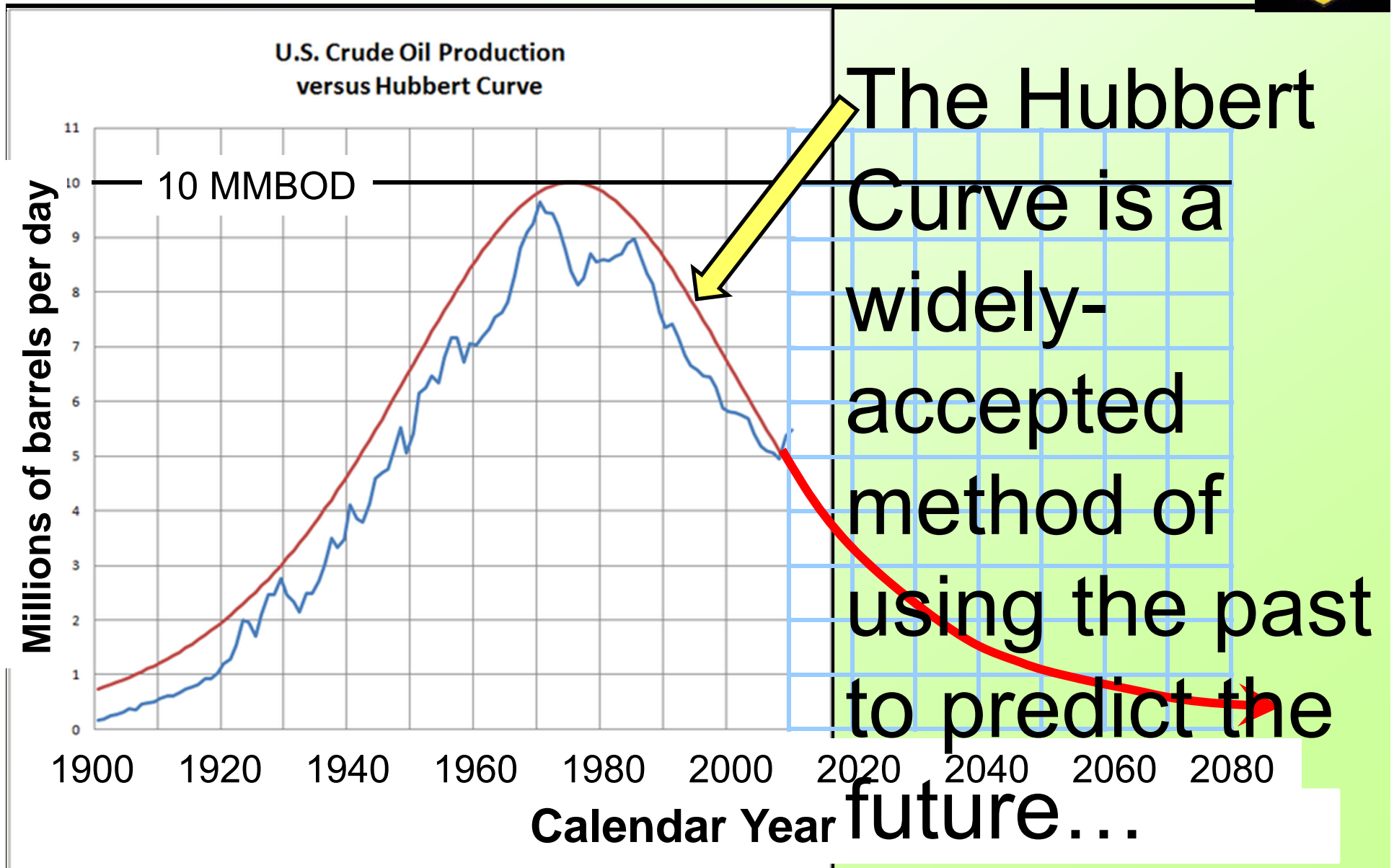




# How Your Energy World Has Changed ...and will continue to change...

*Maurice B Dusseault*  
*University of Waterloo*

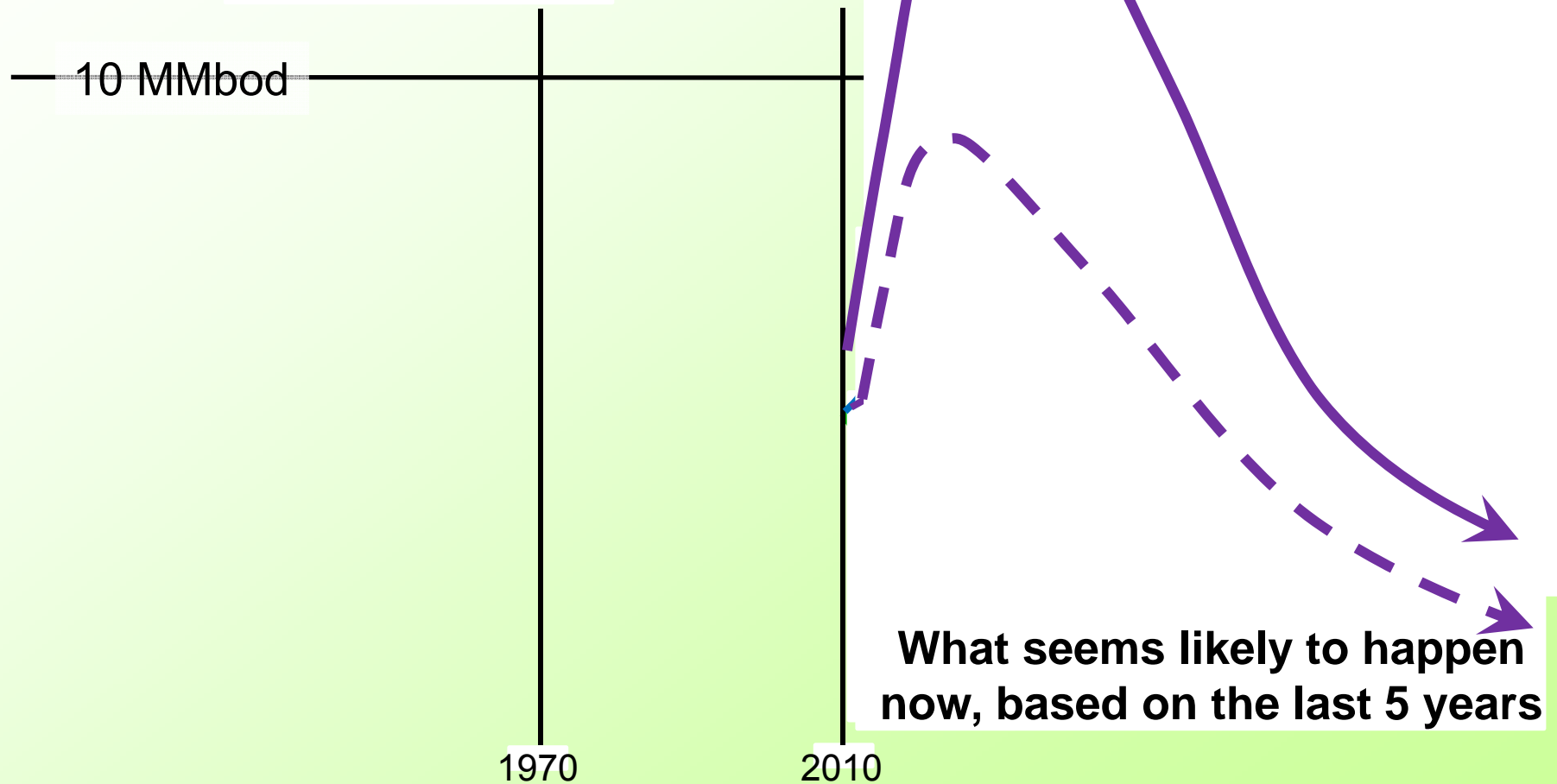
# How Do Fixed Resources Deplete?



# Views of the Future...



US Crude Oil Production Curve  
and a Hubbert Curve Fit



## + Data for the Last Two Years...

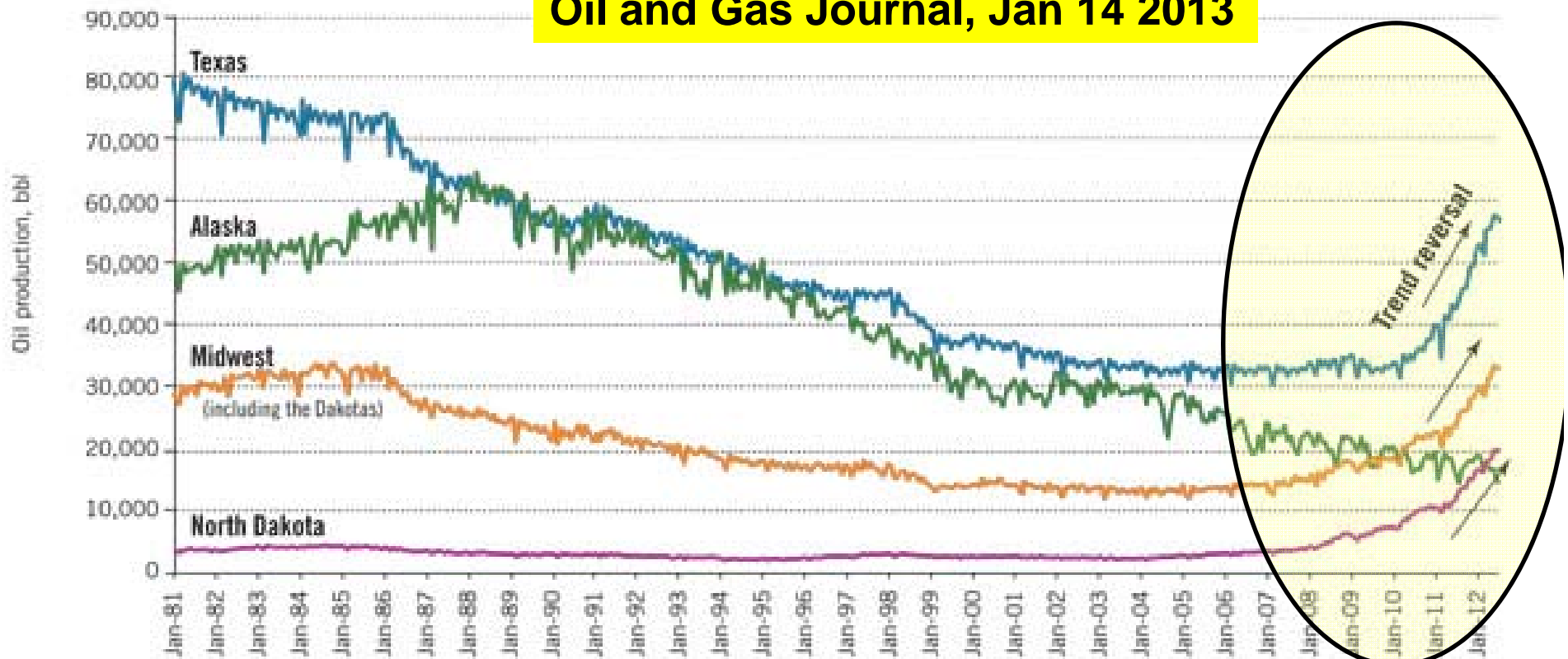


- ◆ New exploration and production technologies are changing the game...

TREND REVERSAL IN MAIN US PRODUCING REGIONS ATTRIBUTED TO SHALE OIL PRODUCTION

FIG. 2

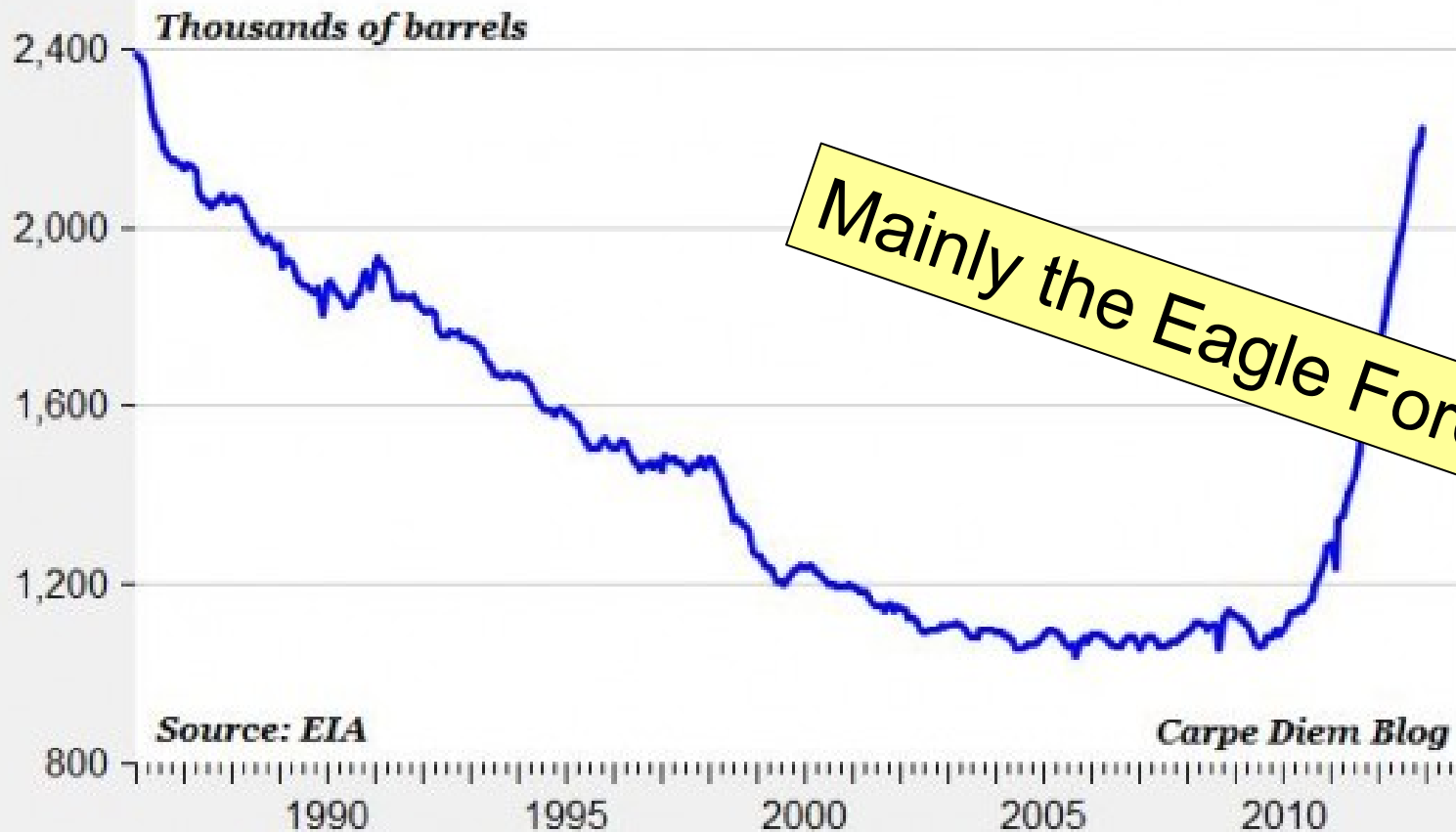
Oil and Gas Journal, Jan 14 2013



...even More Recently...



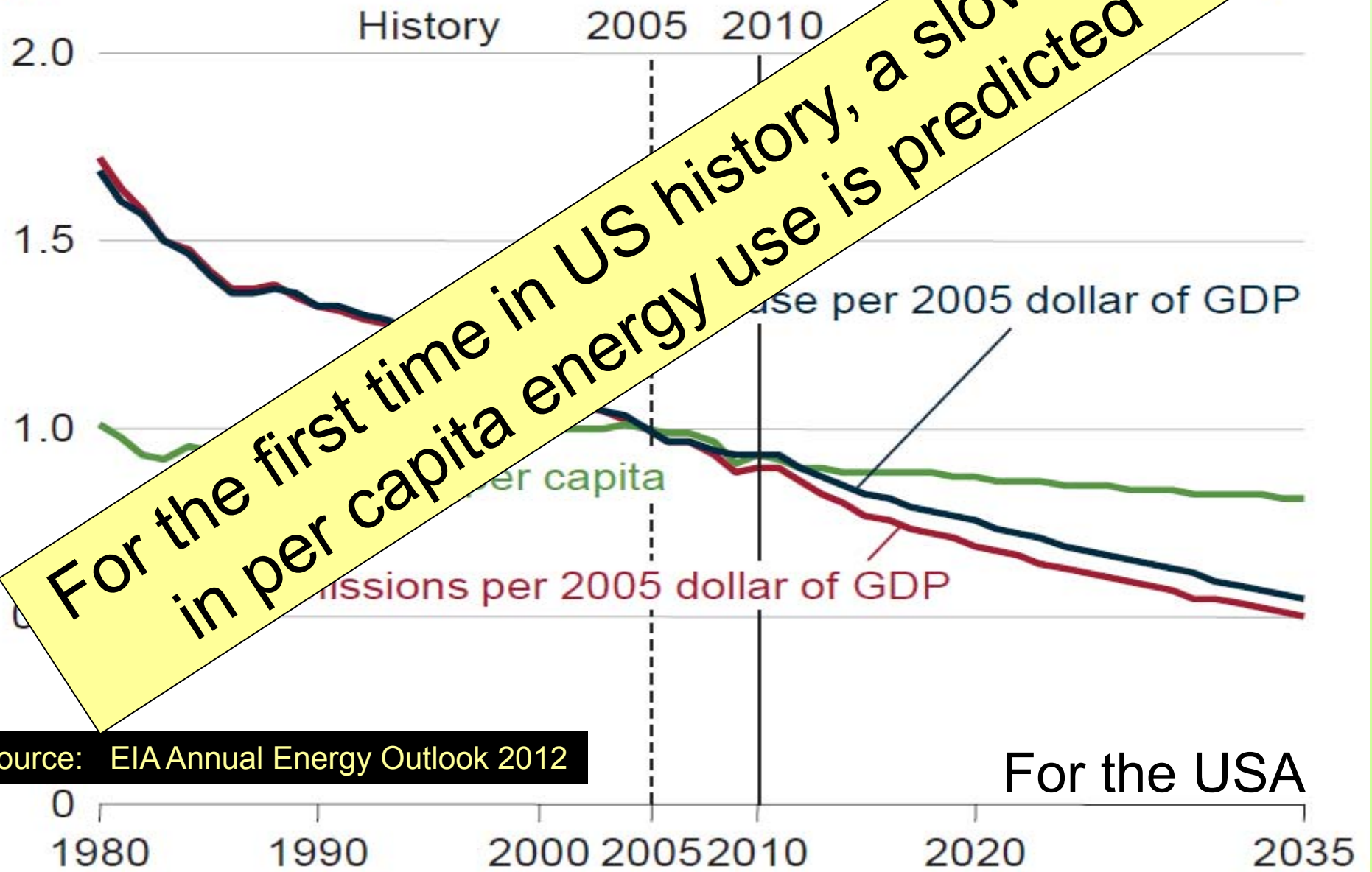
## Texas: Daily Oil Production January 1986 to December 2012



# Natural Gas Price in USA



Figure 9. Energy use per capita and per dollar of gross domestic product and emissions per dollar of gross domestic product, 1980-2035 (in 2005 dollars)

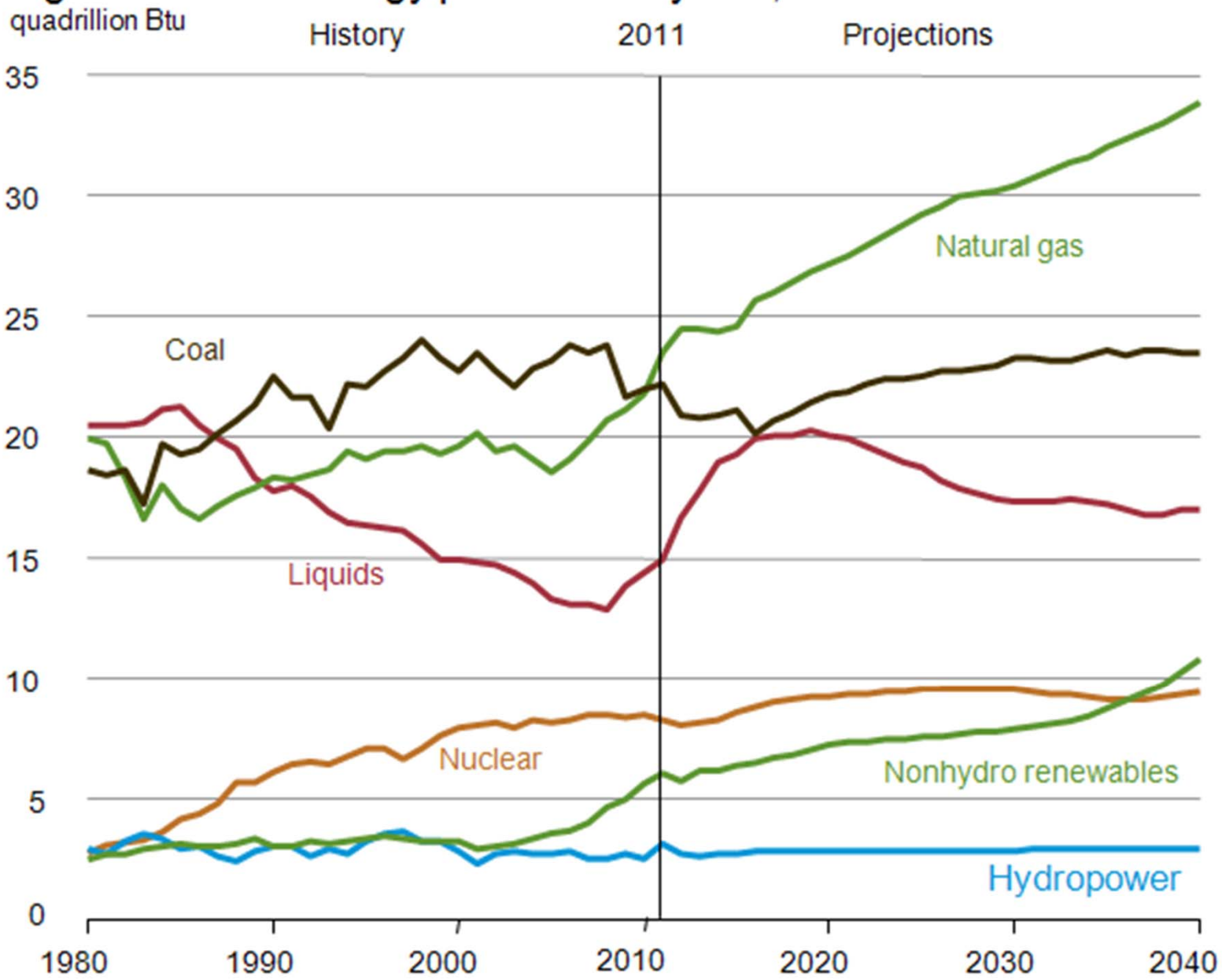


Source: EIA Annual Energy Outlook 2012

For the USA



### Figure 10. U.S. energy production by fuel, 1980-2040





Predictions...



**“Predictions are difficult,  
especially about the future...”**

**Variously attributed to...**



**...and others...**

# Predictions...



A few years ago,  
Jeff Rubin (CIBC)  
predicted massive  
shortages and  
price escalation  
fossil fuels  
hasn't  
W



## Predictions...



Despite this, I will finish my talk with some predictions... But first, we have to set up their quantitative basis...

# What Has Happened Recently?

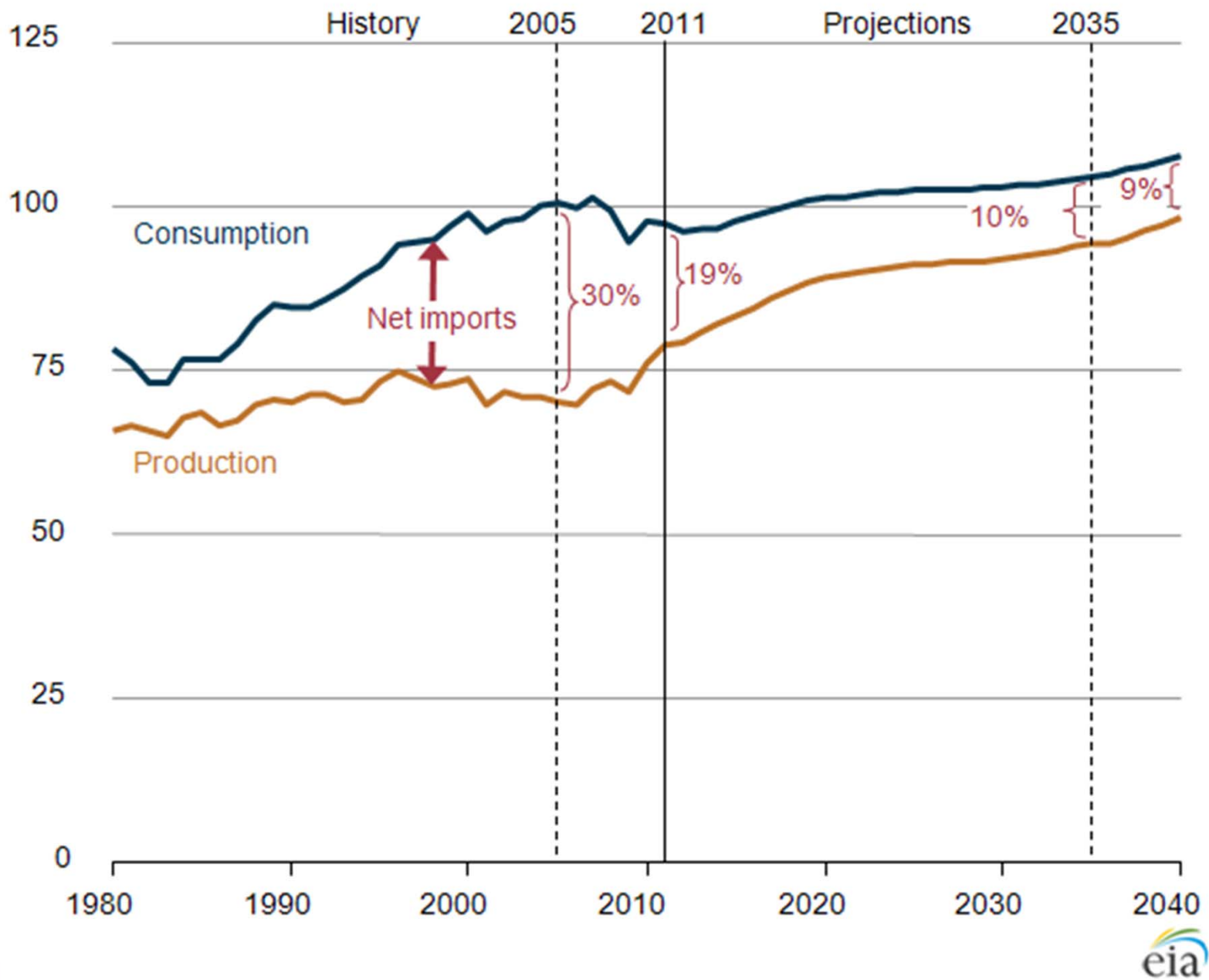


- ◆ The “**Enhanced Oil Recovery Revolution**”

**Fossil fuel shortages in the next generation or two are not likely**

- ◆ ...and...
- ◆ Continued technical advances will bring other fossil fuel resources to the consumer...
- ◆ The “**Methane Hydrate Revolution**”
- ◆ The “**Colorado Oil Shale Revolution**”

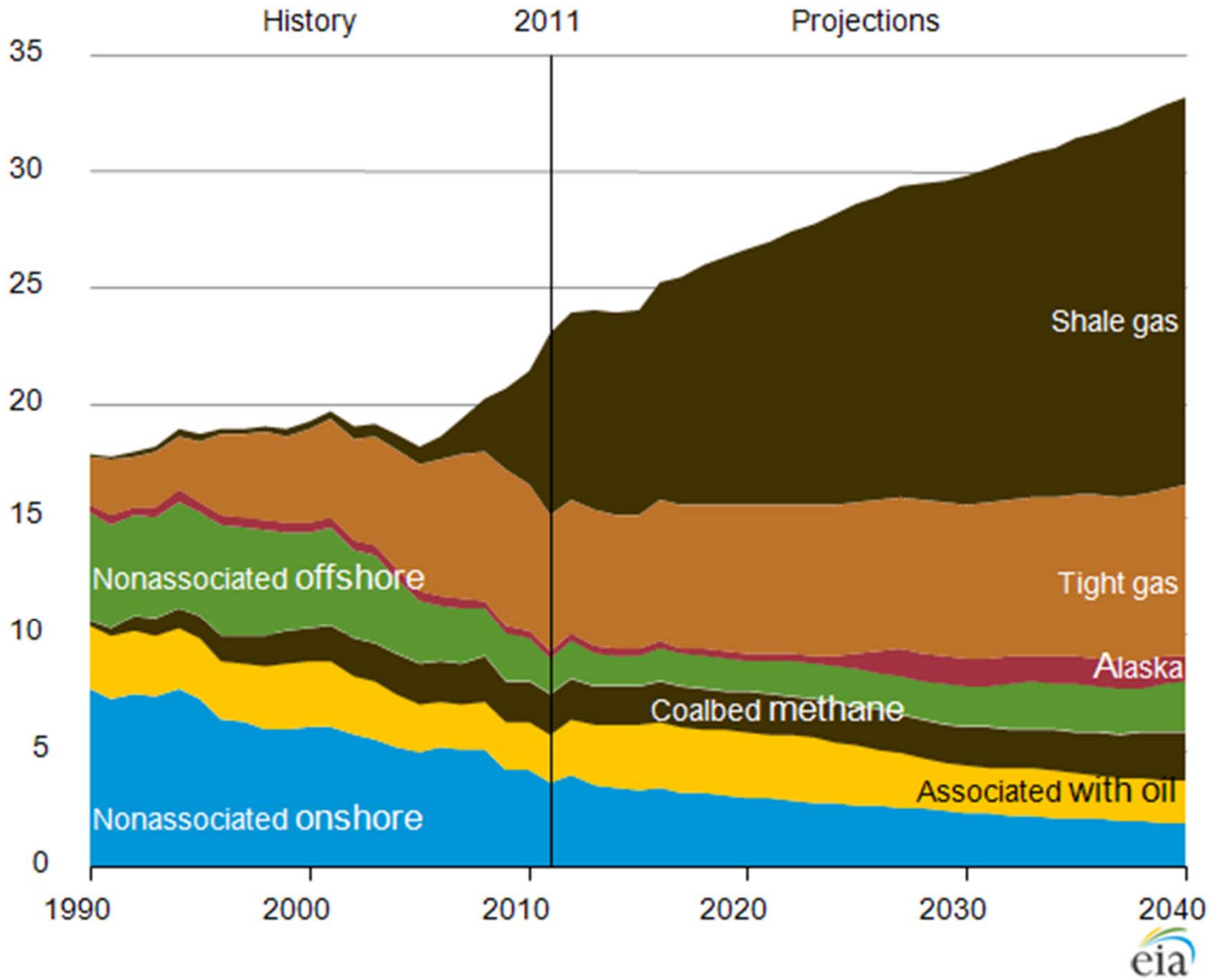
Figure 9. Total energy production and consumption, 1980-2040  
quadrillion Btu



Sp  
char  
& no

Figure 3. U.S. dry natural gas production by source, 1990-2040

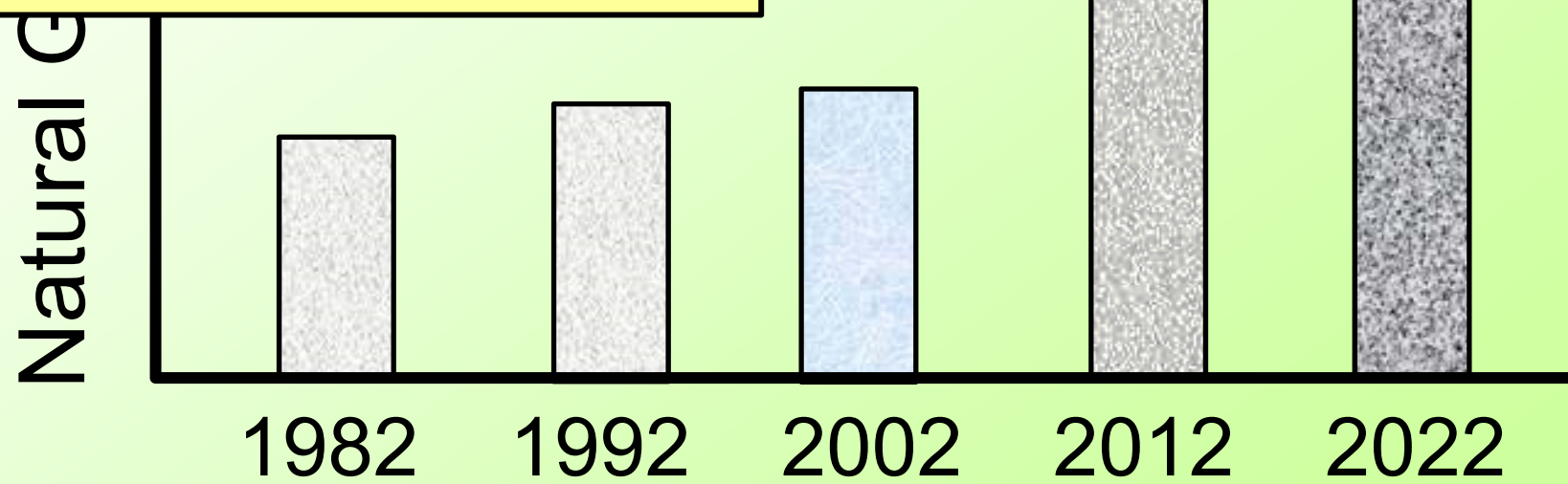
trillion cubic feet



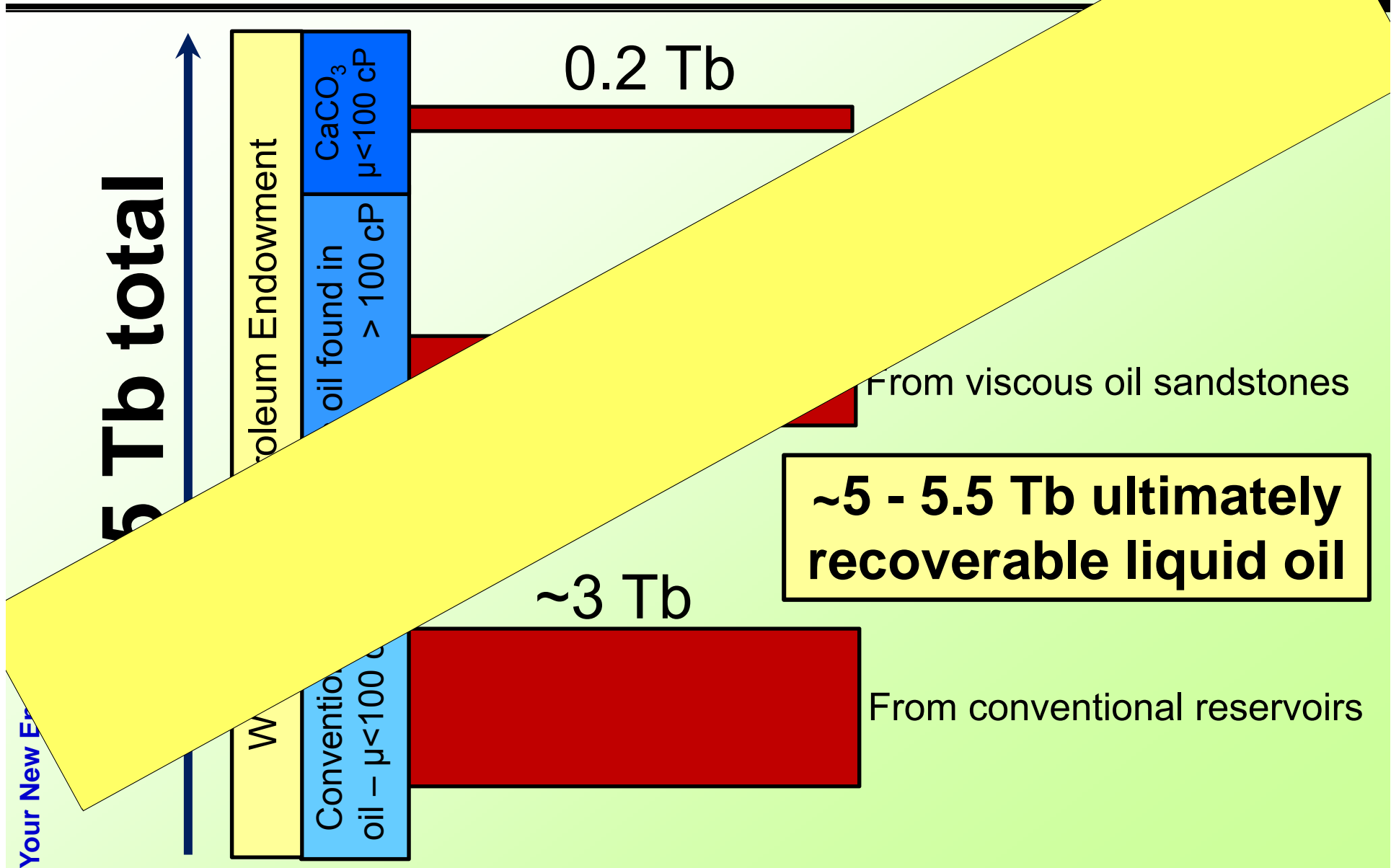
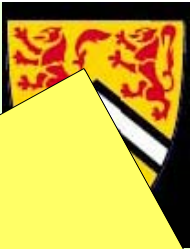
# Changing Views...



The view of world gas reserves has totally changed in the last 10 years!

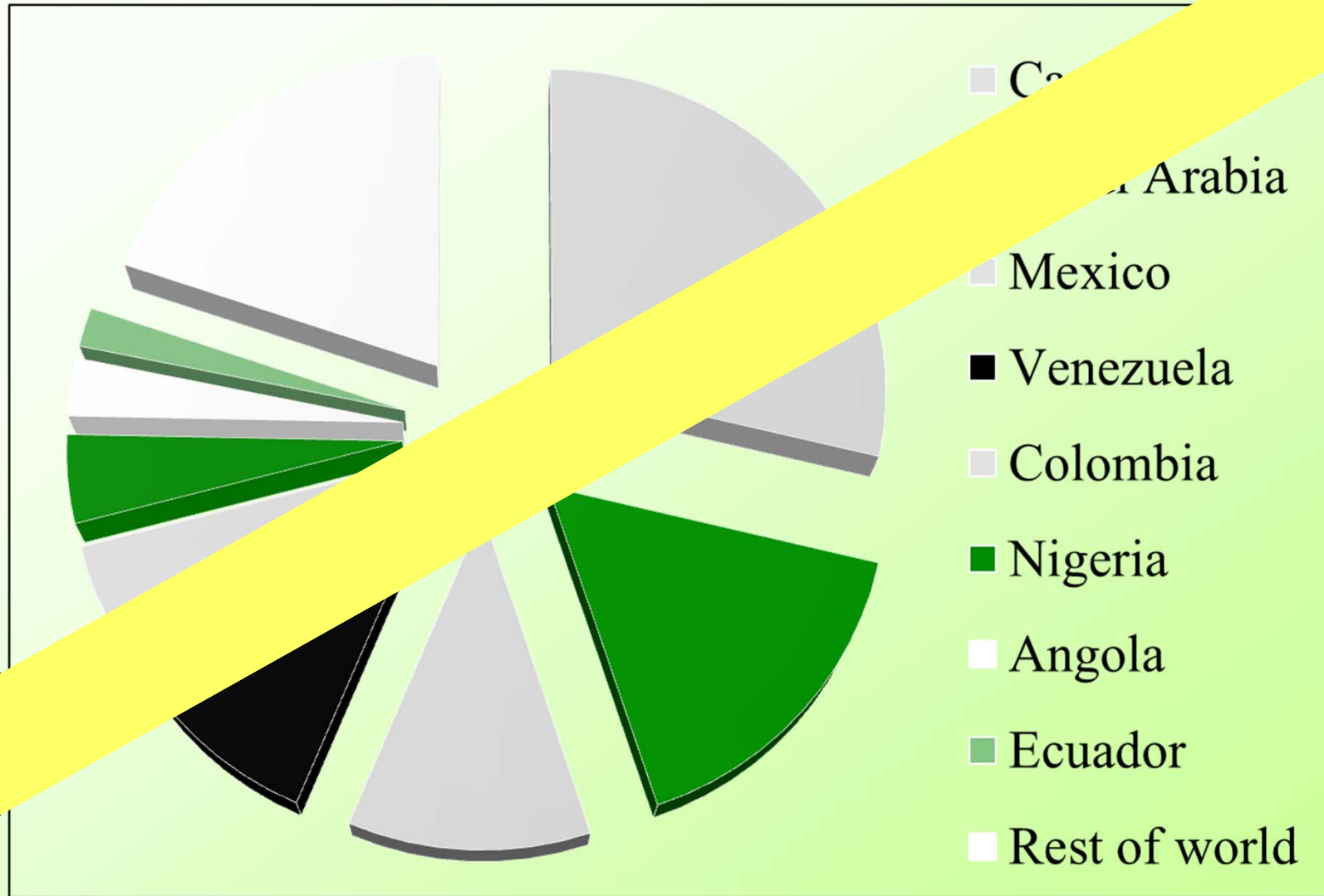


# Changing Views...





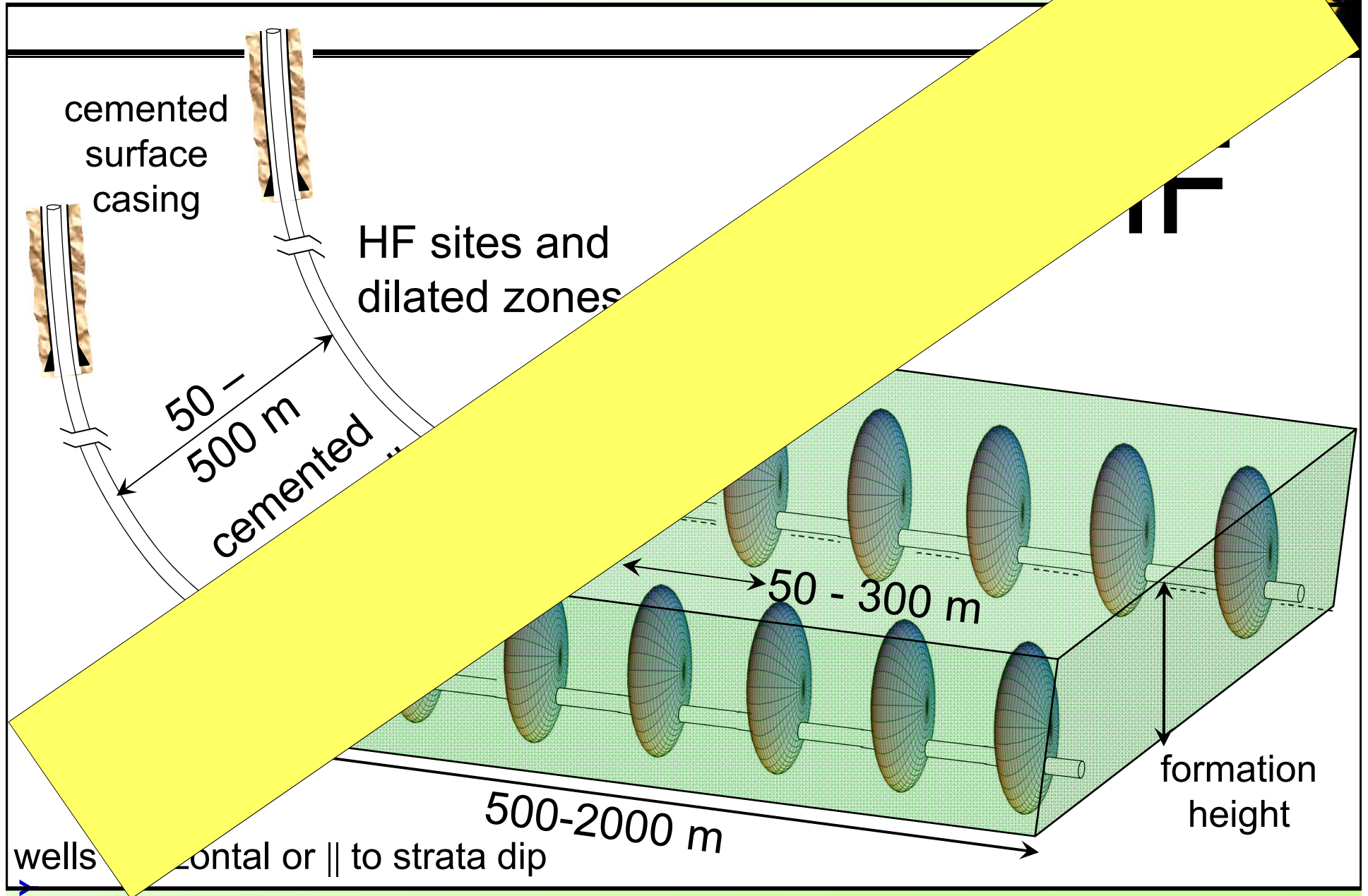
# US Crude Oil Imports Are Down...



orld

Your Ne

# Carefully Placed Horizontal Wells



# Hydraulic Fracturing – Oil & Gas

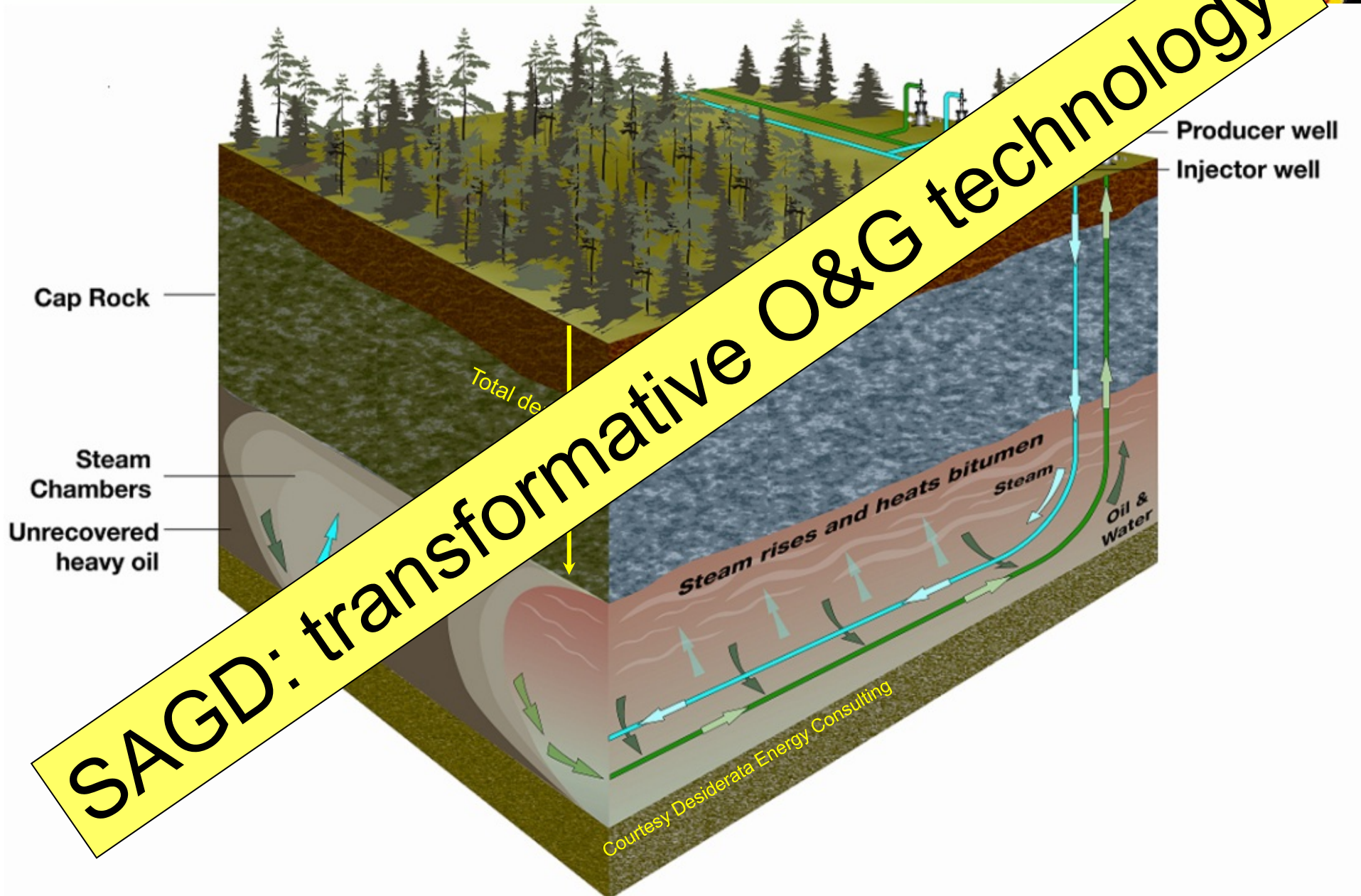


**MSHF: transformative O&G technology**

Your New Energy World

Courtesy BJ Services

# Steam-Assisted Gravity Drainage

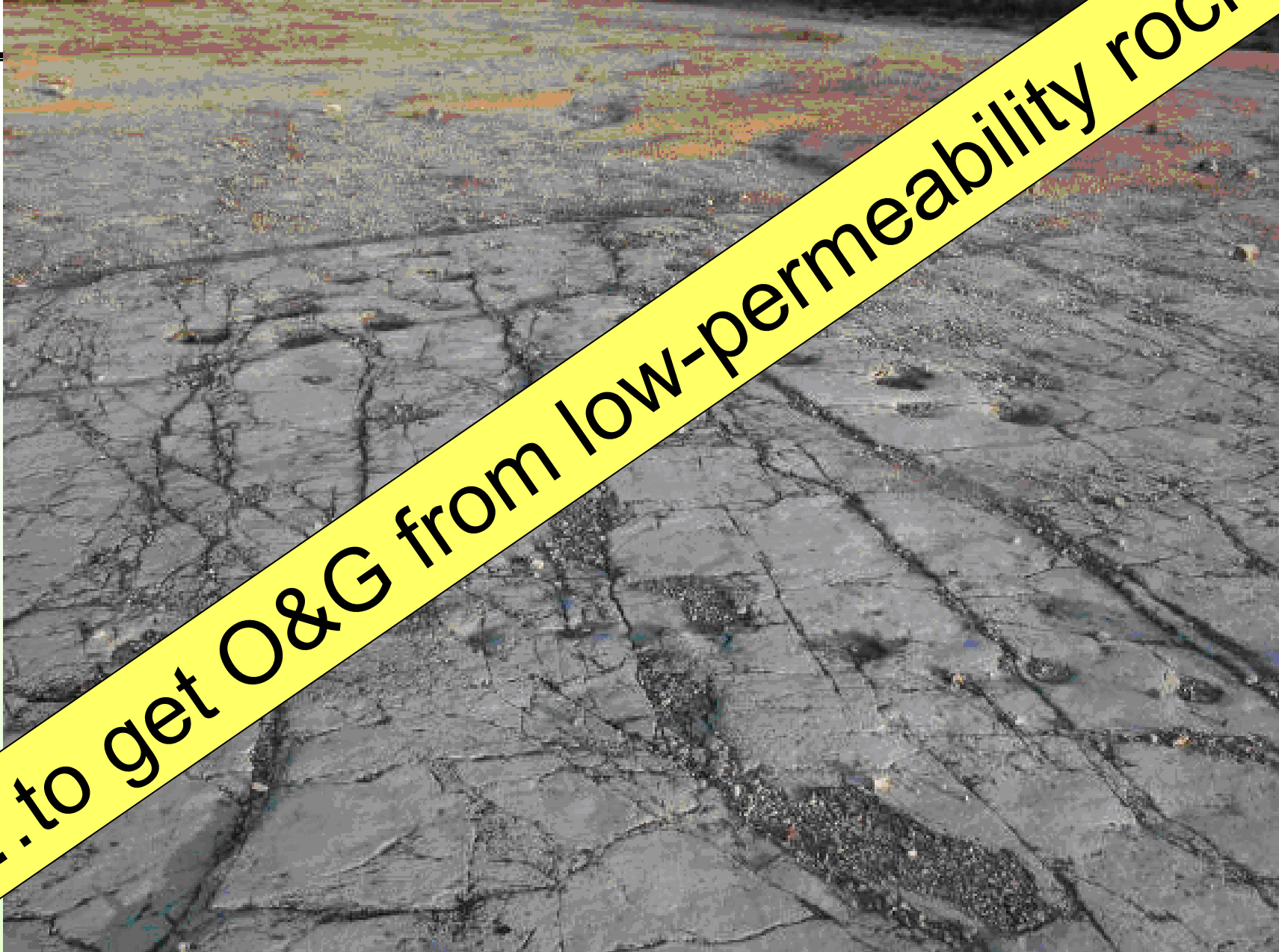


# Access to Low Permeability O & G

World

Your N

...to get O&G from low-permeability rocks

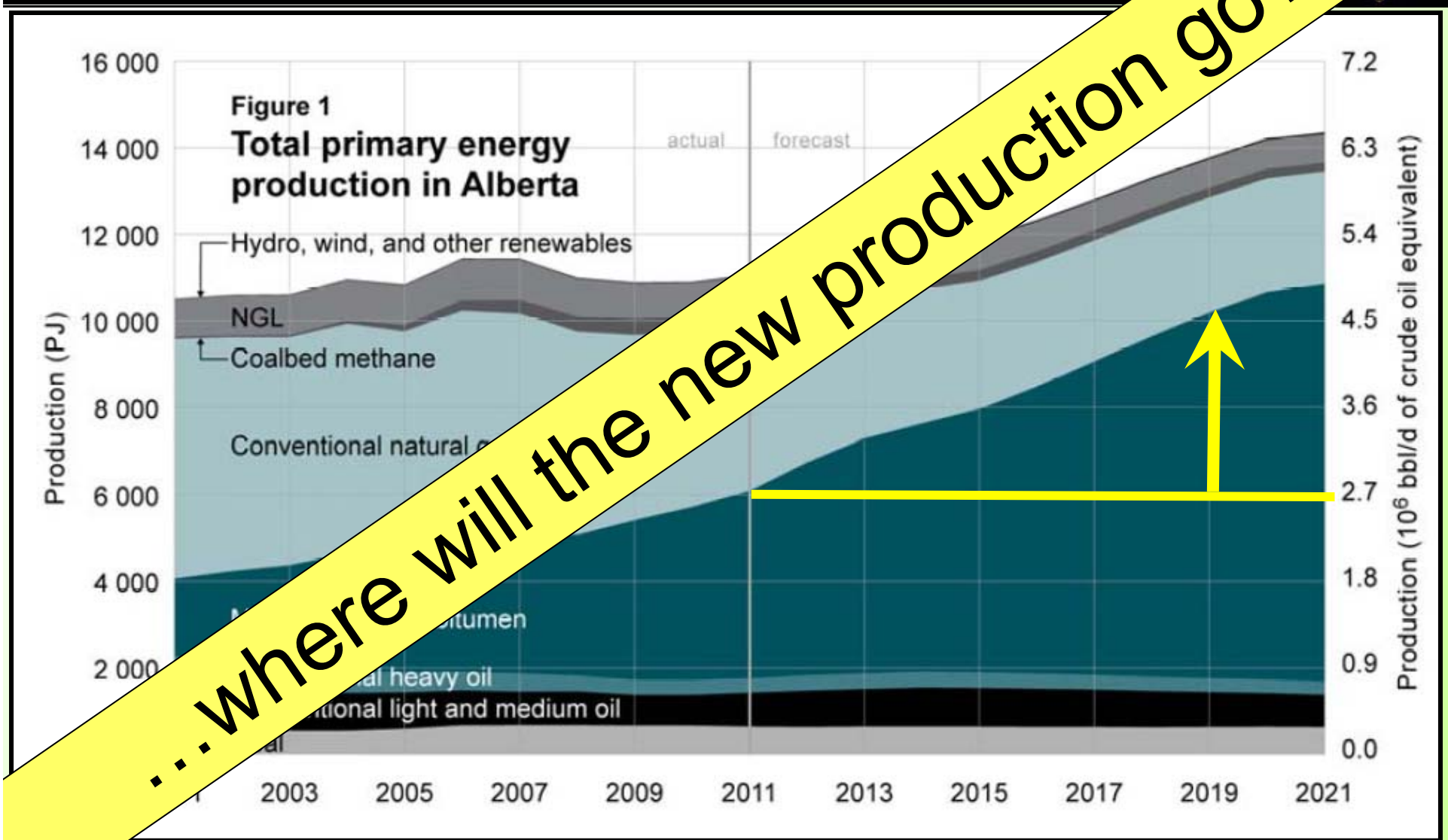


# SAGD Site, Alberta

Oil?



# Canadian Context – Alberta



## PIPELINES

### Natural Gas Pipelines

1 Canadian Mainline

Will Northern Gateway gain approval? +600,000 b/d

5 Foot Hills

6 Ventures LP

7 Bison

8 Tamazunchale

9 North Baja (38.2% effective ownership)

10 Tuscarora (38.2% effective ownership)

11 Northern Border (19.1% effective ownership)

12 Great Lakes (71.3% effective ownership)

13 Iroquois (44.5% ownership)

Keystone XL: +830,000 b/d  
Nebraska Gov. says OK. US Senators coax Pres. Obama. Nothing yet...

Doubling the Trans-Mountain Pipeline? +600,000 b/d

(proposed by TransCanada)

18 Mackenzie Gas Project  
(proposed by producers)

### Oil Pipeline

19 Keystone

20 Keystone U.S. Gulf Coast Expansion  
(in development)

### Natural Gas Storage

▲ AMT Natural Gas Storage



## PIPELINES

Natural Gas

TCPL see pipeline may

Let's examine the nature  
of our energy exports  
from the various  
Canadian Provinces

17

Alaska

(proposed)

may be reversed...

18

Mackenzie Gas Project

(proposed by producers)

### Oil Pipeline

19

Keystone

20

Keystone U.S. Gulf Coast Expansion

(in development)

### Natural Gas Storage

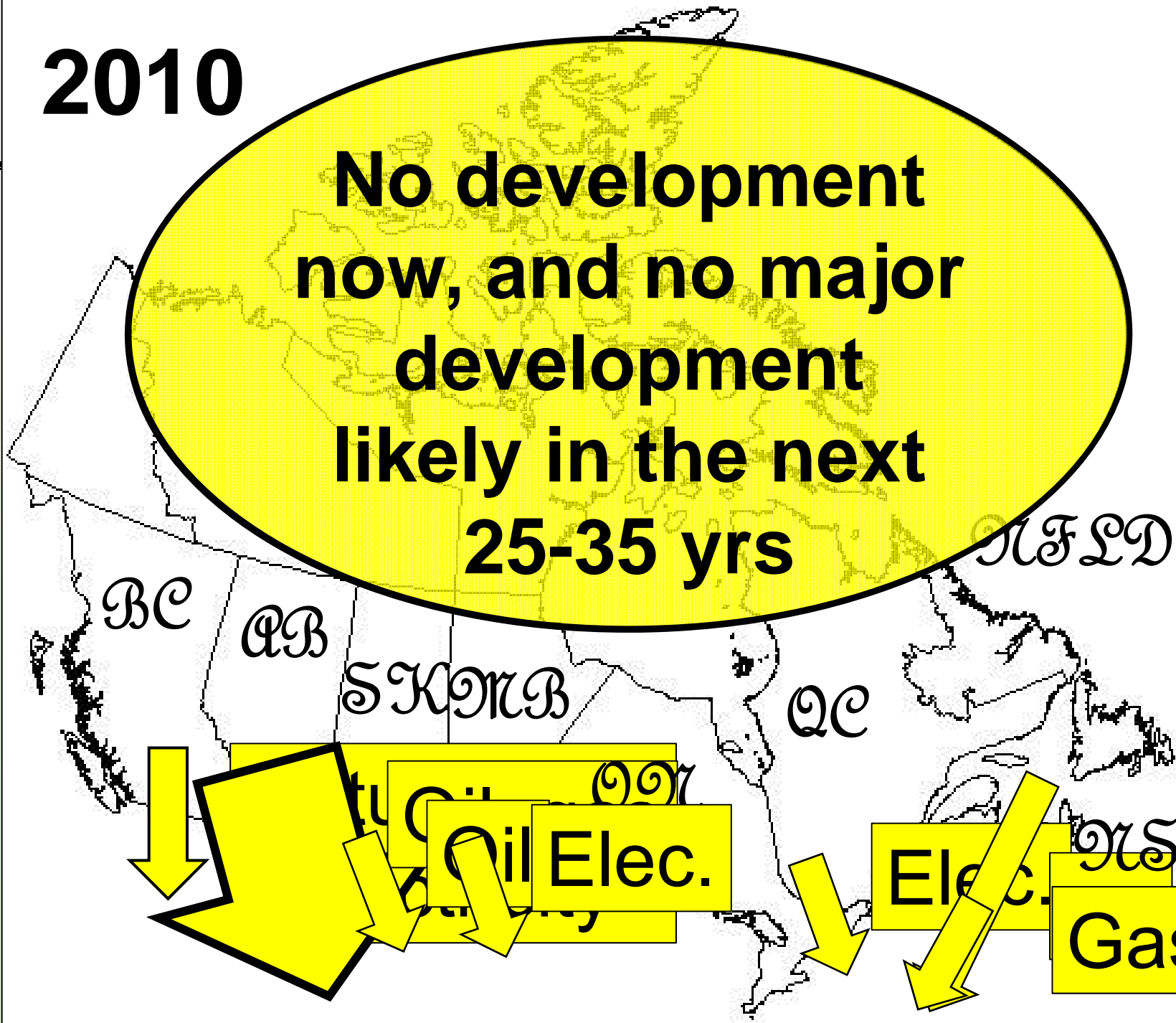


AMN Natural Gas Storage

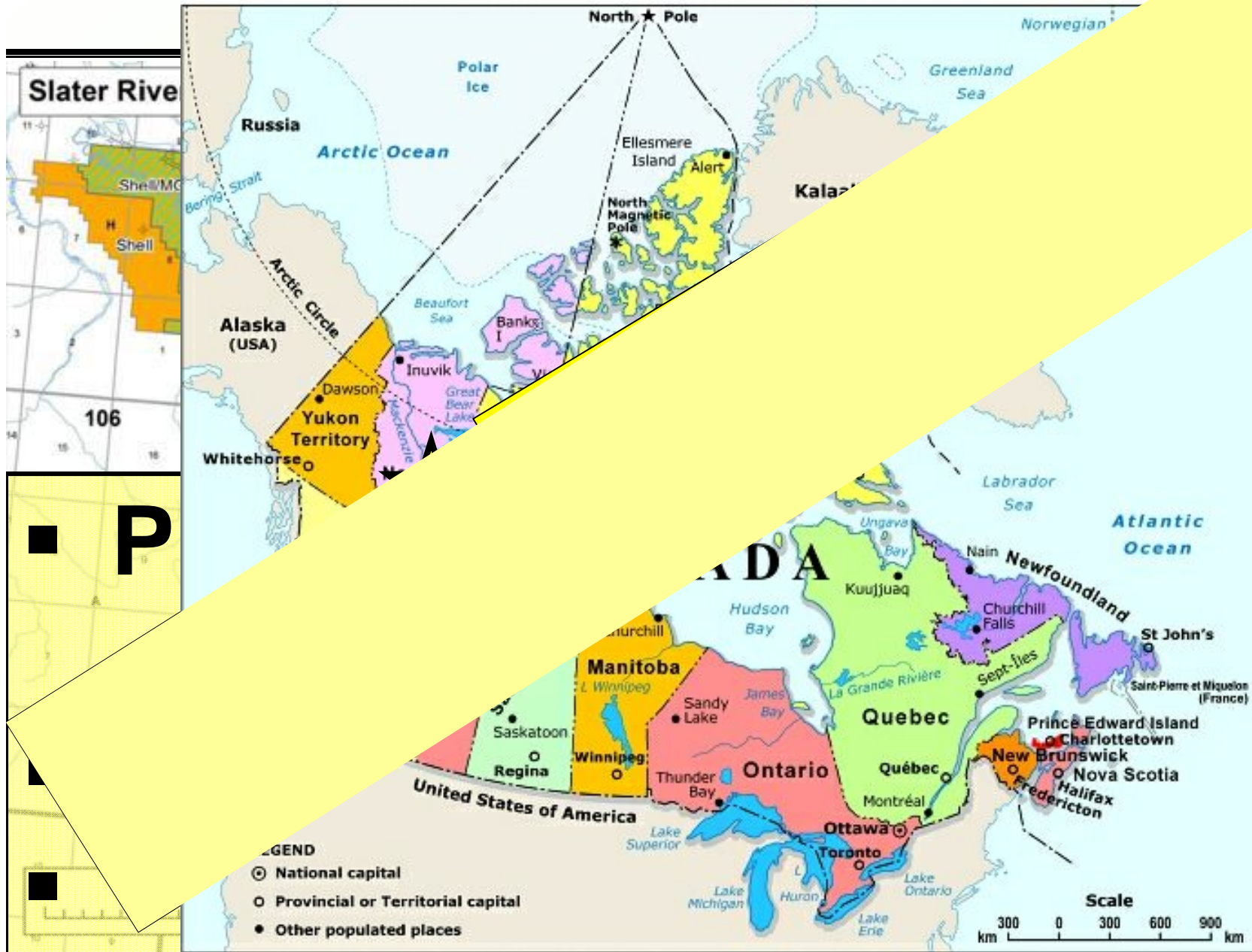
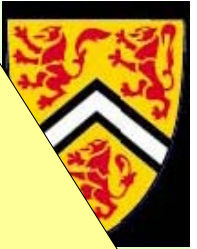


2010

No development  
now, and no major  
development  
likely in the next  
25-35 yrs



# The Canol River Shale Oil Play



Shale  
next  
y in  
a?  
a?

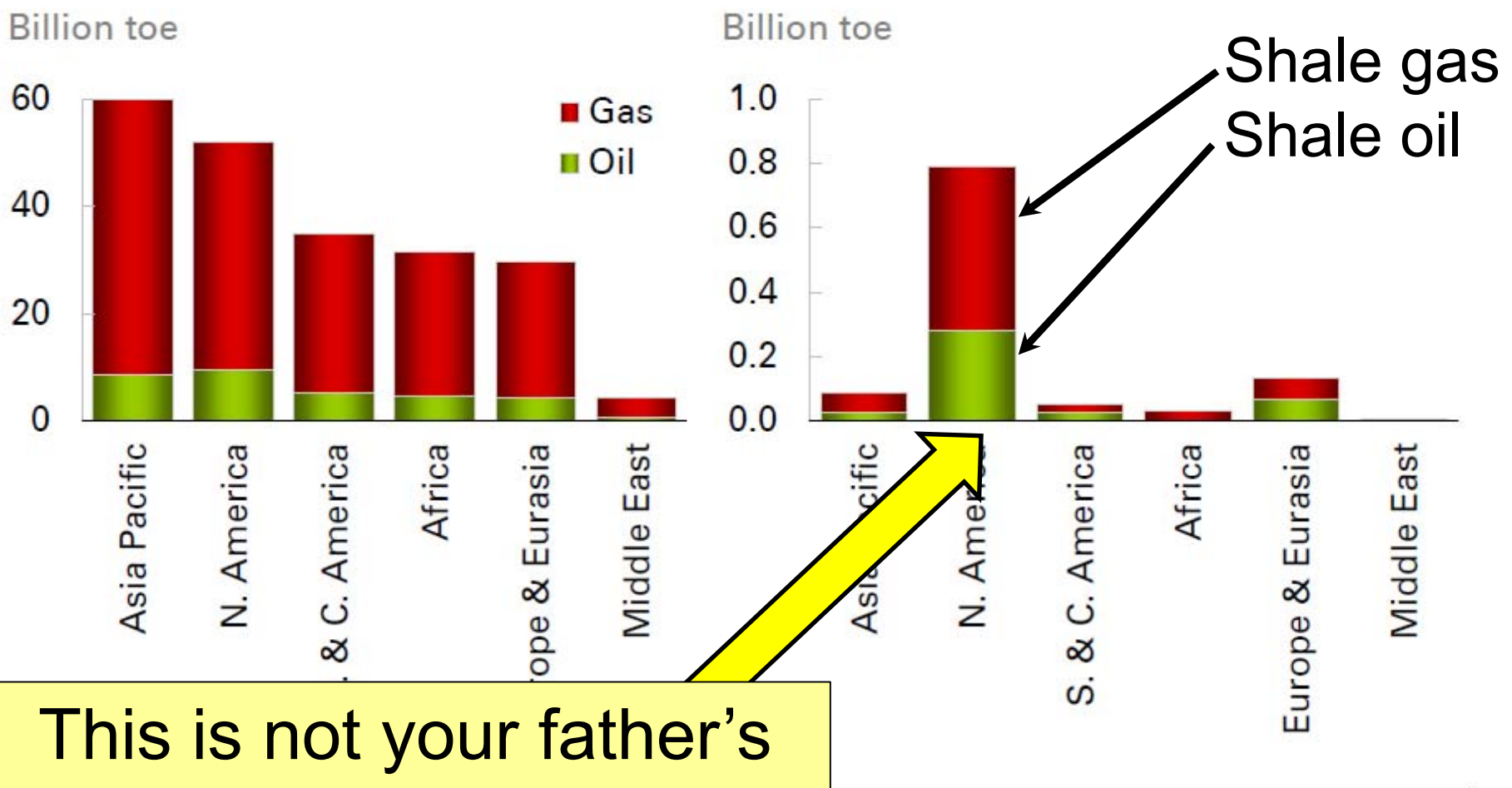
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# The North American Production Landscape is Changing...



Current resources

Production in 2030



This is not your father's oil industry anymore!

# Market Challenges



- ◆ Regionalization of energy markets
- ◆ Economy given priority over environment...
  - How many people switch to a higher cost source because they are environmentally conscious?
- ◆ Energy independence...
  - Development of shale gas and tight oil in the Williston Basin is leading to a loss of market
- ◆ ...and, electricity...!
  - Shift from coal to natural gas (BC, ON!)
  - Reduction of CO<sub>2</sub>, not because of environmental concern, but because CH<sub>4</sub> is cheaper than coal!

# Let's Look at BC...



- ◆ Small oil production potential
- ◆ Huge potential from shale gas
  - Horn River
  - Montney Formation
  - Cordoba Embayment
  - Bowser Basin
  - Extensions into Yukon
- ◆ First LNG exports possible by 2017
- ◆ Has BC won the Lottery?

## *World's Largest Frac Job*

- **Currently, there are no BC gas exports except to USA (WA, OR, CA)**
- **LNG to Japan, S Korea, 4-5 years**
- **Currently, \$13-15 MMBtu is the price!**
- **But, liquefaction and regasification cost about \$3.50 per MMBtu**
- **What will the price be in 2017-18?**
- **Qatar, Australia, Indonesia, Trinidad...  
There are many competitors lurking...**
- **Will gas be so lucrative in 2017-18?**
- **Good luck to British Columbia...**

# Impact on BC



- ◆ Massive LNG exports eventually
  - 4 LNG terminals planned (Kitimat area)
  - AB wants to tie in to some of the export market
- ◆ BC still will supply some natural gas to WA, OR, CA
- ◆ BC Hydro's high priced exports of electrical power to the US will be threatened...
- ◆ US states can produce cheaper electrical energy from their own shale gas supplies
- ◆ So, BC electricity export prices must drop

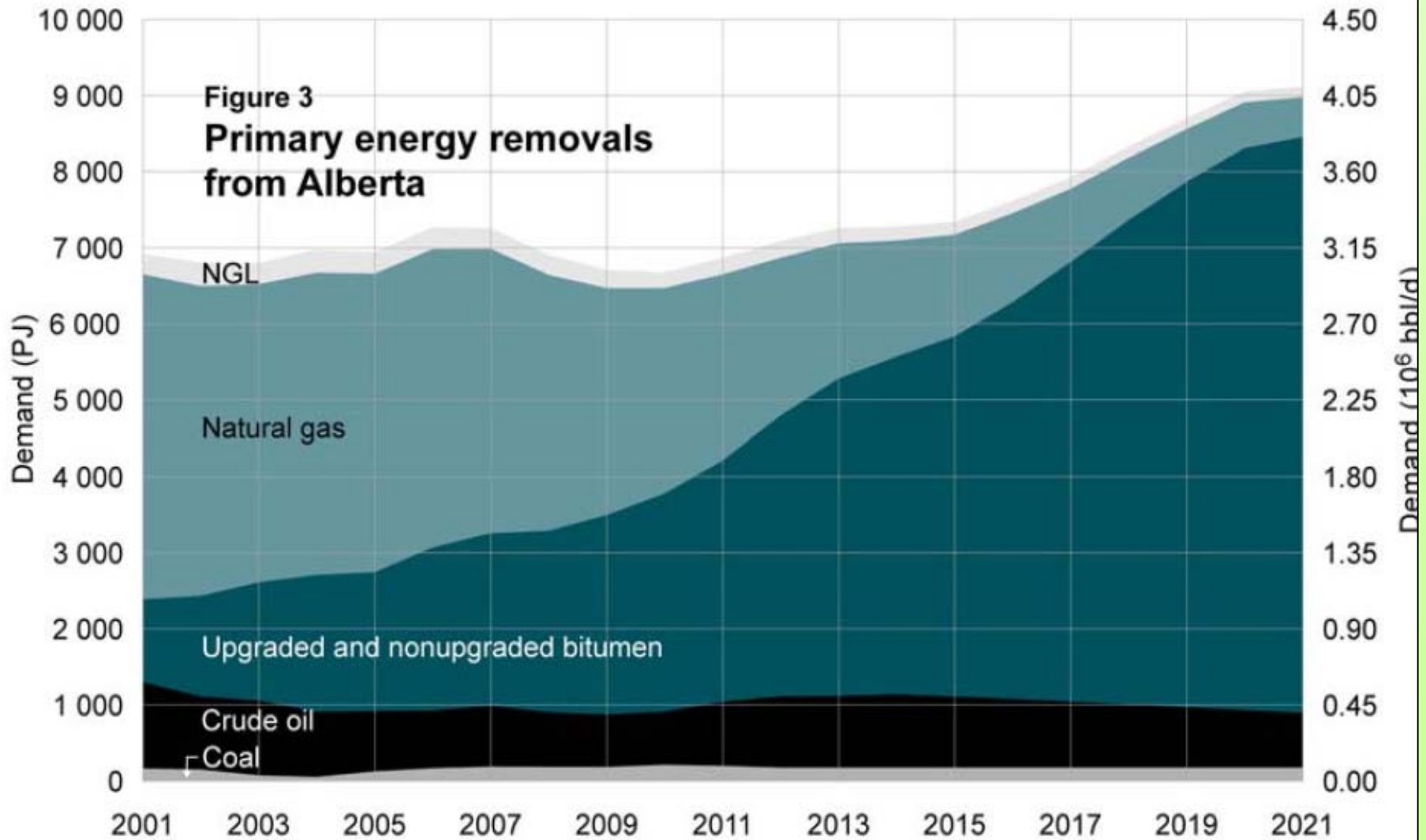


# Effect on Alberta

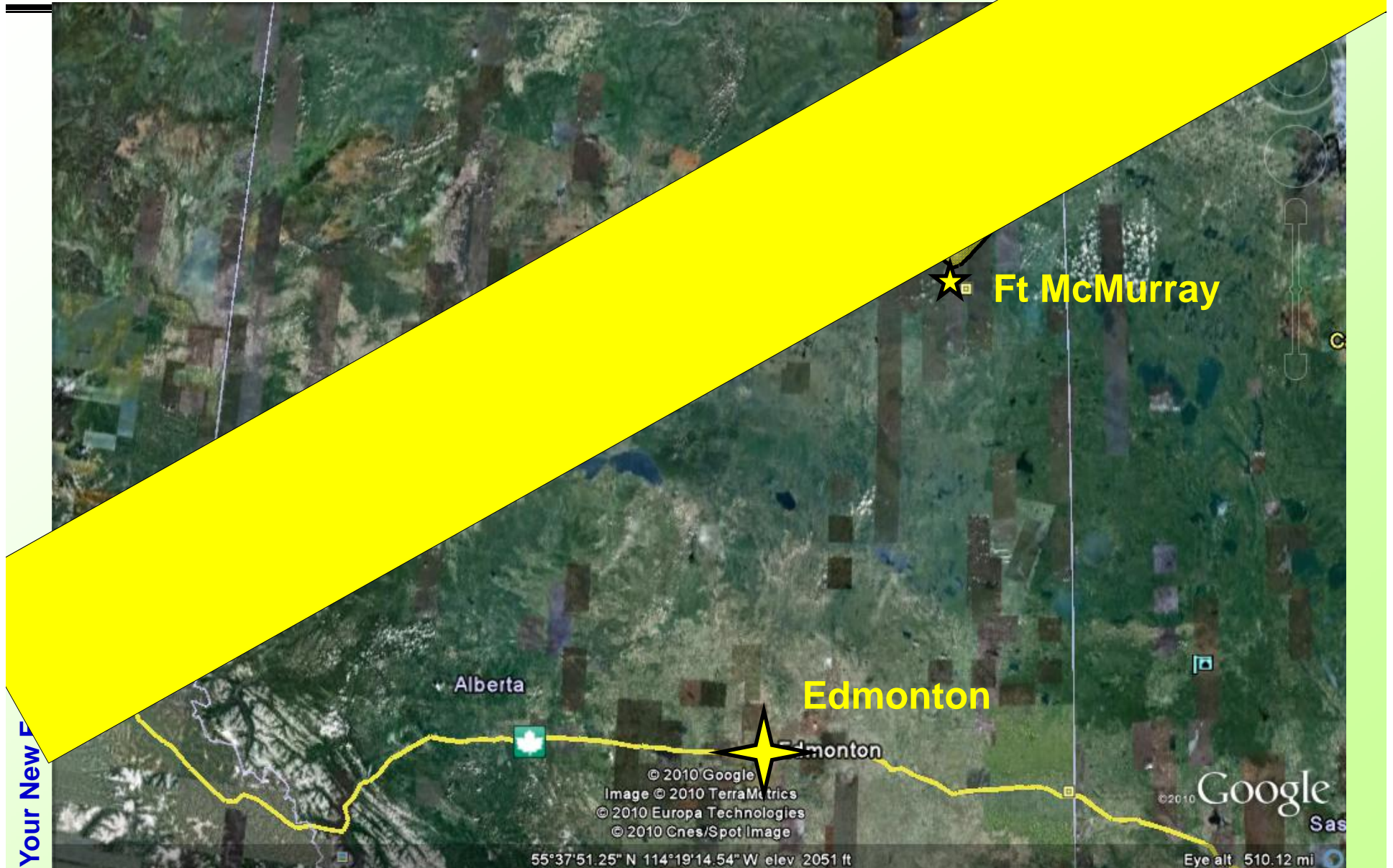


- ◆ Oil exports will slowly grow
- ◆ Keystone is likely to go ahead, but even if it does not...
  - Other pathways exist for some shipping increase
  - Oil exports to eastern Canada can grow
  - Perhaps oil will get to the West Coast...
- ◆ Gas exports to USA will disappear...
  - US gas displaces Alberta gas, for a long time...
  - Gas shipping to eastern Canada?? No longer...
  - Leaving only the West Coast as an export option

# Energy Exports from Alberta



# Alberta's Oil Sand Mining Area



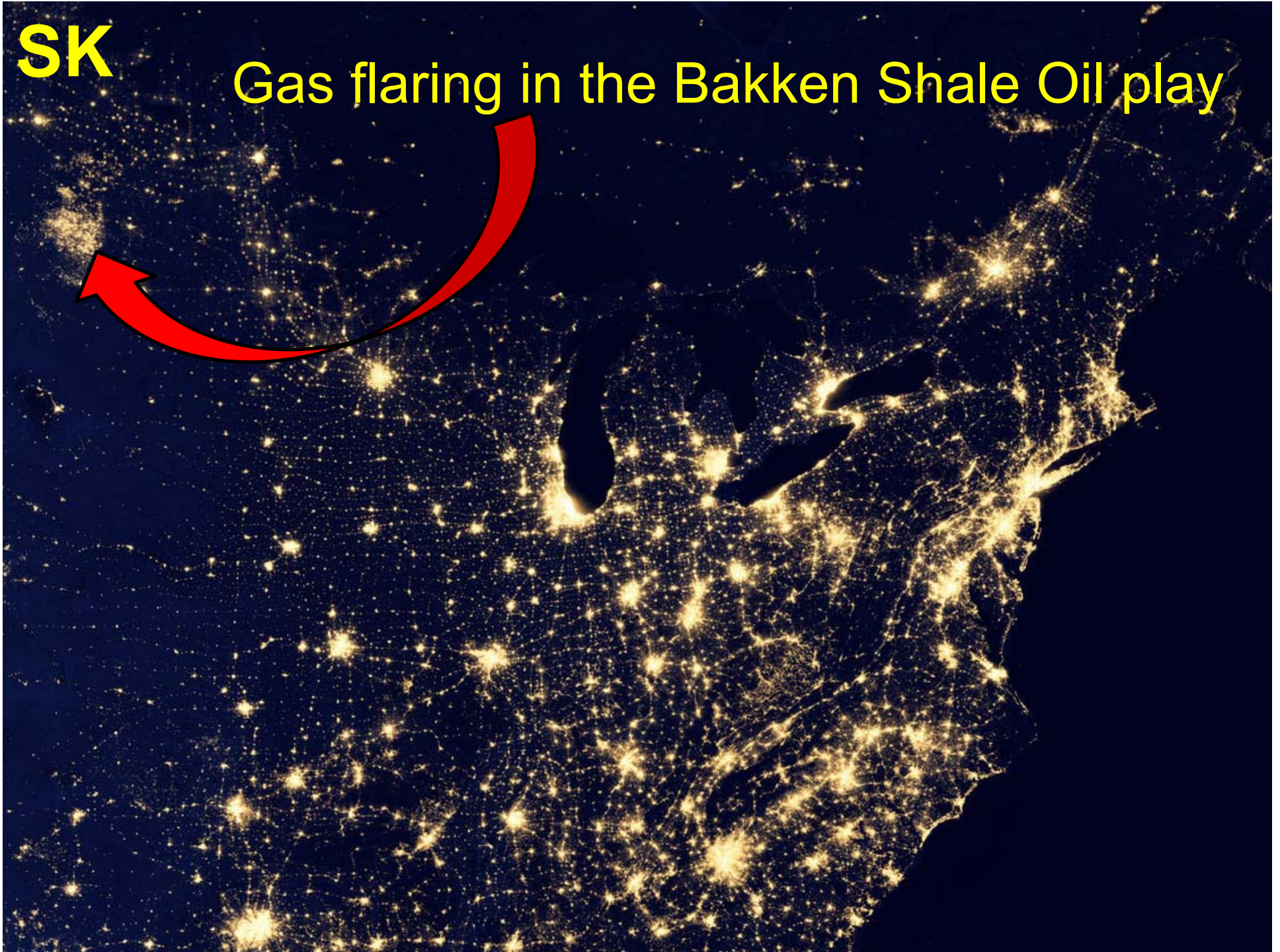
# Saskatchewan?



- ◆ Exports heavy oil and SCO from heavy oil to the USA Midwest only
- ◆ SK is being affected by Bakken shale oil
  - Pipeline capacity shifting to Bakken light oil
  - Heavy oil exports are stable, for now, as long as the price is far less than Bakken light oil...
- ◆ Overall, the impact on SK is going to be minor
  - South SK Bakken development going ahead
  - Heavy oil exports to USA will be stable

**SK**

# Gas flaring in the Bakken Shale Oil play

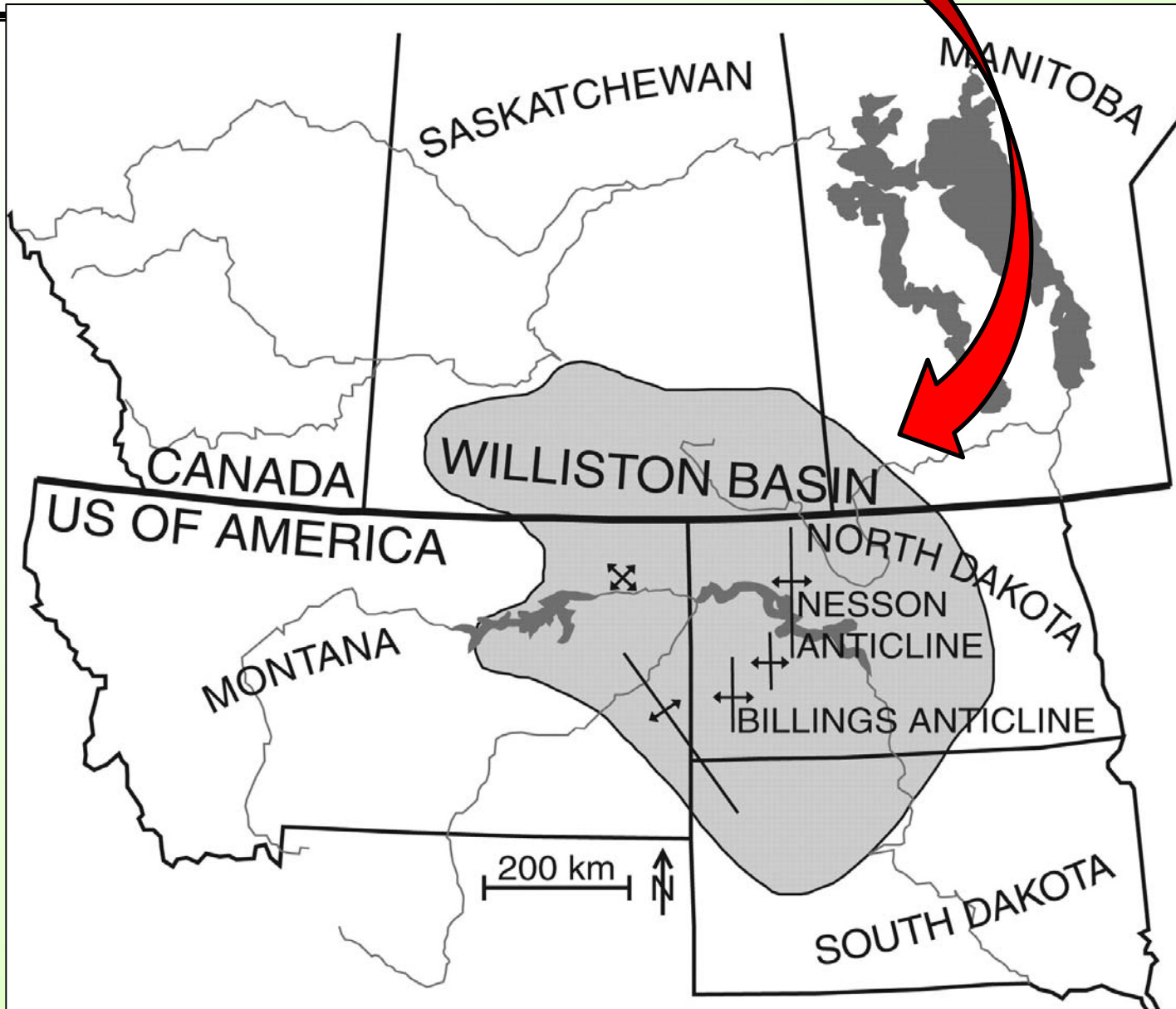


# Manitoba?



- ◆ Oil and gas imports continue from AB & SK
- ◆ Manitoba sells a lot of hydro power to the USA – Dakotas, Minnesota...
- ◆ Now, natural gas power generation in USA is cheaper than Manitoba power, so...
- ◆ Manitoba Hydro will have to reduce its prices to stay competitive.
- ◆ So, Manitoba will feel the effects of the shale gas revolution, not the shale oil effect

# Manitoba was Left Out!



# Ontario?



- ◆ Largest gas and oil user in Canada...
- ◆ Oil shipments will come almost exclusively from western Canada
- ◆ ...but, gas will come mostly from the USA within 5-8 yrs
- ◆ TCPL will no longer be needed
- ◆ ...and, hydro will come from gas-fired power plants, much cheaper than nuclear...
- ◆ So, no more nuclear plants in our lifetimes!
- ◆ Cheap shale gas is a boost for Ontario



# US Shale Gas Is Good for Ontario...



More NG-fired power plants will be built



# Quebec?



- ◆ Oil is imported from Africa, Middle East...
- ◆ Gas mainly from Western Canada...
- ◆ In the most likely future...
  - Oil pipeline extension to QC brings cheaper AB & SK oil to QC, refineries altered, expanded
  - Rebirth of a refining industry, based on the need for products on the USA east coast
  - Shipment point for crude overseas
- ◆ Electricity price is already dropping (SG)
- ◆ What about the current SG moratorium?

...a Prediction...



Quebec  
drop the  
moratorium  
on SG  
development  
within  
a month



New Brunswick? PEI?



Irving refinery in NB



# Some comments on Refineries, Arbitrage

Prices in January of 2013

- 5 Foothills
- 6 Ventures LP
- 7 Bison
- 8 Tamazunchale
- 9 North Baja (38.2% effective ownership)
- 10 Tuscarora (38.2% effective ownership)
- 11 Northern Border (19.1% effective ownership)
- 12 Great Lakes (71.3% effective ownership)
- 13 Iroquois (44.5% ownership)

Refineries are finely tuned systems

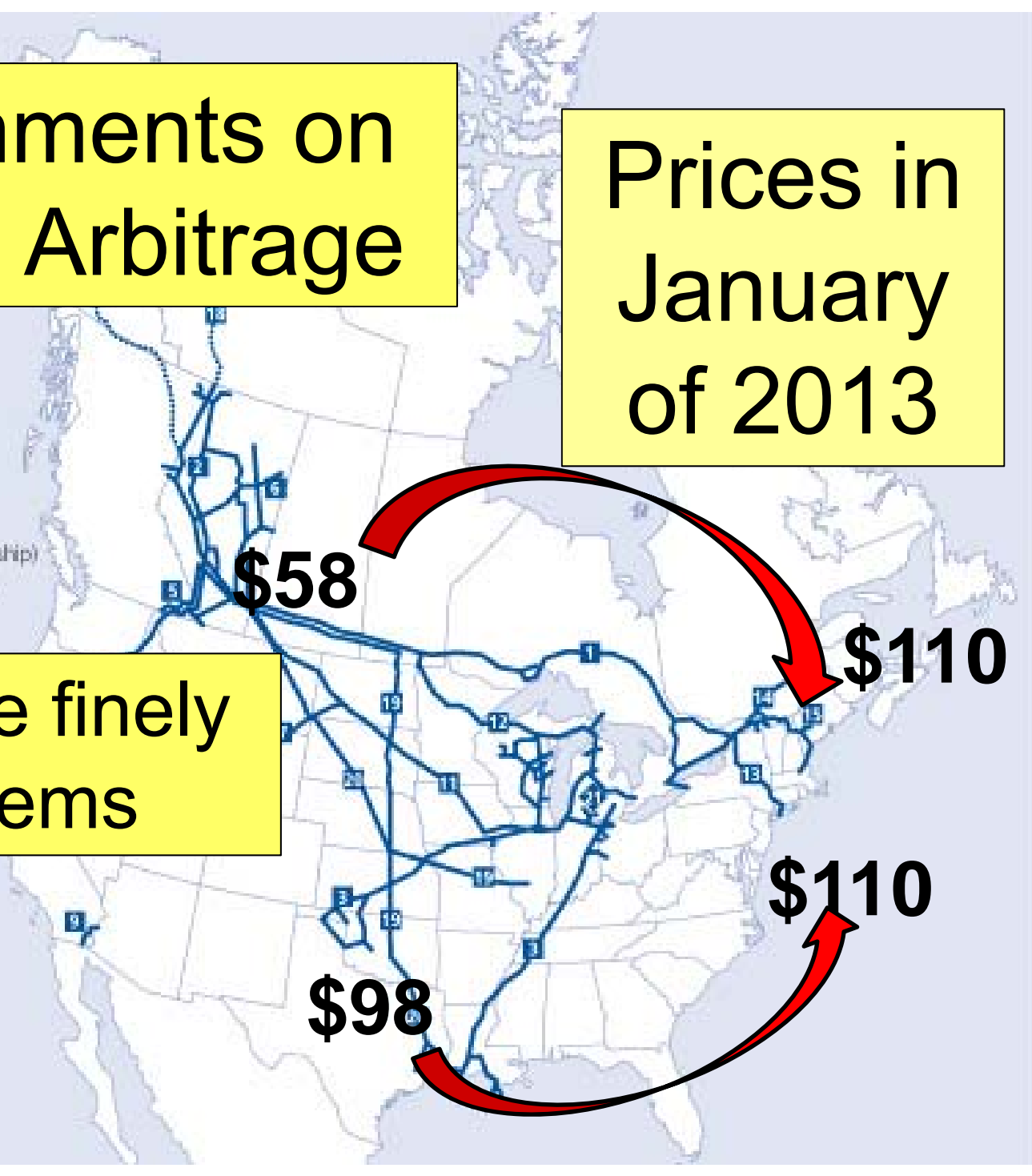
(proposed by producers)

## Oil Pipeline

- 19 Keystone
- 20 Keystone U.S. Gulf Coast Expansion (in development)

## Natural Gas Storage

▲ WWS Natural Gas Storage



# Nova Scotia?



- ◆ Natural gas has been the foundation of the NS offshore E&P activity
- ◆ Cheap SG in the USA means...
  - Likely, no more offshore gas development
  - Existing assets will continue producing to depletion (10-15 years)
  - Only if gas prices rise again will activity start
- ◆ Cheaper electricity from SG generation
- ◆ Other types of power plants will not be built



# Newfoundland and Labrador?

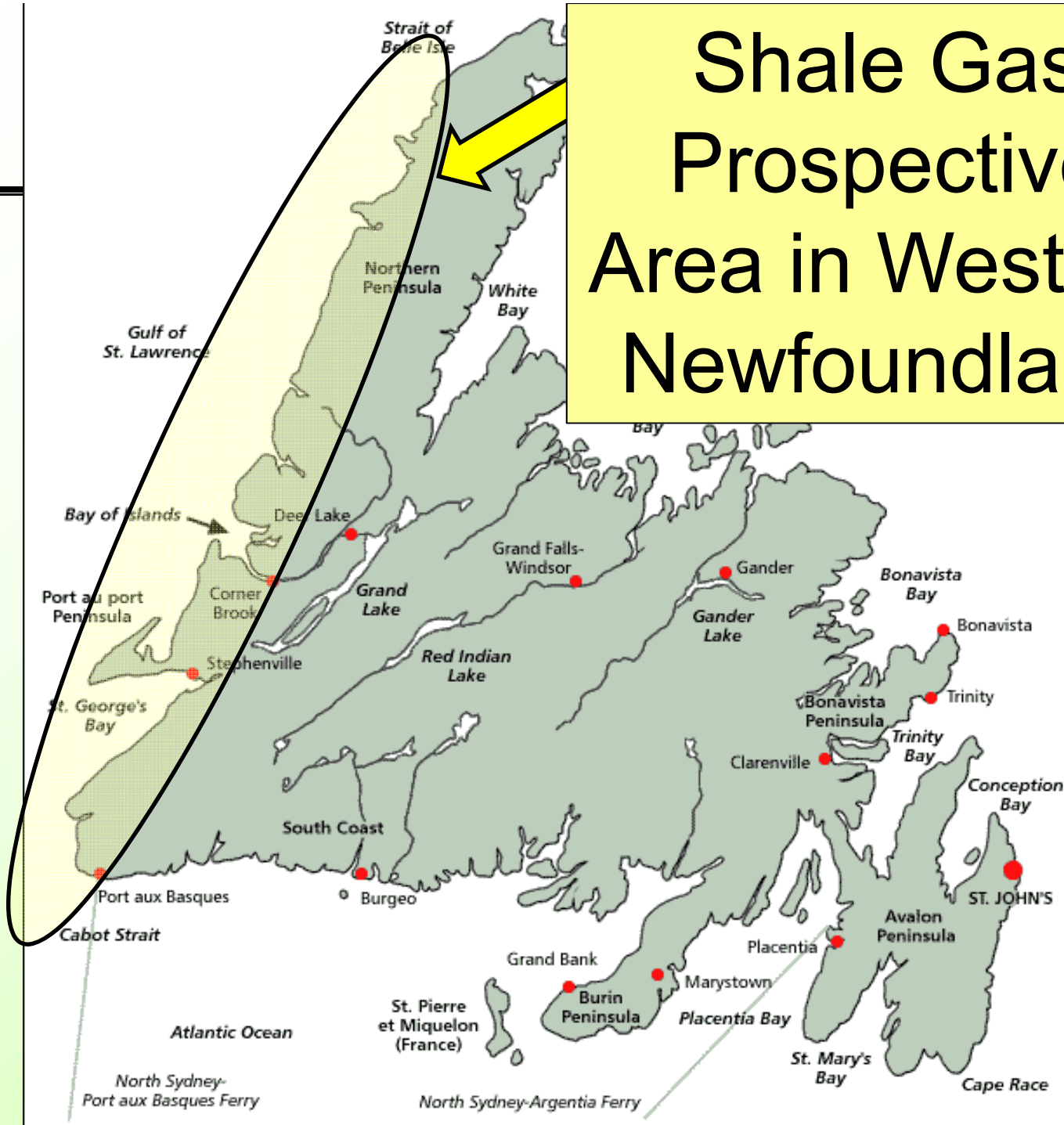


- ◆ Now... SG exploration on NFLD west coast
- ◆ Oil development off-shore will continue
- ◆ But!
  - SG means low electricity price in the USA
  - This puts a barrier to electricity development in Labrador with sub-sea transmission lines to NS
  - Low gas price means no offshore development of the large-scale gas known off Labrador





# Shale Gas Prospective Area in Western Newfoundland



2035

A personal prediction

By 2035, ~5 to 6 MMBOD in Canada

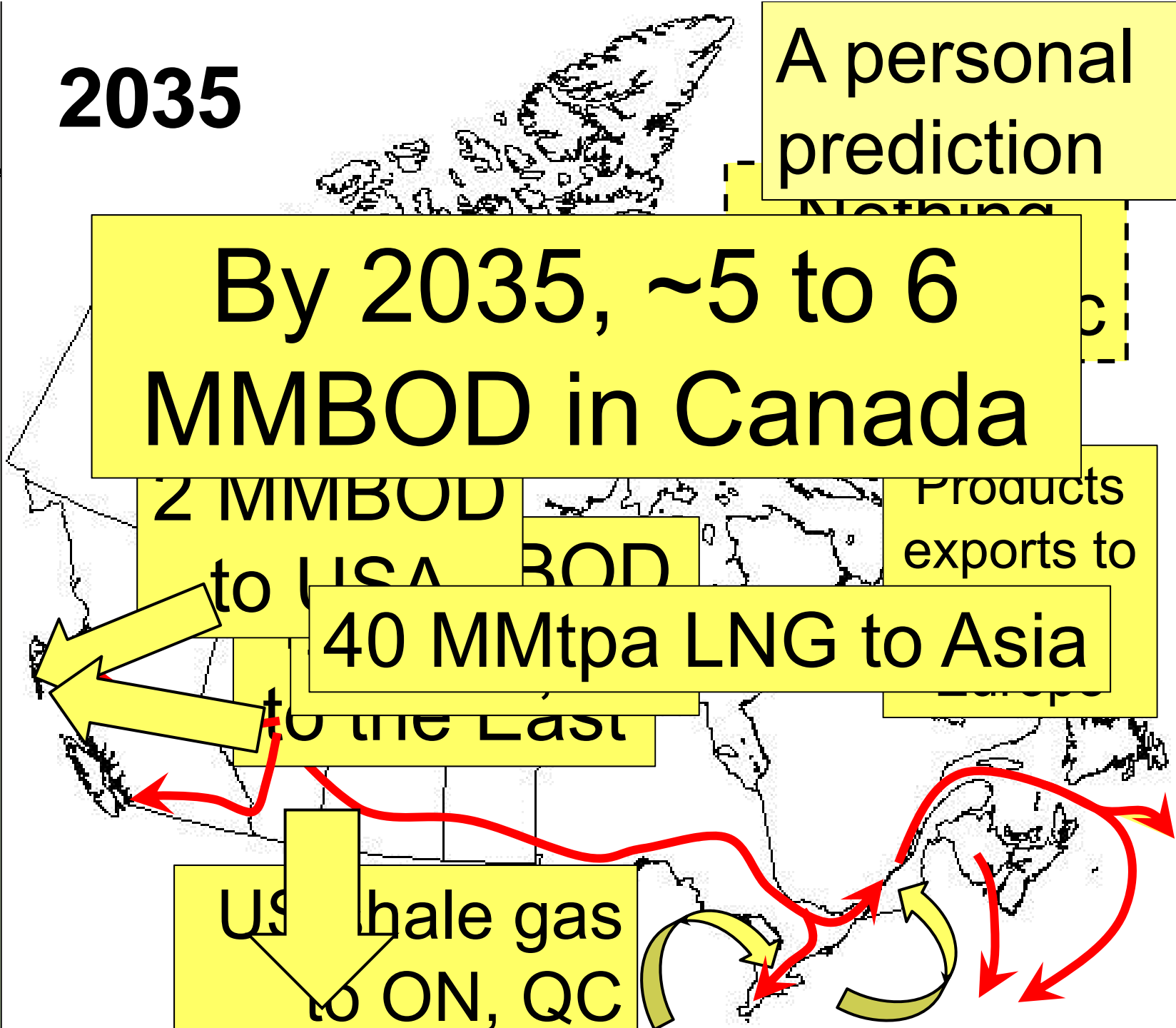
2 MMBOD

to USA

Products exports to

40 MMtpa LNG to Asia

US shale gas to ON, QC



# Overall Canadian Energy Future...



- ◆ Energy exports to the USA are dropping (gas) or decreasing in value (electricity).
- ◆ Oil exports to the US will continue and rise slowly as long as Canadian oil is cheaper
- ◆ Lower oil prices 2-4 years out are likely
- ◆ Canada's economy will be affected
- ◆ Your Energy World is Changing - Rapidly
- ◆ **...and, be careful in making predictions!**

# Acknowledgements



- ◆ WISE - Waterloo Institute for Sustainable Energy
- ◆ University of Waterloo, Faculty of Science
- ◆ The Government of Canada
- ◆ Friends and colleagues