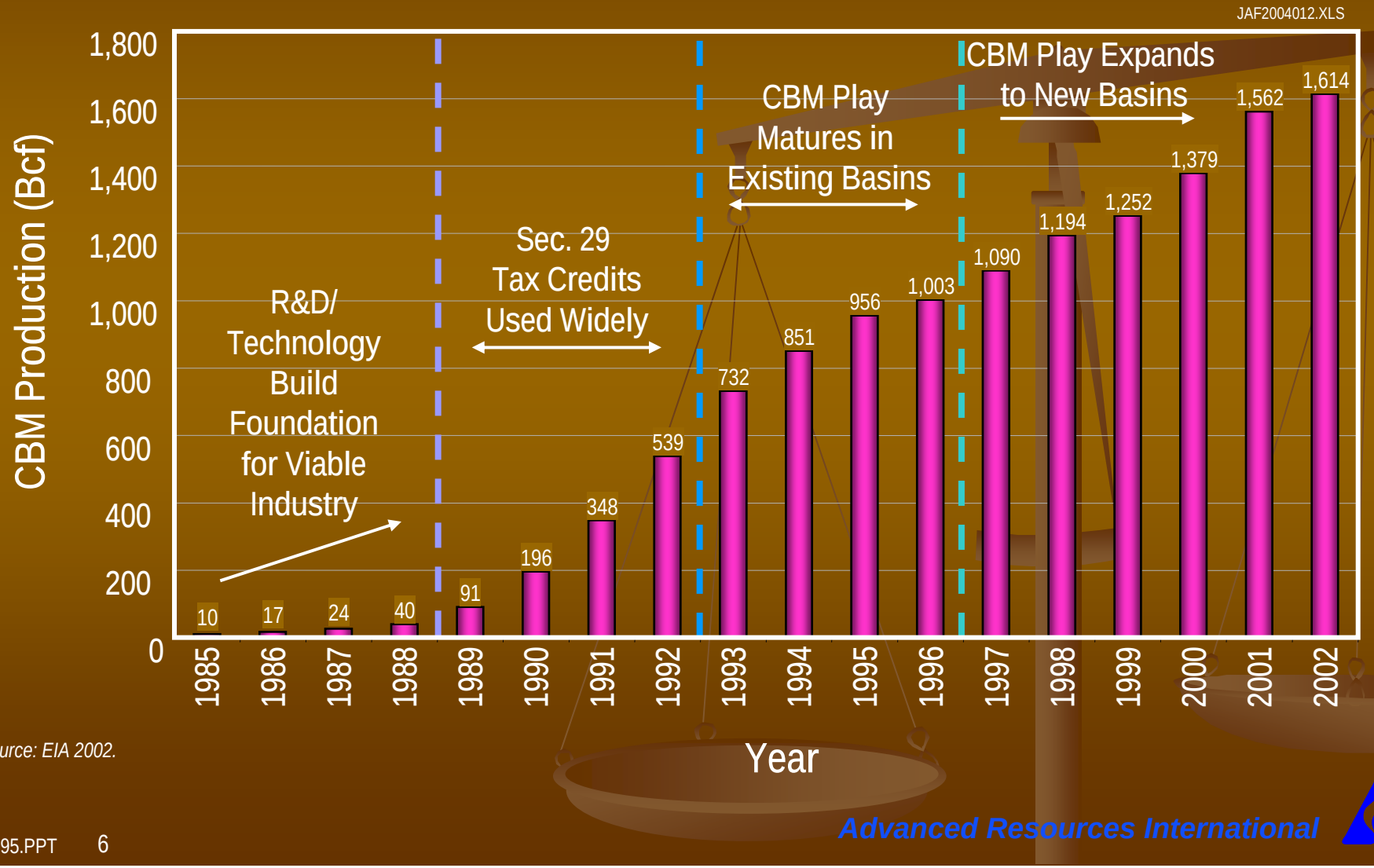
ANNUAL PRODUCTION



Source: EIA 2002.

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2. CO_2 SEQUESTRATION AND ECBM

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A series of compelling reasons exist for combining enhanced coalbed methane recovery (ECBM) and CO_2 sequestration:

1. ***Offsetting Revenues.*** Injecting CO_2 into coal seams can provide additional gas recovery and a revenue stream that may partially offset the costs of CO_2 storage.
2. ***Increased Reserves and Recovery.*** In many basins, only a portion of the gas in-place will be recovered using conventional depletion. ECBM can significantly increase this volume.
3. ***Accelerated, Higher Pressure Production.*** Injecting CO_2 will help accelerate gas recovery and enable the produced gas to be recovered at higher pressures.

2. CO_2 SEQUESTRATION AND ECBM (Cont'd)

4. ***Proximity of Storage Sites to CO_2 Emission Sources.*** Coal fields and reservoirs are widely distributed and often close to major power plant sites, reducing CO_2 transportation costs.

5. ***High Storage Capacity at Moderate Pressures.*** The favorable shape of the CO_2 adsorption isotherm enables large volumes of CO_2 to be stored at relatively low (300 to 1,000 psi) pressures, reducing CO_2 compression requirements.

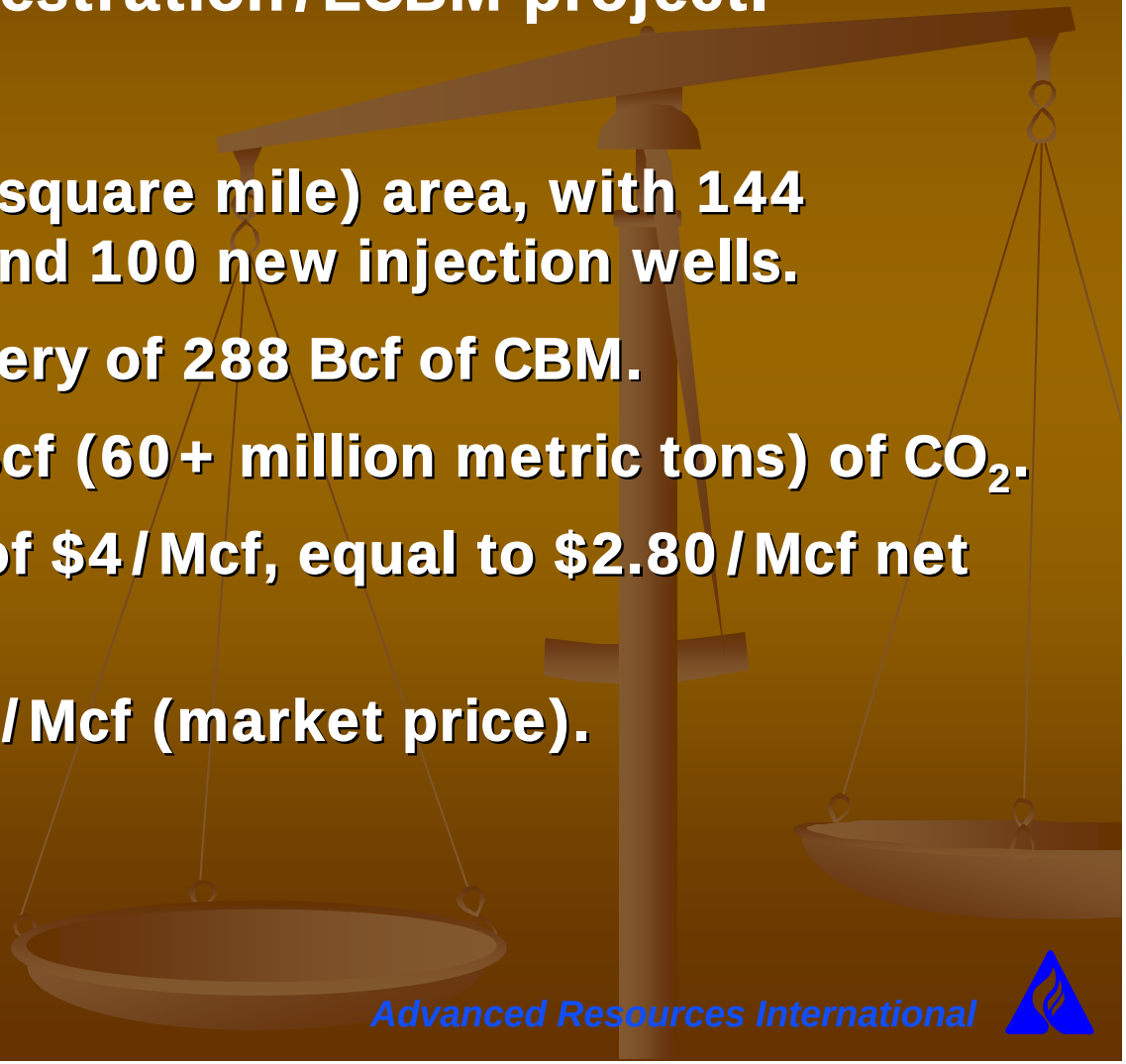
6. ***Lower Risks of CO_2 Losses or Leakage.*** Pressure rather than a structure or a seal provides the primary trapping mechanism for CO_2 stored in coals, providing an additional level of safety.

OFFSETTING REVENUES AND INCREASED RESERVES

Example CO_2 sequestration/ECBM project.

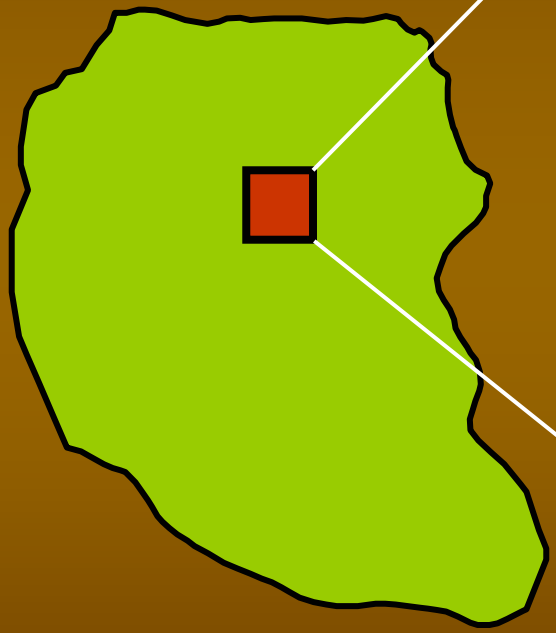
Assumptions:

1. One township (36 square mile) area, with 144 production wells and 100 new injection wells.
2. Incremental recovery of 288 Bcf of CBM.
3. Storage of 1,152 Bcf (60+ million metric tons) of CO_2.
4. Natural gas price of $4/Mcf, equal to $2.80/Mcf net (at wellhead).
5. CO_2 costs of $0.75/Mcf (market price).



ECBM/CO_2 STORAGE IN DEEP COALS

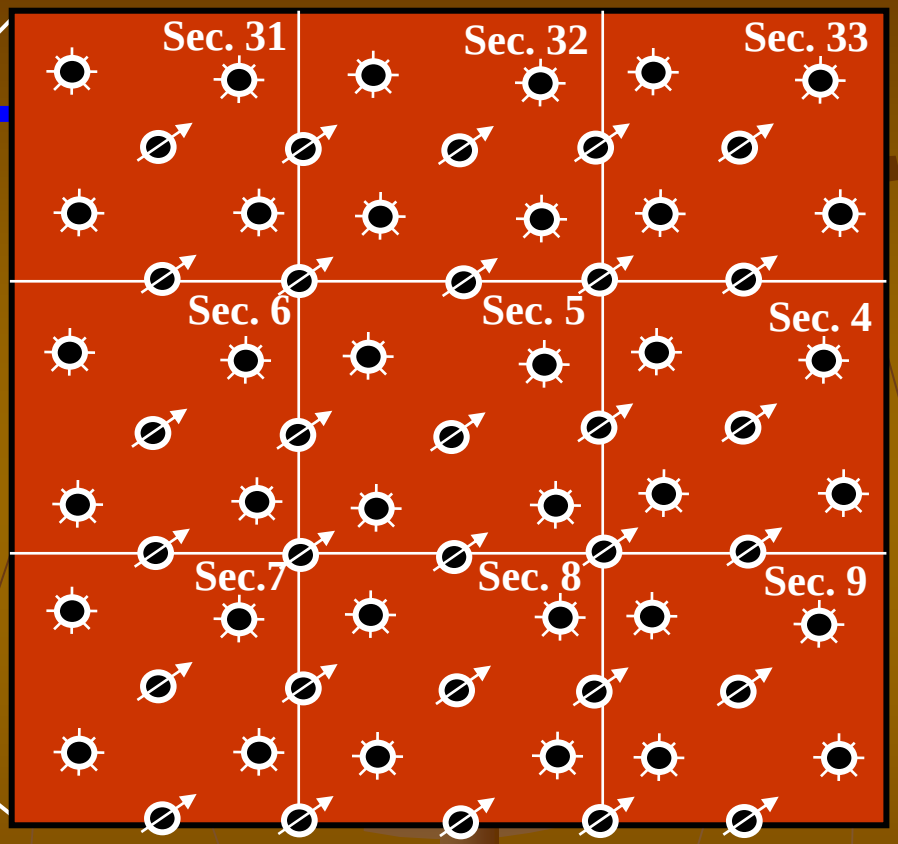
Example CBM Basin



Gas In Place – 50 Tcf
Conventional Recovery – 24 Tcf
Production Wells – 8,000
Depth – 3,000 ft

High Example Performance (CO_2/ECBM Project)

(36 Sections/50 Such Projects In Basin)



Gas In-Place – 900 Bcf
Conventional Recovery – 432 Bcf
Production Wells – 144
Injection Wells – 100 (new)
Incremental Recovery – 288 Bcf (est.)

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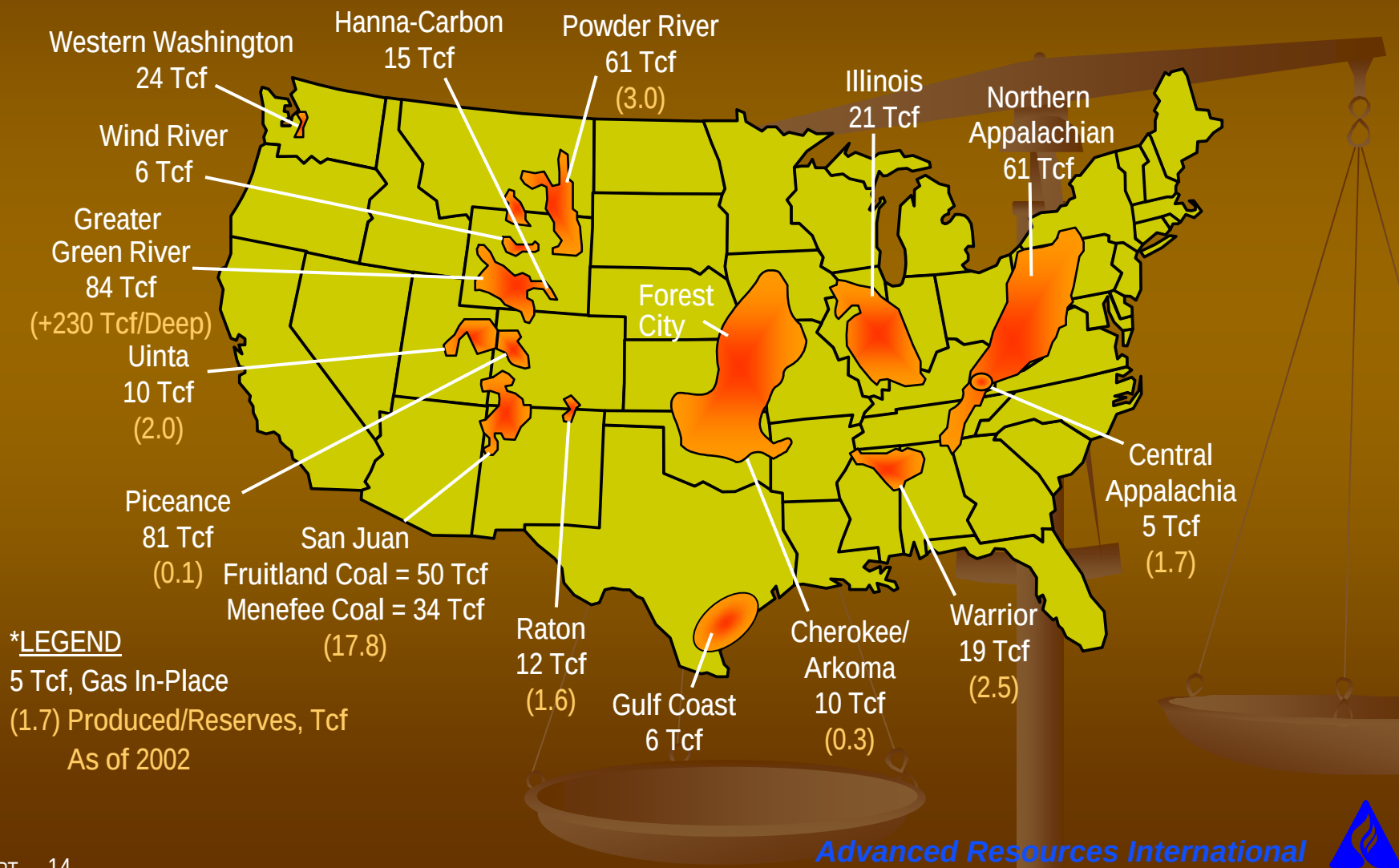
OFFSETTING REVENUES AND INCREASED RESERVES EXAMPLE CO_2 SEQUESTRATION/ECBM PROJECT

			$ (Millions)	$ /metric ton CO_2
1	Capital Costs			
	▪Injection Wells	$50.0		
	▪Other Facilities	$14.4		
	▪SMV (@ 20%)	$12.8		
	▪Capital ChaRge	$154.4		
	Total		$232	$4
2	Operating and Maintenance			
	▪Field O&M	$201.6		
	▪G&A	$40.3		
	▪SMV (@ 20%)	$48.4		
	Total		$290	$5
3	CO2 Costs (@ Market Price)		$864	$14
4	TOTAL COSTS		$1,386	$23
5	Offsetting Revenues		($806)	($13)
6	Net Cost		$580	$10

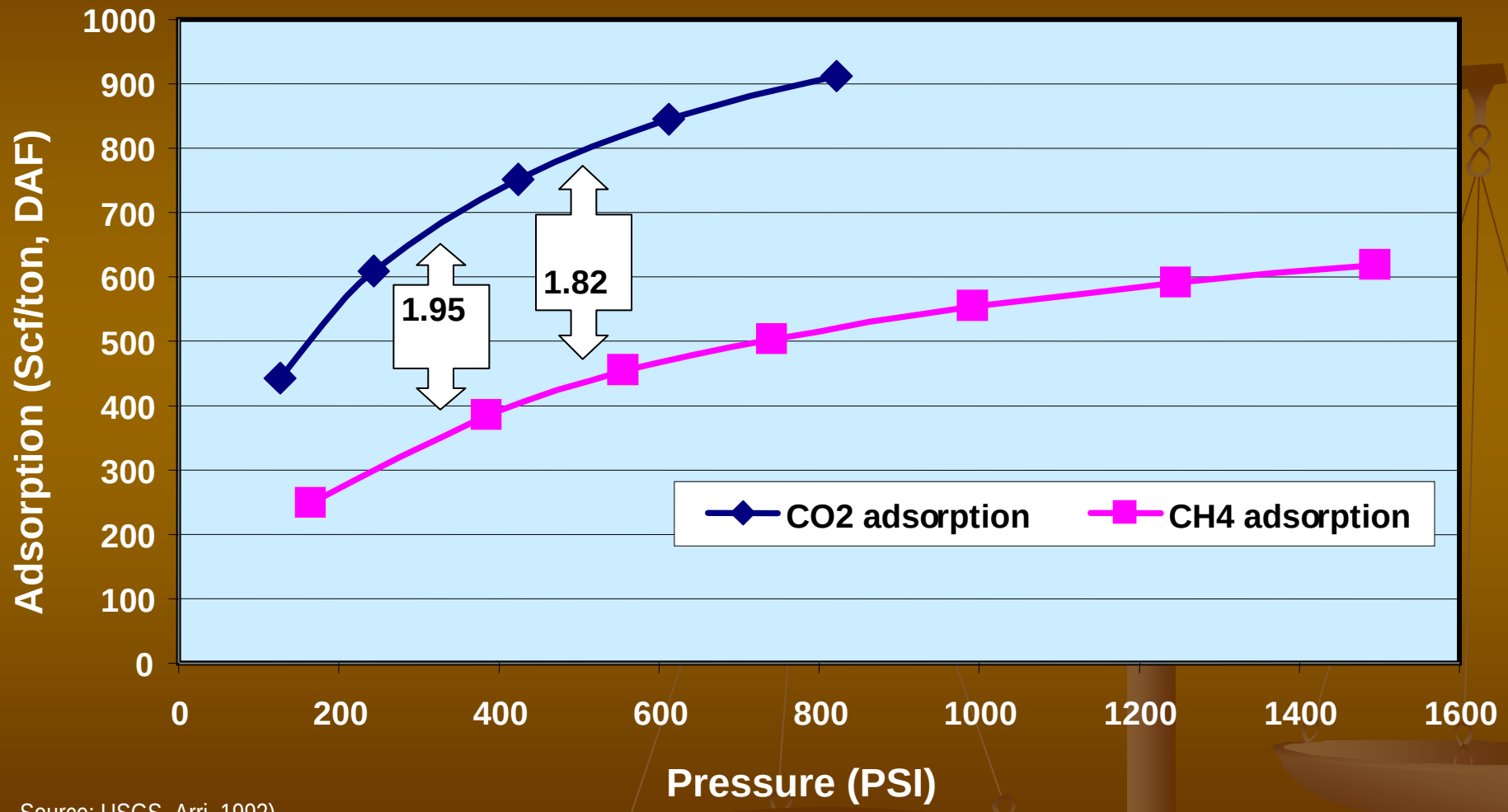
OFFSETTING REVENUES AND INCREASED RESERVES

- ECBM can help offset over half of the costs of CO_2 transportation and storage.
- ECBM could nearly double the ultimate natural gas recovery from domestic coal reservoirs.
- One favorable coal basin can provide large storage capacity of CO_2 (3,000 million metric tons); five to ten such opportunities exist for domestic coal resources.
- Incentives for CO_2 capture and storage of $50/metric ton (or "free" CO_2) would make the project economic.

COALBED METHANE RESOURCES OF THE U.S.



METHANE AND CARBON DIOXIDE ADSORPTION, BITUMINOUS COAL SAN JUAN BASIN



Source: USGS, Arri, 1992)

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3. NEXT STEPS

A series of "next steps" would improve the outlook for CO_2 sequestration using ECBM:

1. **Address the technical issues and uncertainties (e.g., injectivity; alternate injection strategies; CO_2 w/N_2 , etc.).**
2. **Sponsor a series of "flagship" field demonstration projects.**
3. **Define appropriate safety, monitoring and verification requirements and technologies.**
4. **Provide performance-based economic incentives for CO_2 storage.**

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