

The Range of Impacts of Oil Price Crashes on CO₂ EOR

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In the world of oil prices:
“It is déjà vu all over
again” *

- * Quote attributed to an American sports icon,
Yogi Berra (*we'll miss you*)

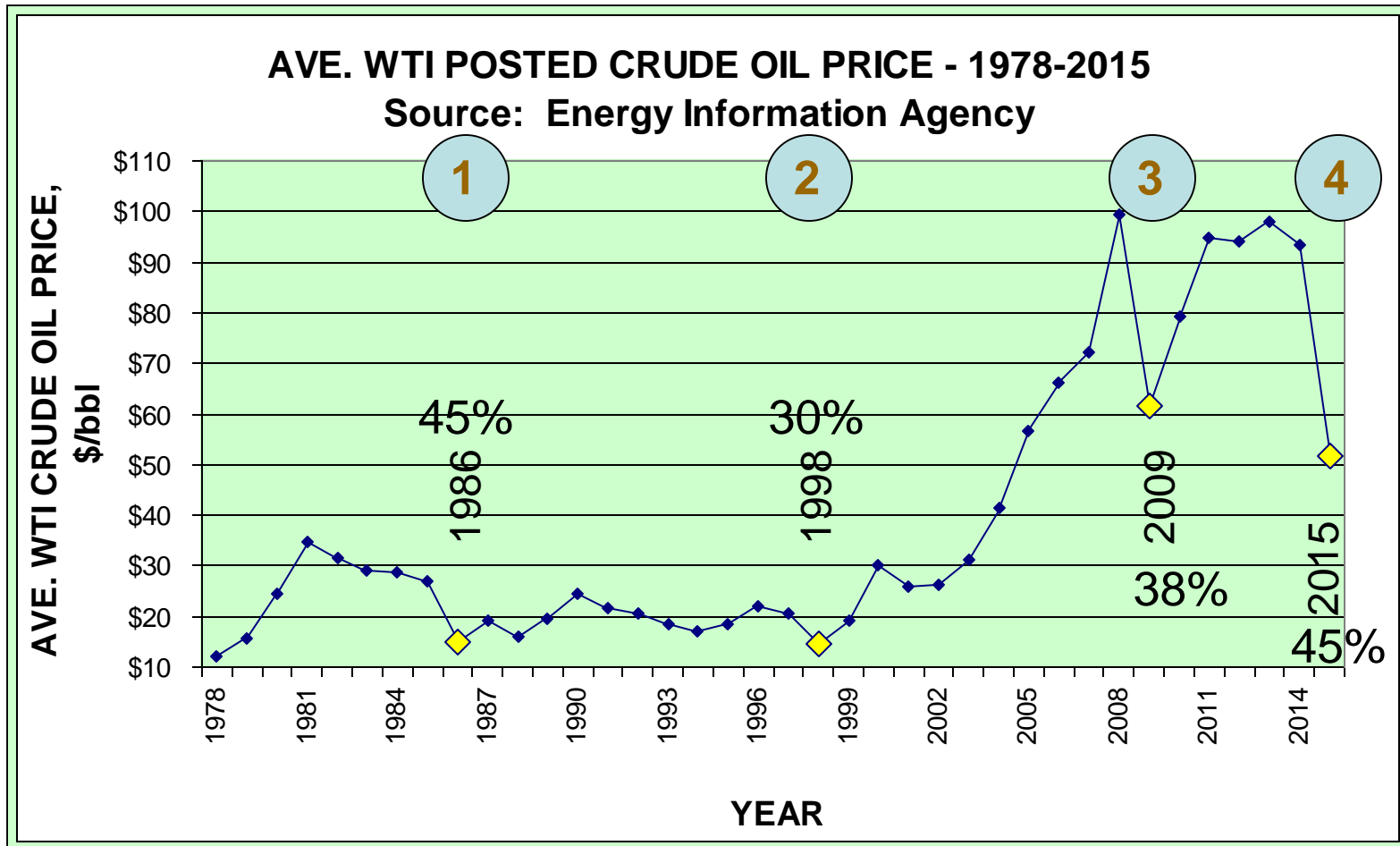


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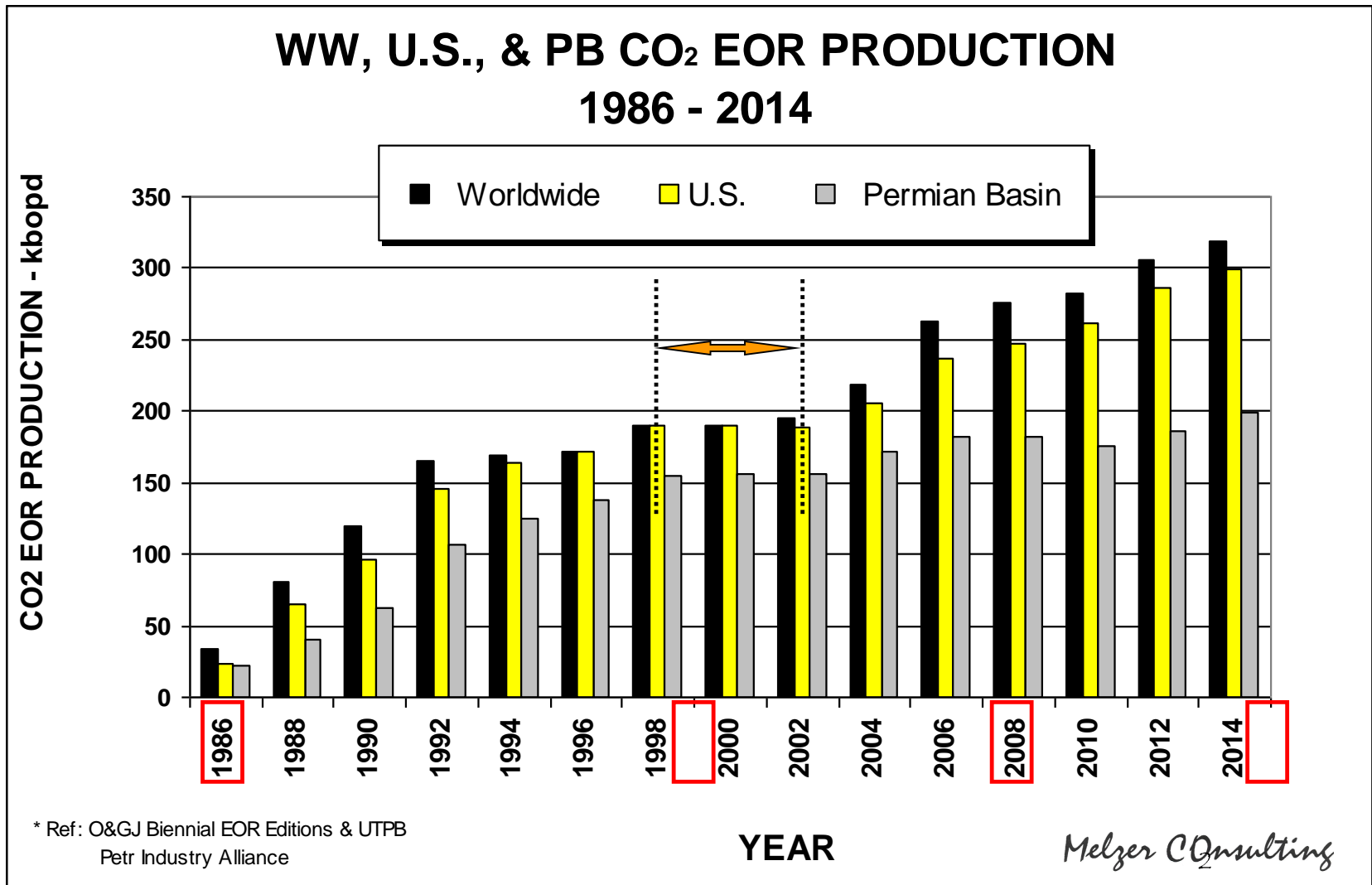
OUTLINE

- I. What History Tells us About Oil Price Crashes on CO₂ EOR Activity
 - Impacts on Oil Production, Flood Starts, CO₂ Sales, Flood Longevity, Innovation, etc.
- II. A “New Day” This Time Around?
- III. Impact on CO₂ Capture & ‘Low Carbon’ Oil
- IV. Factors in the Future

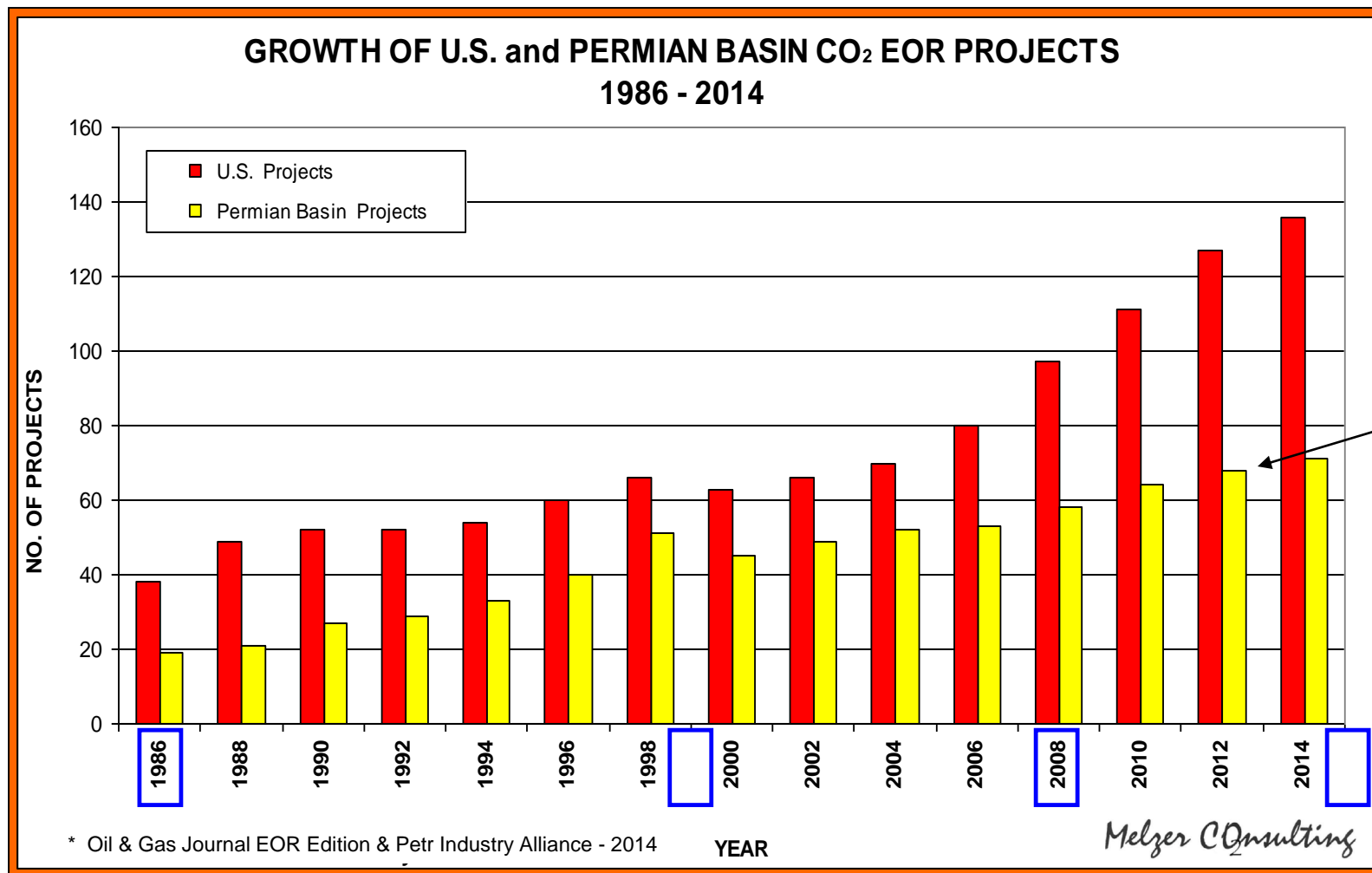
West Texas Intermediate Oil Price vs. Year and Oil Price Crashes Over the Last Four Decades



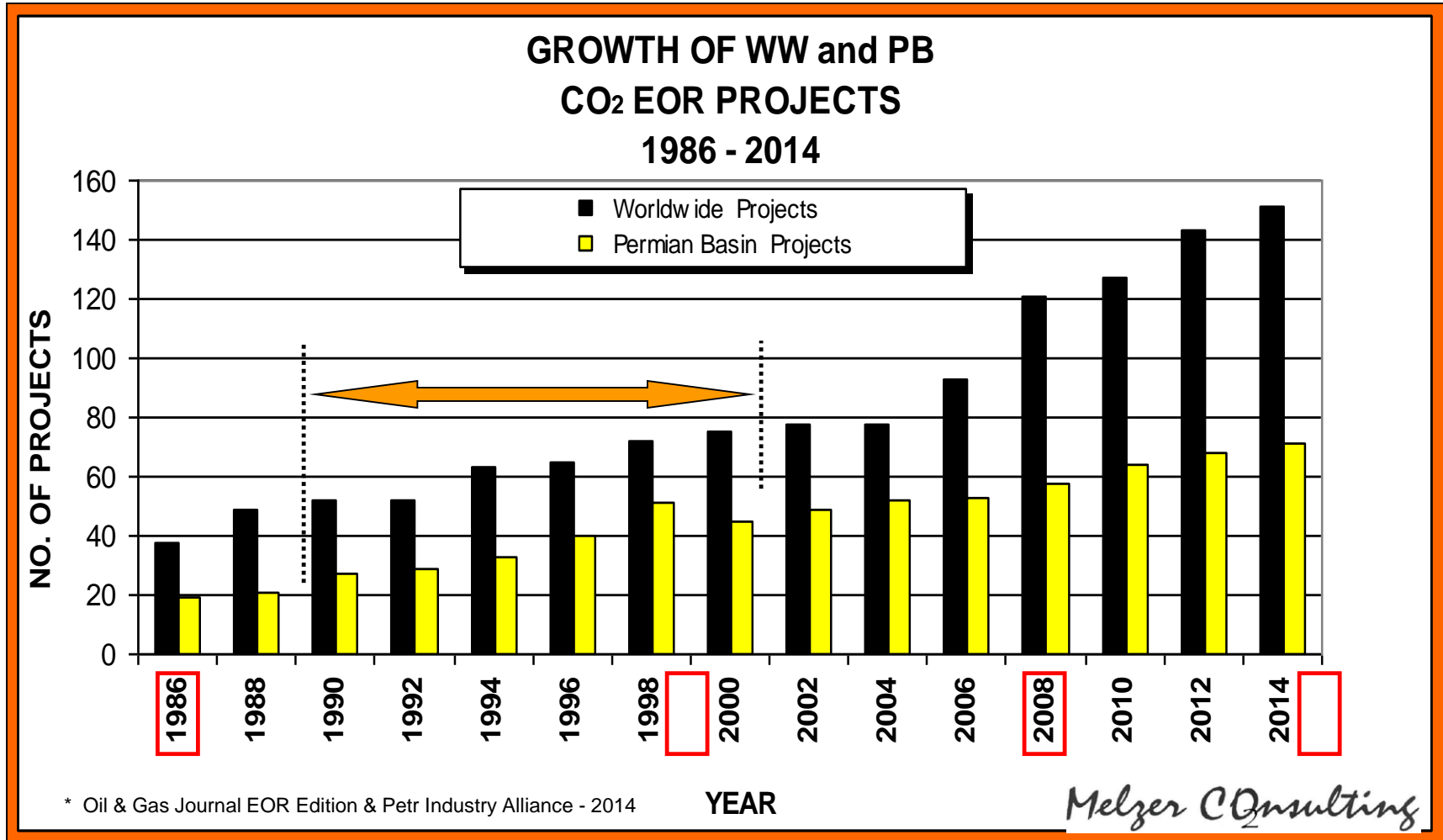
CO₂ EOR and its Steady Growth (Production)



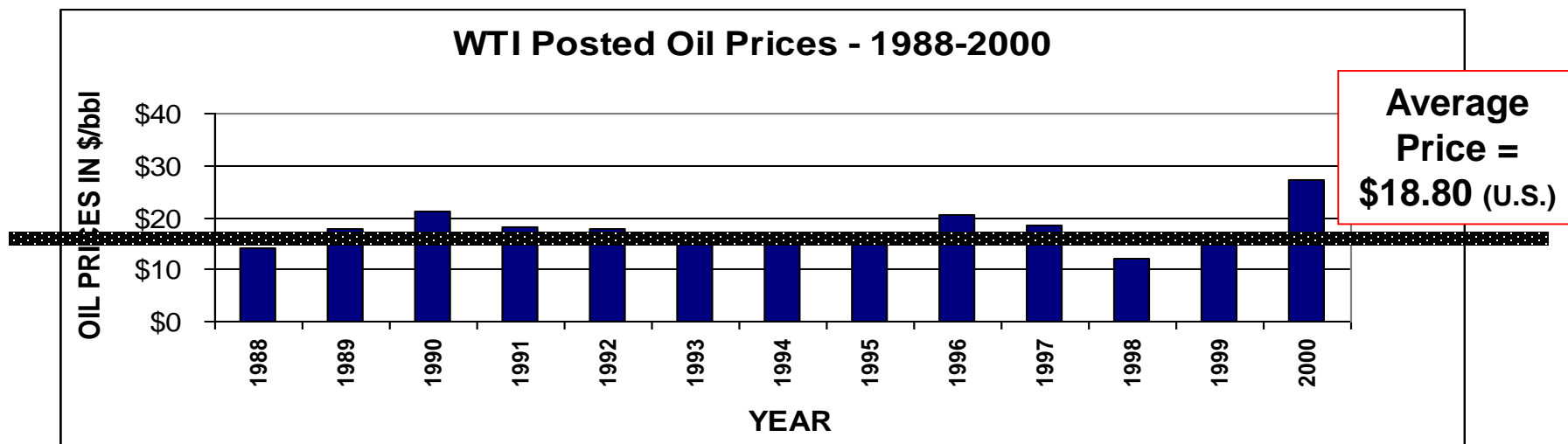
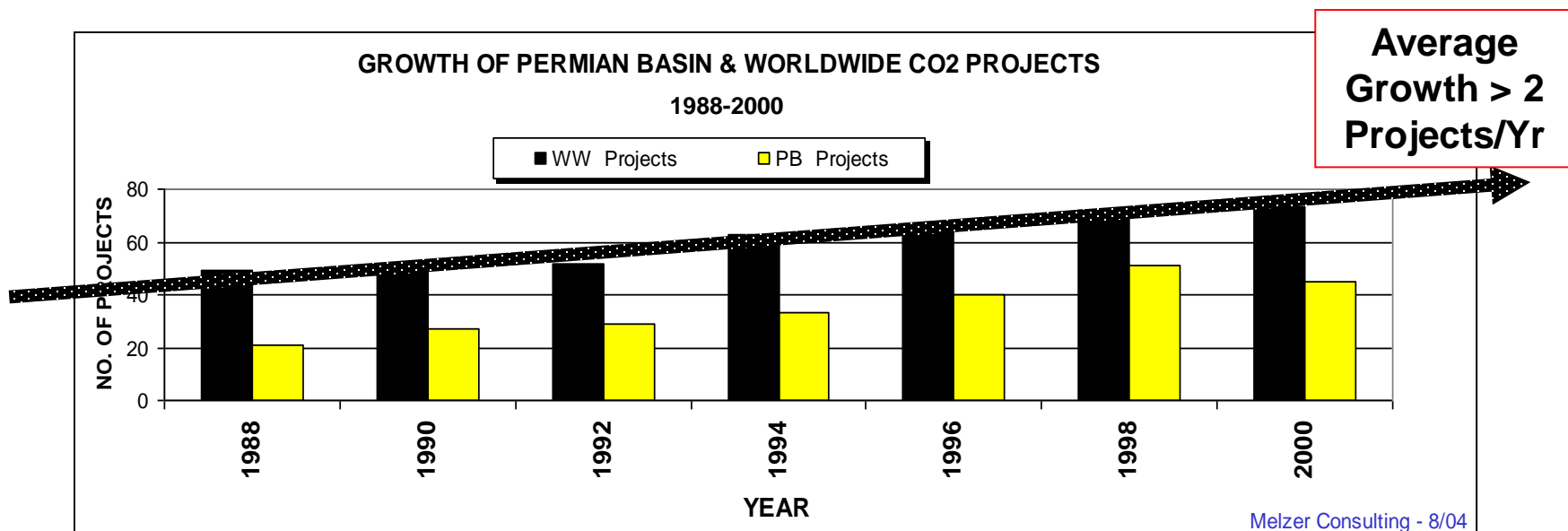
History of CO₂ EOR Project Growth*



Worldwide and PB Project Growth*)



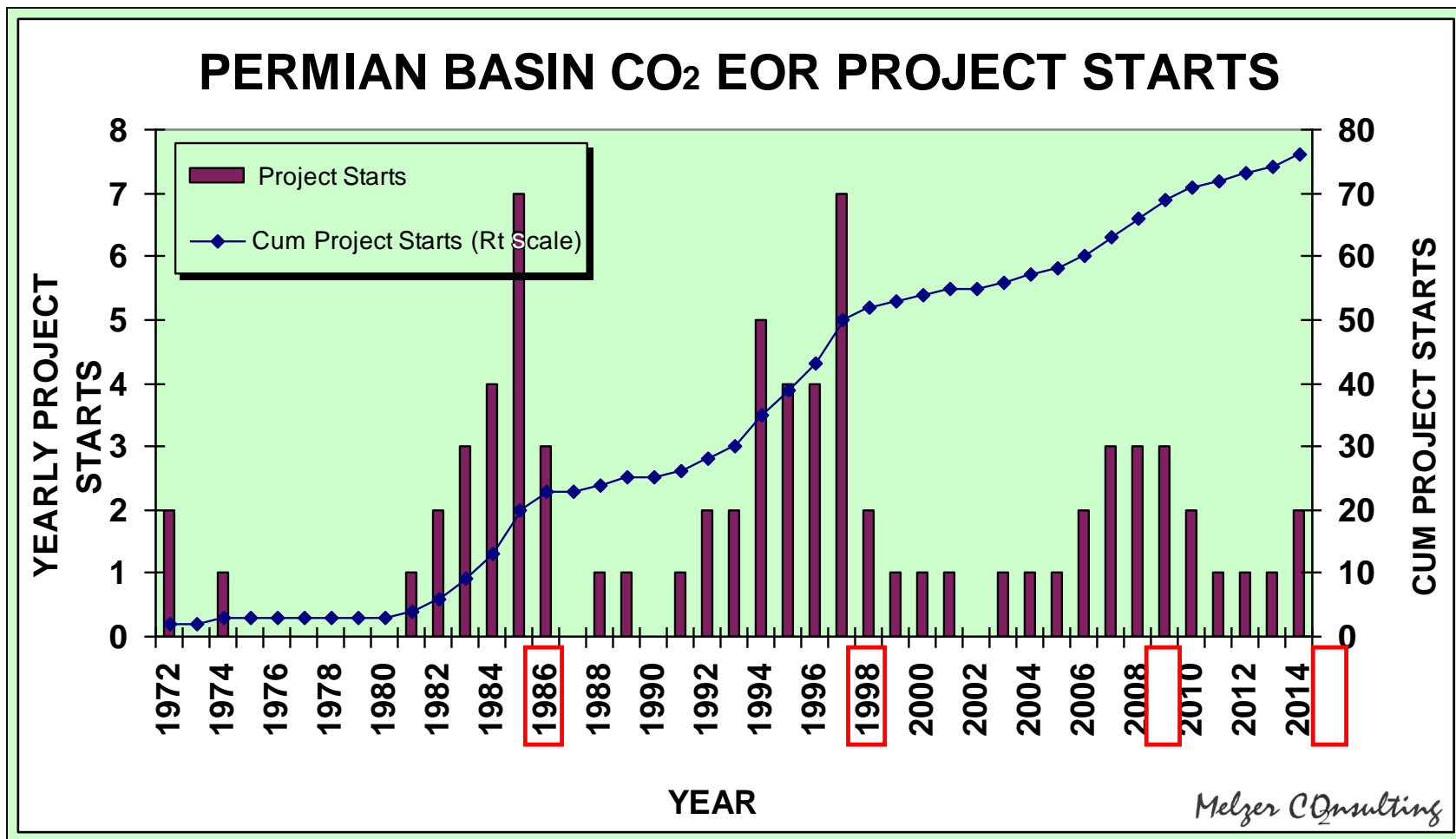
.....and Growth Even with Languishing Oil Pricing



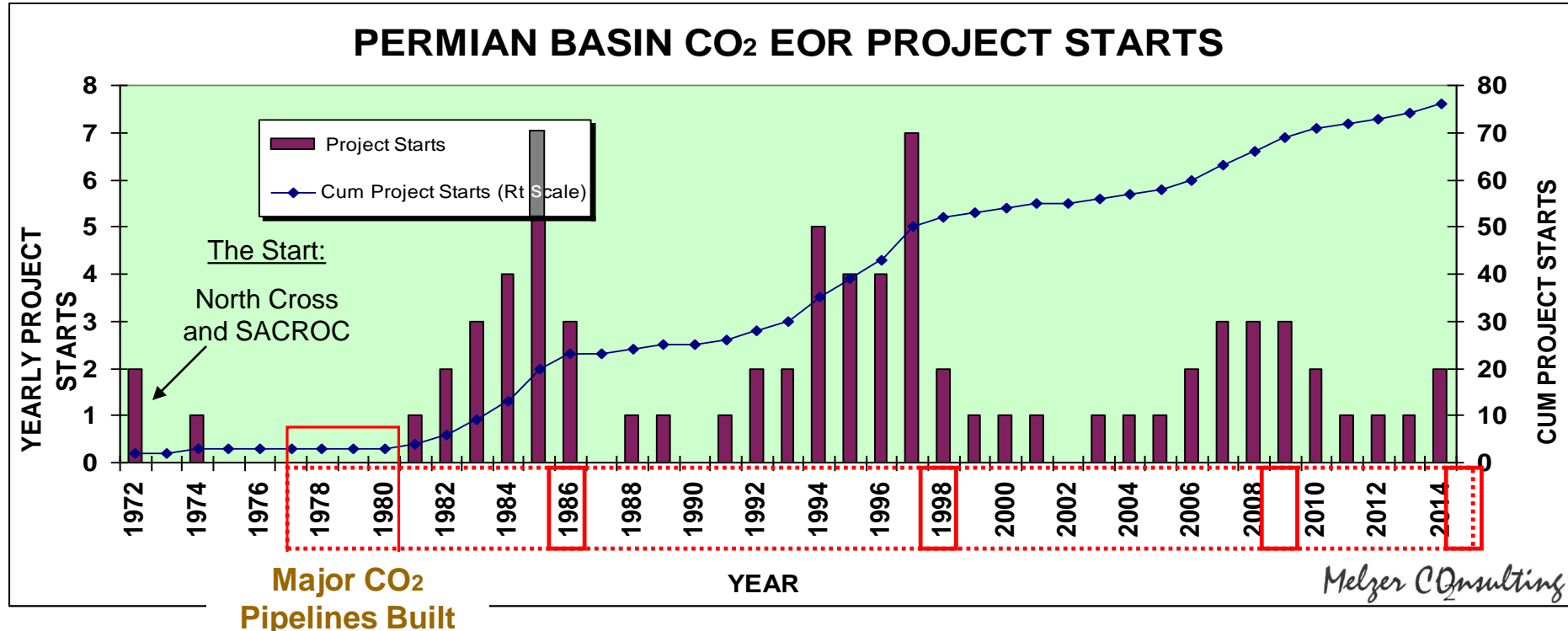
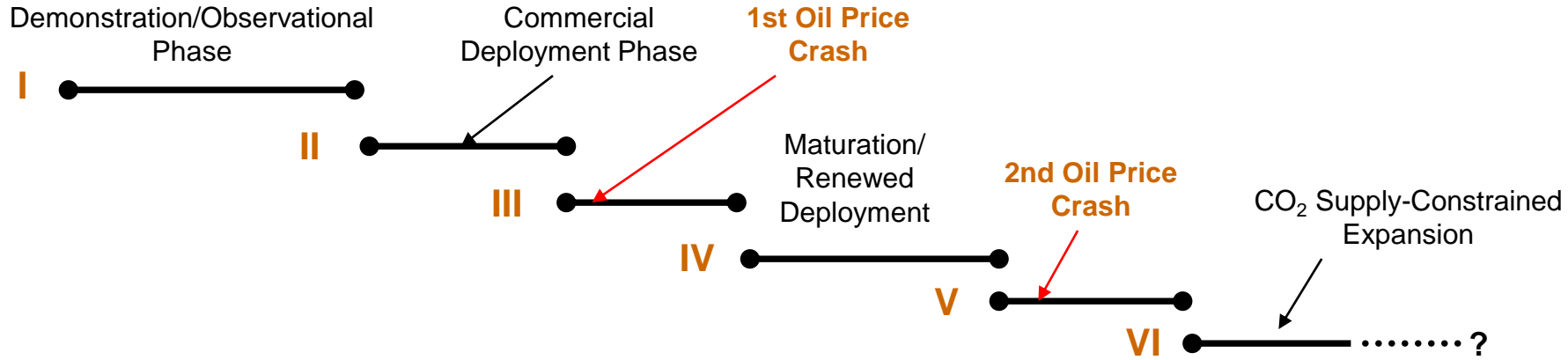
Conclusion: CO₂ EOR Technology had Matured

Oil Prices Do Affect CO₂ Flood Starts

The History of Newly Implemented Floods (PB)



THE PHASES OF CO₂ ENHANCED OIL RECOVERY*



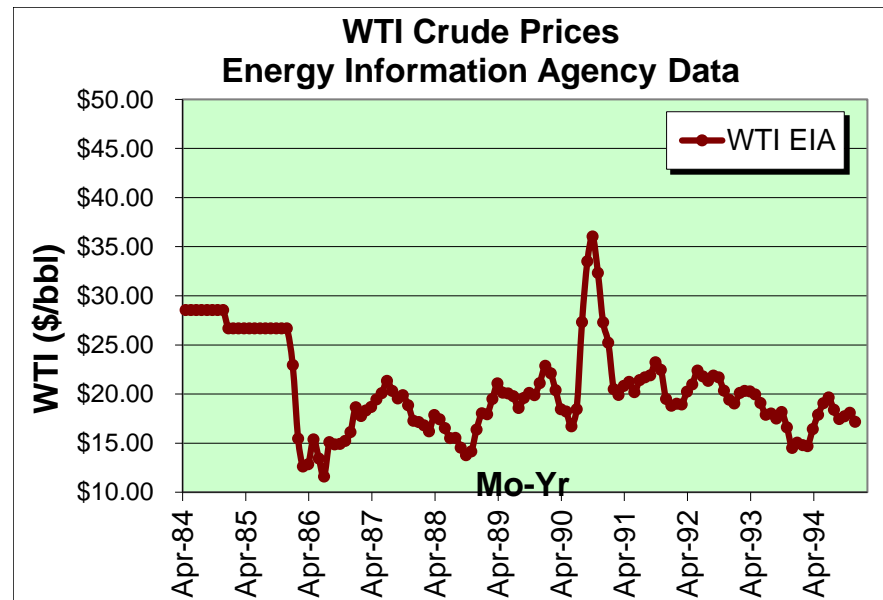
* as "Benchmarked" to the Permian Basin Region of the SW U.S.

A “New Day” This Time Around?

First, About Oil Supply in General, *What is the Same?*

- Oversupply of Oil When Compared to Demand
- Drop in Oil Price is Dramatic (about 45-50%)
 - ~ Same as 1986 Crash

We Might Look at the 1986 Crash as the Best Analogue?



But...What is Different?

Oil Supply and Oil Demand

- Excess WW Production Capacity Today is Very Limited (~2 Million bbls/day)
 - In 1986, Just before Crash, it was in excess of 9 Million bbls/day
- Much of the Incremental Oil Creating the Surplus in Supply Will Decline Rapidly
- Maybe Early to Tell Yet but Demand Elasticity (to Oil Price) was Greater in the Past

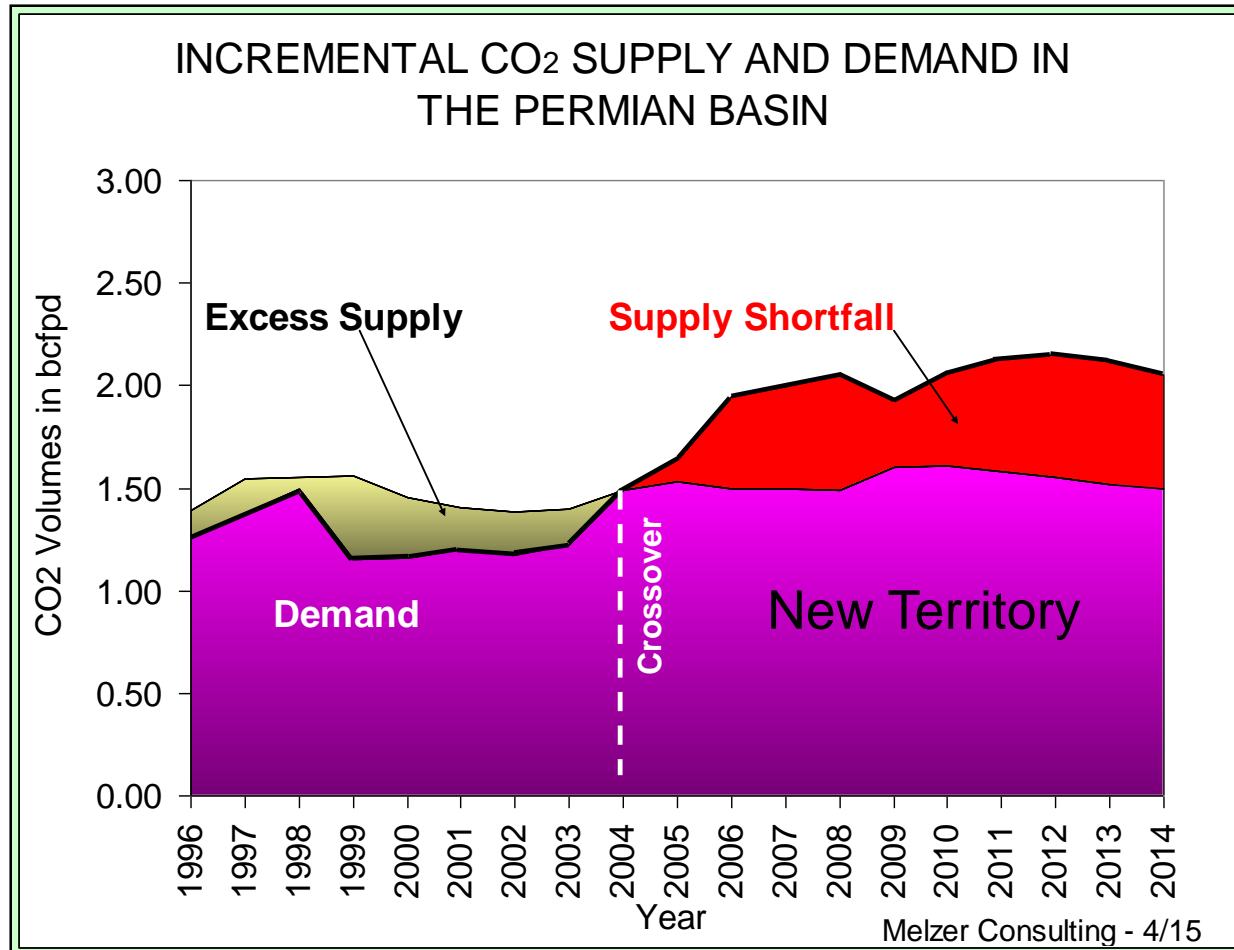
What is Different?

CO₂ EOR in Particular

- The World Places a Higher Value on Clean Energy than in the Past
- Can CO₂ EOR Play a Role in the Clean Energy Transformation?
- We Entered the Current Oil Price Bust Short of CO₂ for EOR

What is Different?

CO₂ Supply and Demand in the PB



The CO₂ Suppliers Held the Cards

- In Order to Implement a New CO₂ Flood, the Companies were “Forced” to Accept Terms That they Now Regret, i.e., High CO₂ Price Floors, High Take or Pay Terms
- Will the Flooders Without their own CO₂ be Squeezed out of the Industry?
- Less Competition? Fewer Players?

Impact on CO₂ Capture and 'Low Carbon' Oil

How 'Low Carbon' Is My Oil?*

- CO₂ EOR projects store 240-460 kg CO₂/BBL in the reservoir
- Carbon balance is sensitive to the system boundary
- EOR project gate-to-gate: Net CO₂ **storage** of 75 to 410 kg CO₂/BBL
- Including up- and down-stream emissions (as in SACROC example):
 - Without oil combustion: Net CO₂ **storage** of 146 kg CO₂/BBL
 - With oil combustion: Net CO₂ **emission** of 260 kg CO₂/BBL (next best oil is North Sea at nearly double that amount (475))
- Additional work using industry data, region-specific storage metrics, and uncertainty quantification is needed to estimate these values with greater accuracy.

* Re: "How Green is My Oil? - A Detailed Look at Carbon Accounting for CO₂ EOR Sites," Presented by Nicholas A. Azzolina and Wesley D. Peck, PCOR Partnership Annual Membership Meeting and Workshop, Chicago, Illinois, Sep 15, 2015

Factors in the Future

After the Crash

Energy Trends

- Peak Oil – OIP Limited? Let's forget about that – there is plenty of oil (Unconventionals, ROZs...)
- Cleaner Fuels (for both Electricity and Motors)
- Long-Trend Oil Demand Leveling Out?
- Oil at \$100/bbl too Elevated for Long Term Demand Trends

CO₂ and CO₂ EOR Trends?

- The CO₂ EOR Business is a Long Term Investment and can (and has) Survive the Ups and Downs of Oil Pricing
- Potential for Accelerated Growth has been Present for Twenty years but Held Back by:
 - Lack of Available, Affordable CO₂ Supplies
 - Limited Experienced Engineering Staffs
 - ~~– Belief Held by Many that CO₂ EOR was Small, Niche Industry~~
 - ~~– Wide Understanding of Technology of CO₂ EOR and Misunderstanding about CO₂ Retention, e.g., “EOR only Stores Half the Injected CO₂”~~ These may be changing
 - “Just Prolongs the Age of Hydrocarbons” and Not Deserving of Clean Energy Incentives
 - Cost of CO₂ Capture and Cost of Large Scale Trials to Prove Economics
 - Cannot Compete in the Financial Markets with the Quick Returns (and Quick Exit Opportunities) from the Unconventionals
- Only the Strong Survive so Where will EOR Competition Come from after the Bust?

“Chaos often breeds life, when
order breeds habit”

Henry Adams

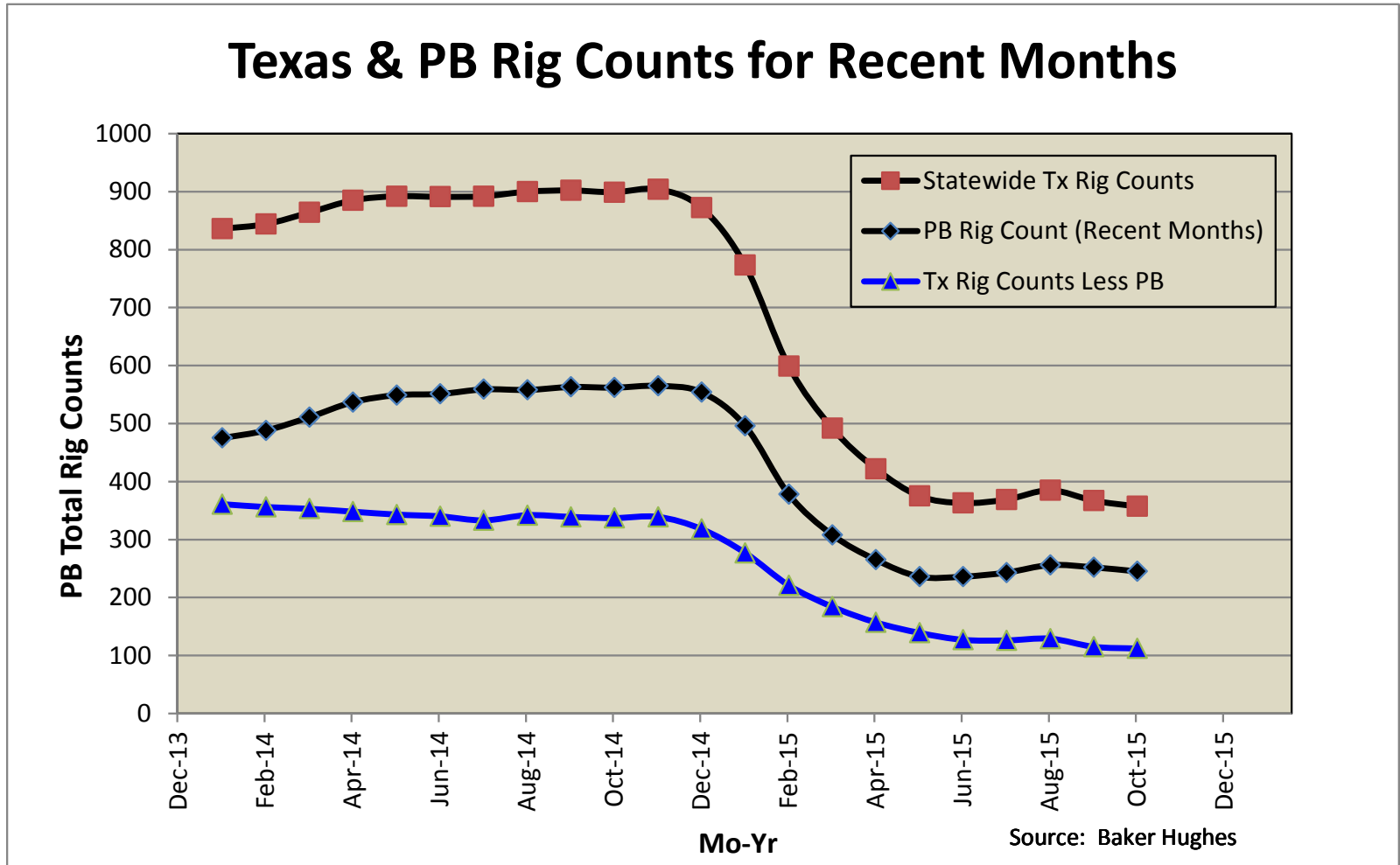
*We should be breeding a lot of
new life at \$45/bbl*

Thank you

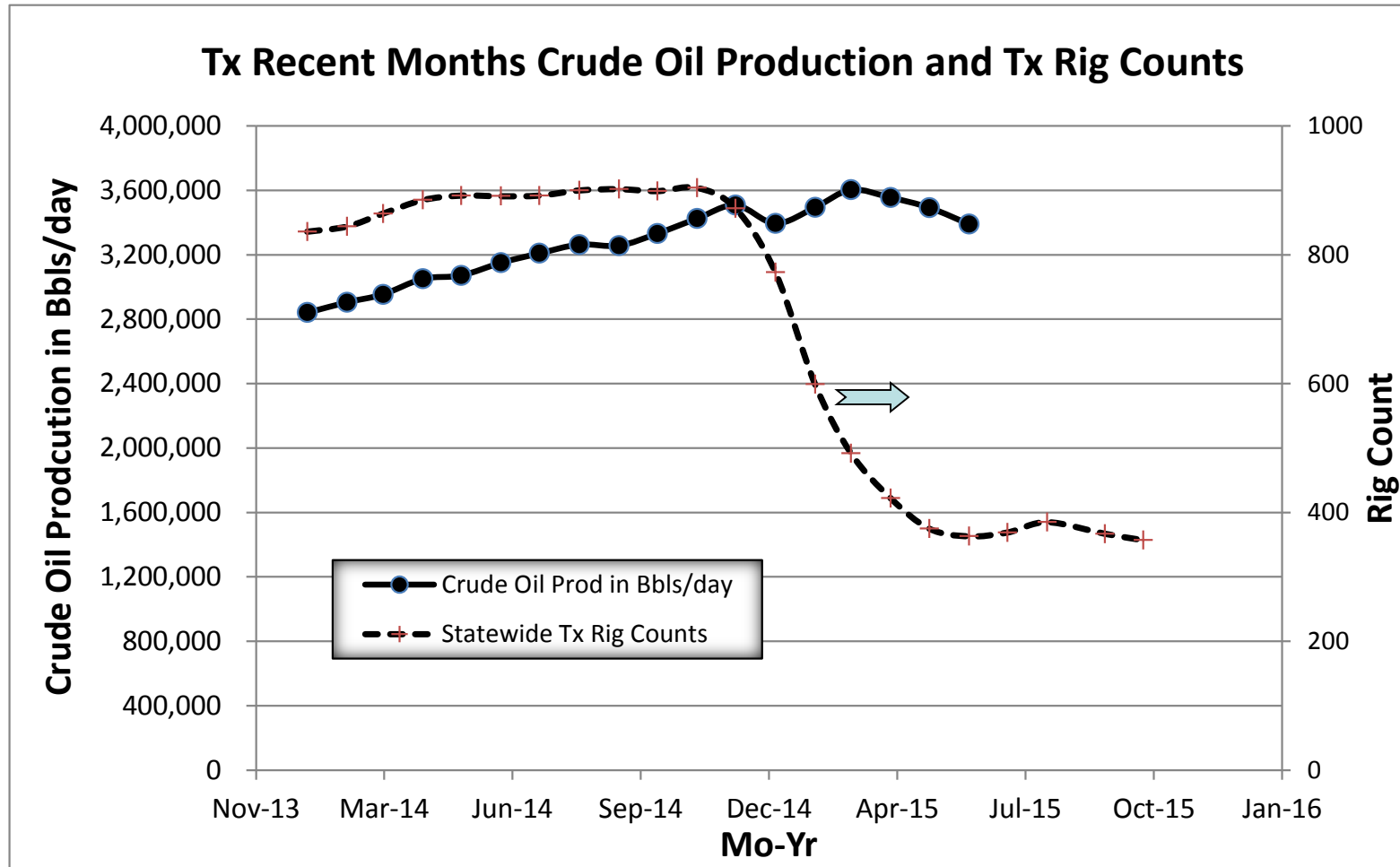
Questions?

BACKUPS

Supply Destruction



Effects of On-going Price Crash on Texas



Sources: Production: Drilling Info Rig Counts: BakerHughes



co2conference.net

Collaborate and create with CO₂'s leading Practitioners

CO₂ Conference Week, December 8-11, 2015

The Annual CO₂ Conference in Midland

www.CO2Conference.net

2014 CO₂ Conference Week: Midland, Texas

(All Events to be held in Downtown Midland Center {MC})

| | -----Tue 12/9----- | | | Wed 12/10 | Thur 12/11 | Fri 12/12 |
|------|---------------------------------|---|---|--|---|---|
| 7am | | | | | | |
| 8am | Session I Carbon Mgmt Workshop | | ROZ Core Display (Rooms 1 & 3) | Check-in {MC} | CO ₂ Theme Session I: CO ₂ EOR Policy and Flood Ops | Session III CO ₂ Theme Session: Reservoir Case Histories |
| 9am | | | | | | |
| 10am | | | | EOR Water Management Shortcourse (Keynote Speaker included) | Luncheon - Keynote Speaker | Light Lunch |
| 11am | | | | | | |
| 12pm | Luncheon - Keynote Speaker MC | Seminar on Well Control for CO ₂ Operations (Room 5) | Field Trip to a Mature CO ₂ EOR Flood and Surface Facilities | Optional Field Trip to Nearby Produced Water Plant | CO ₂ Theme Session II: CO ₂ Flood Ops & Reservoir | |
| 1pm | Session II Carbon Mgmt Workshop | | | | | |
| 2pm | | | | | | |
| 3pm | | | | | | |
| 4pm | | | | | | |
| 5pm | | | | | | |
| 6pm | Reception - Midland Center | | | Reception - Midland Center | Reception - Perm Basin Petroleum Museum | |
| 7pm | | | | LEGEND | | |
| 8pm | | | | EOR Carbon Management Workshop | | |
| | | | | CO ₂ Flooding Conference | | |
| | | | | STIPPLED EVENTS HAVE LIMITED SEATING AND REQUIRE SEPARATE RESERVATIONS | | |