A Closer Look at Shale Development Economics*

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Outline of Presentation

Range in basin economics

Production
- Well spacing
- Phased development stages
- Technology application
- Production constraints

Costs
- Learning curve
- Economies of scale

Price
- Price scenarios
- Project resilience

Selected Reference

Bernstein, P.L., 1998, Against the Gods: The Remarkable Story of Risk: John Wiley and Sons, 383 p.

American Association of Petroleum Geologists

Shale Plays: An Integrated Approach for Enhanced Exploration, Development and Valuation

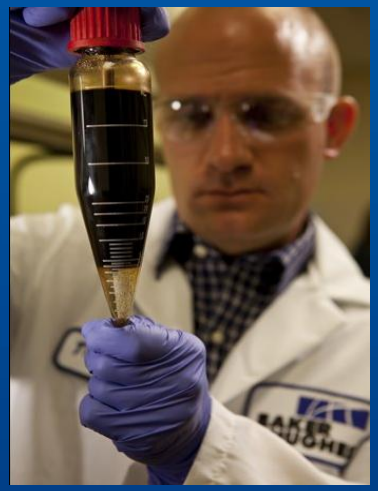
A Closer Look at Shale Development Economics

Florent Rousset – Gaffney, Cline & Associates (GCA)

Houston – November 13, 2012

Gaffney, Cline & Associates 50 1962-2012 YEARS OF EXCELLENCE

Gaffney, Cline & Associates (GCA)



Upstream	Midstream	Downstream	Commercial
Geophysics	Pipeline	Chemical	Economics
Geology	Process	Power	Finance
Petrophysics	Operations	Marketing	Law
Reservoir			Strategy
Production			Regulatory

... averaging around 20 years of experience

Supporting the Oil and Gas Industry since 1962

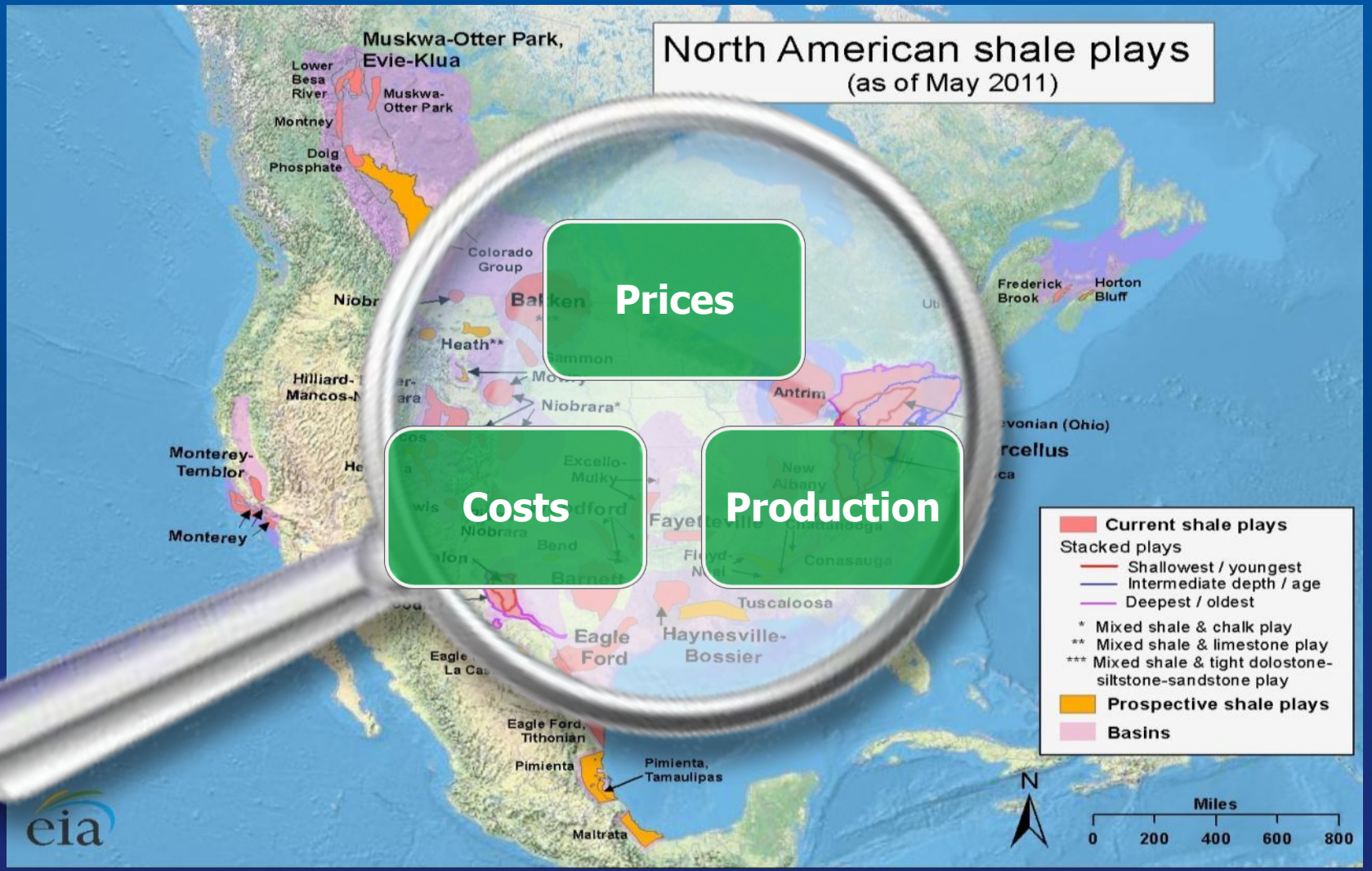
Oil & Gas Companies

Sovereigns

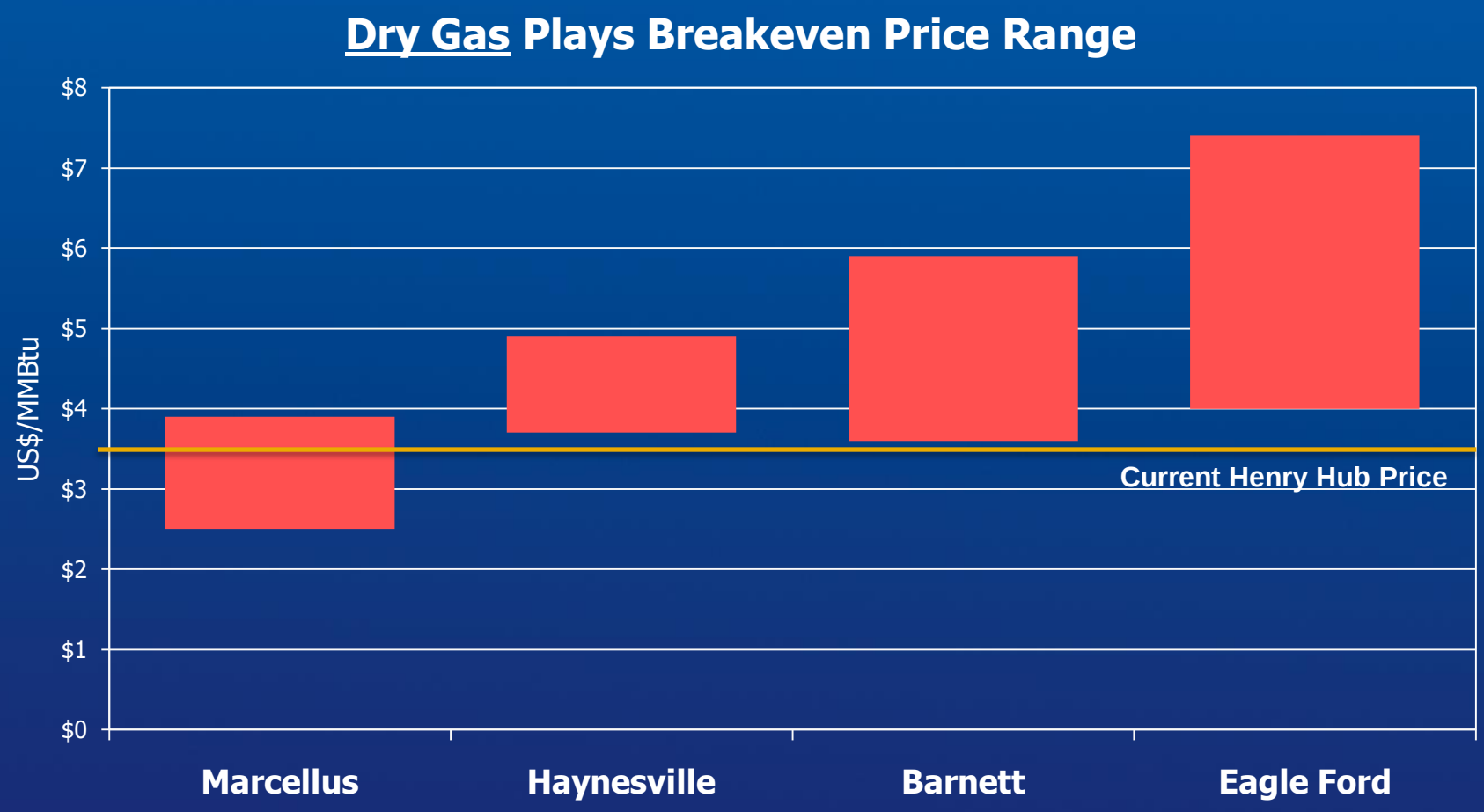
Financial Institutions

Non-exhaustive

Shale Development Economics



Basin Economics Range



Note: 10% after tax rate of return
Source: Tudor, Pickering, Holt & Co.; Barclays (2012)

PRODUCTION

Well Spacing Drivers

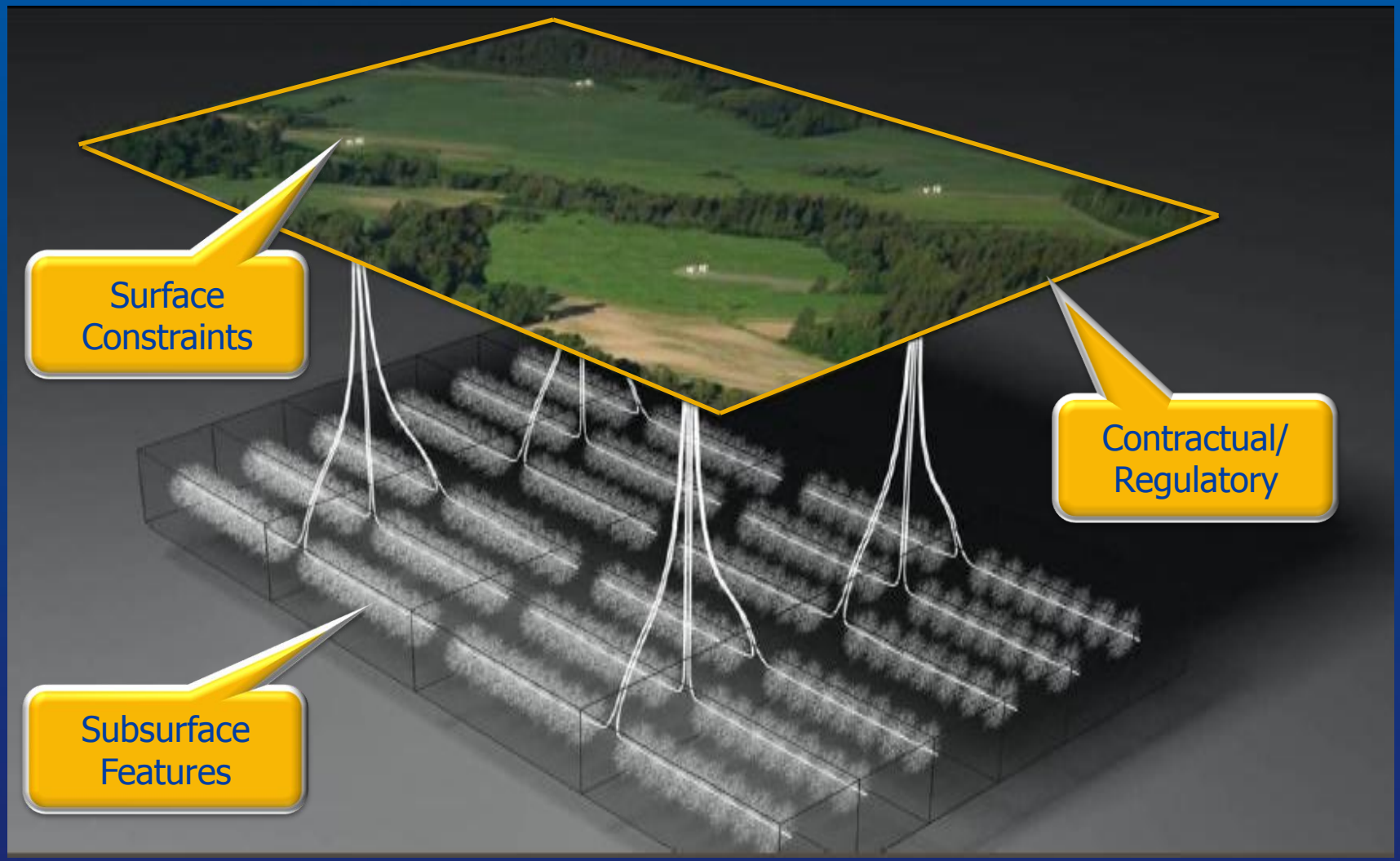


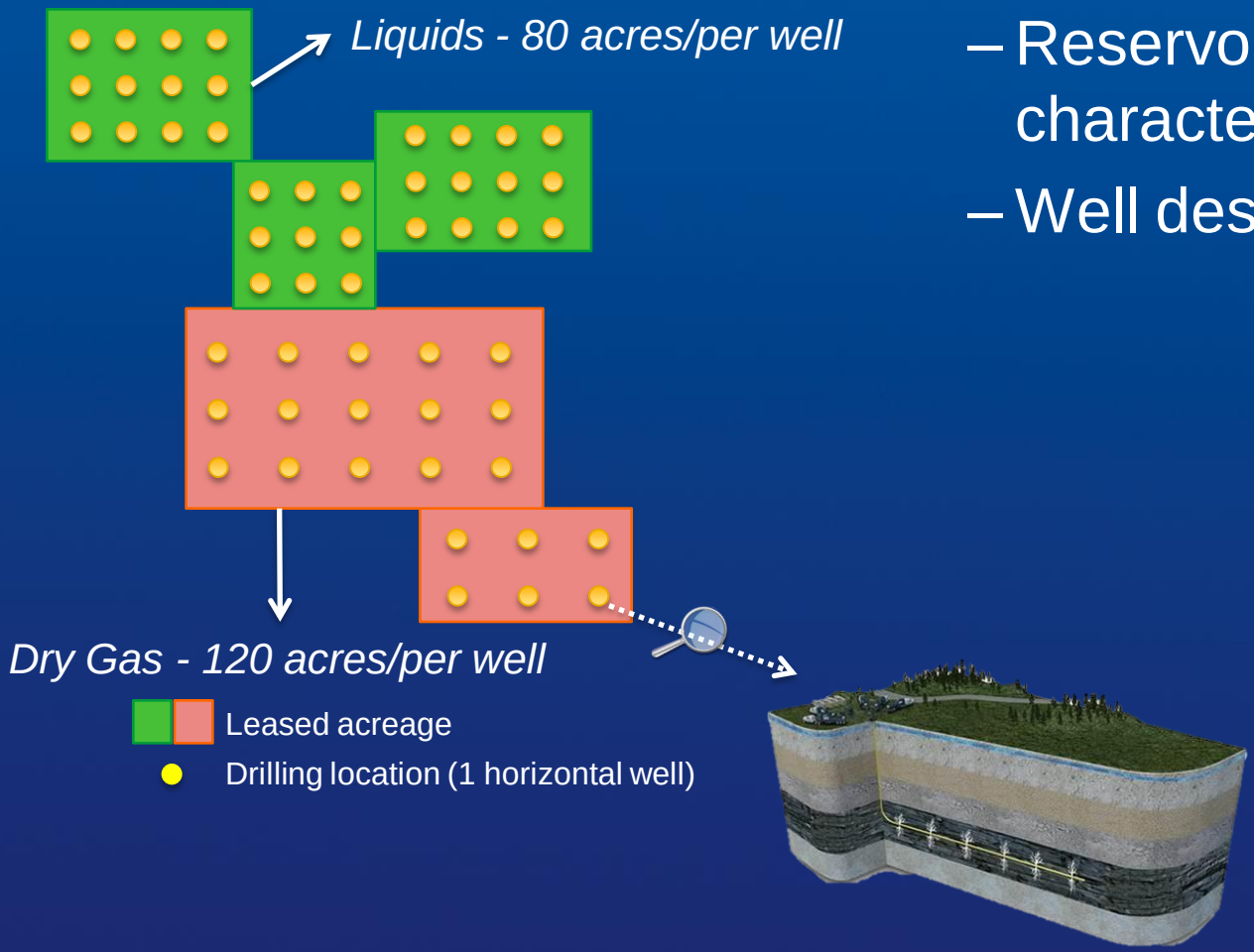
Image source: Statoil

Well Spacing

ILLUSTRATIVE

Prod.

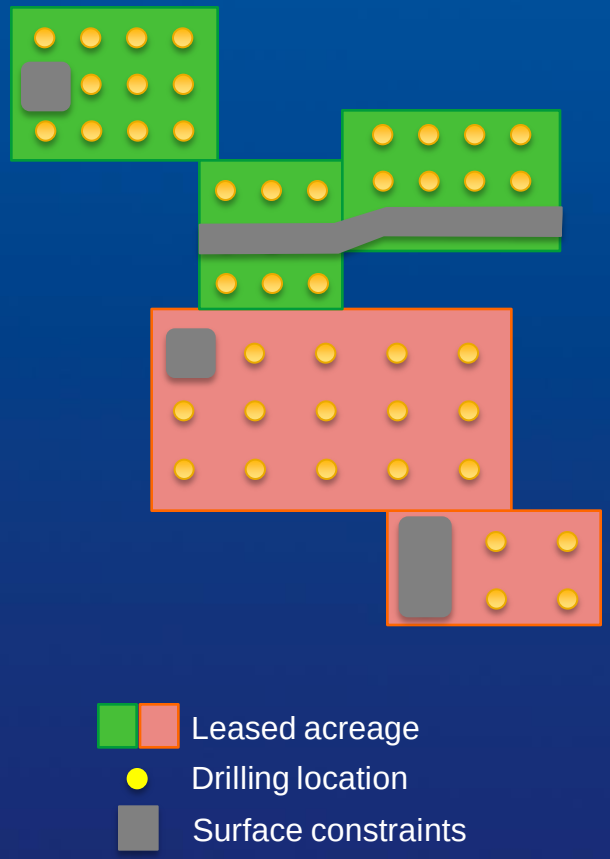
- Subsurface / Drainage
  - Reservoir characteristics
  - Well design



Note: not to scale

Well Spacing

ILLUSTRATIVE

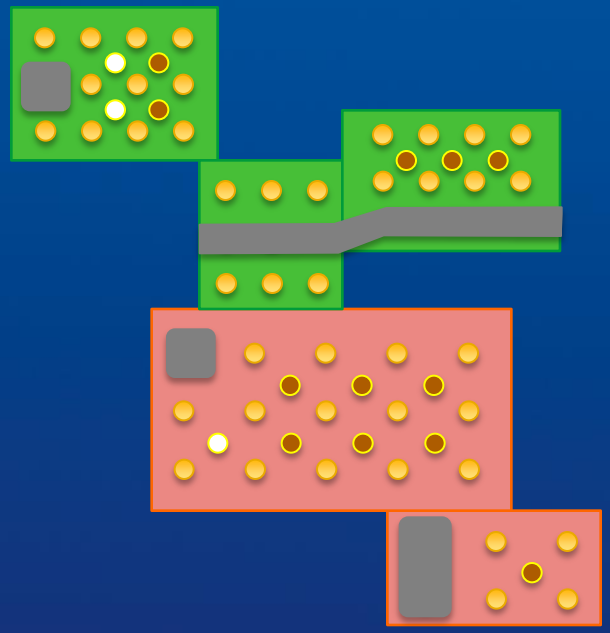


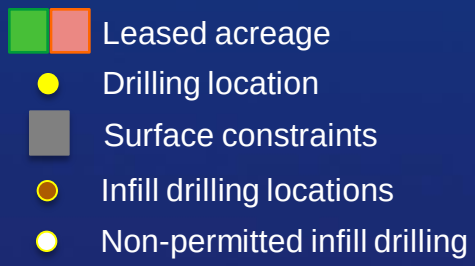
- Subsurface / Drainage
  - Reservoir characteristics
  - Well design
- Infrastructure & Access
  - Houses & roads
  - Topography
  - Offtake facilities

Note: not to scale

Well Spacing

ILLUSTRATIVE





- Subsurface / Drainage
  - Reservoir characteristics
  - Well design
- Infrastructure & Access
  - Houses & roads
  - Topography
  - Offtake facilities
- Contractual / Regulatory
  - Infill drilling permits
  - Contractual constraints

Note: not to scale

Phased Development Stages

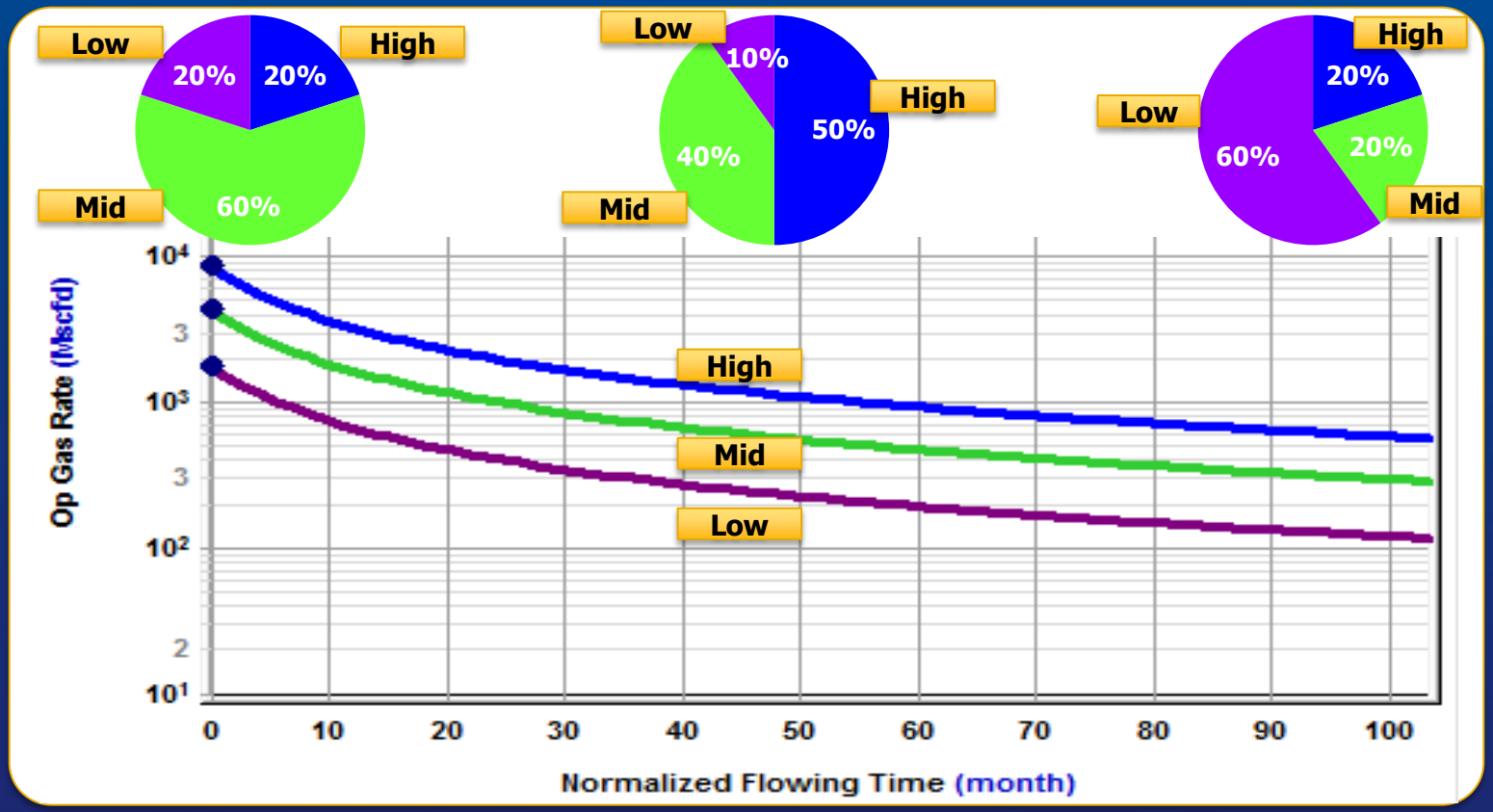
Prod.

ILLUSTRATIVE

Exploration & Appraisal

"Core Areas" Development

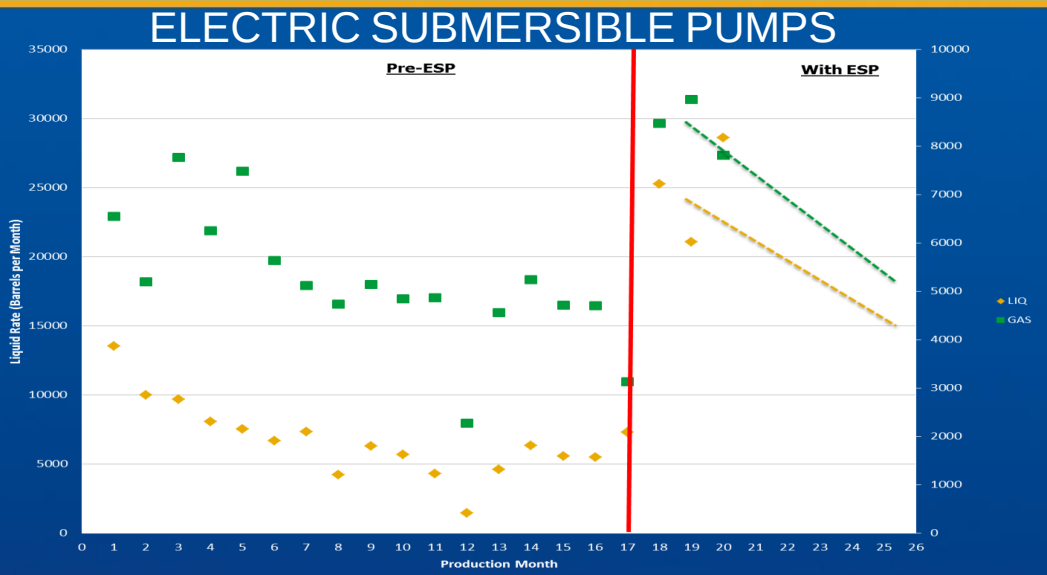
Later Project Life

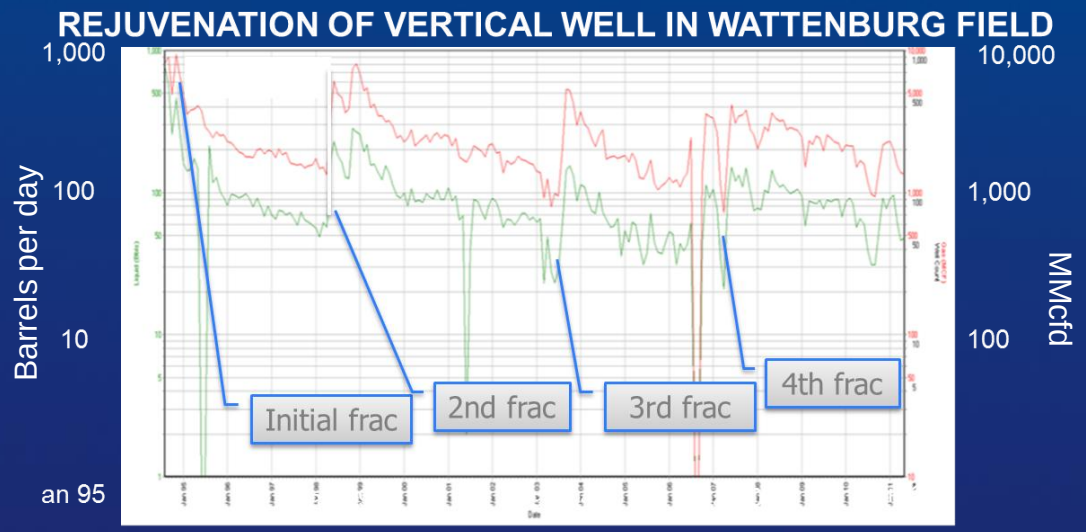


Technology Applications

Prod.

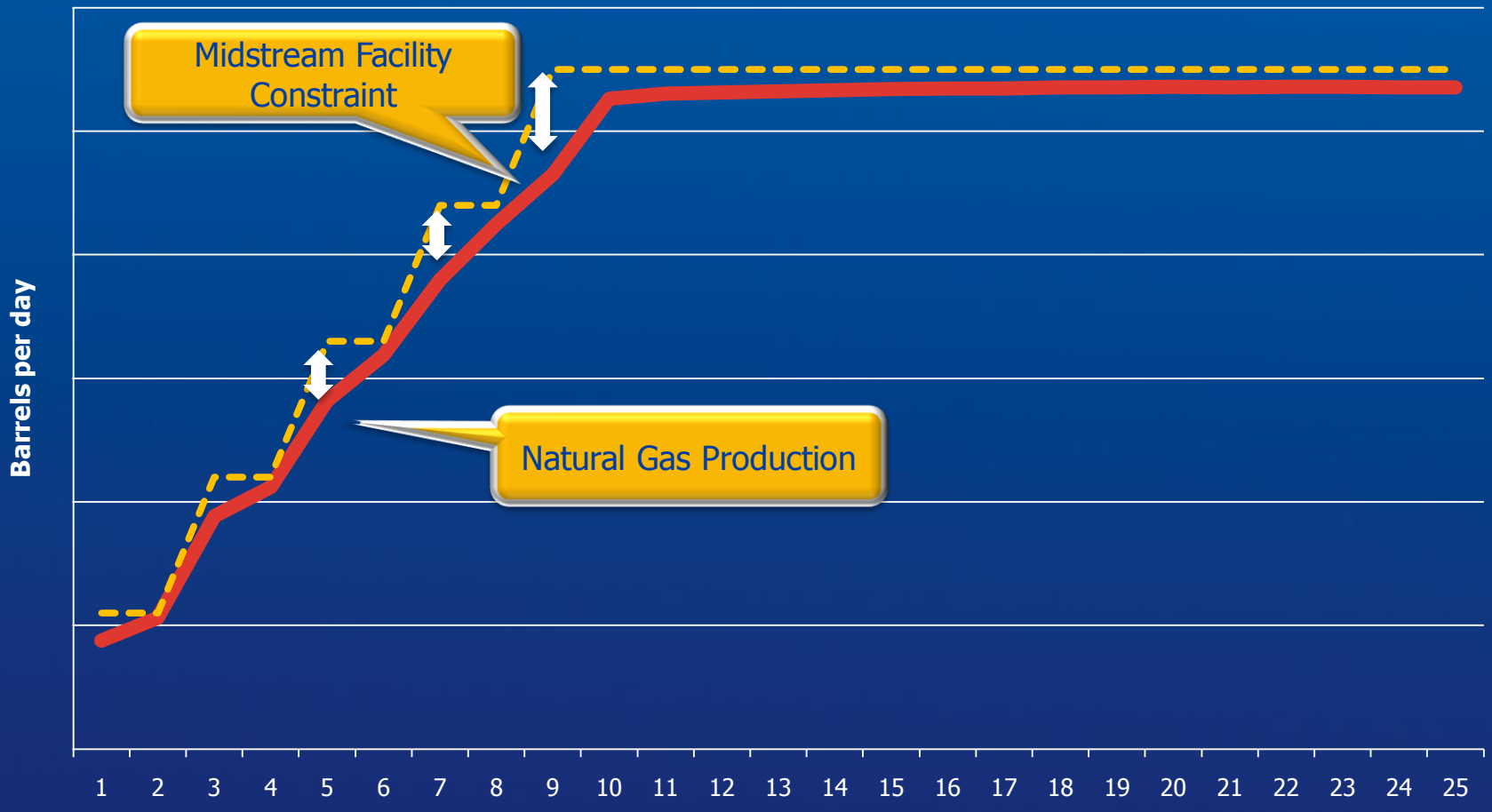
- Artificial lift
- Repeated hydraulic fracturing
- Water flooding or gas cycling?
- Others



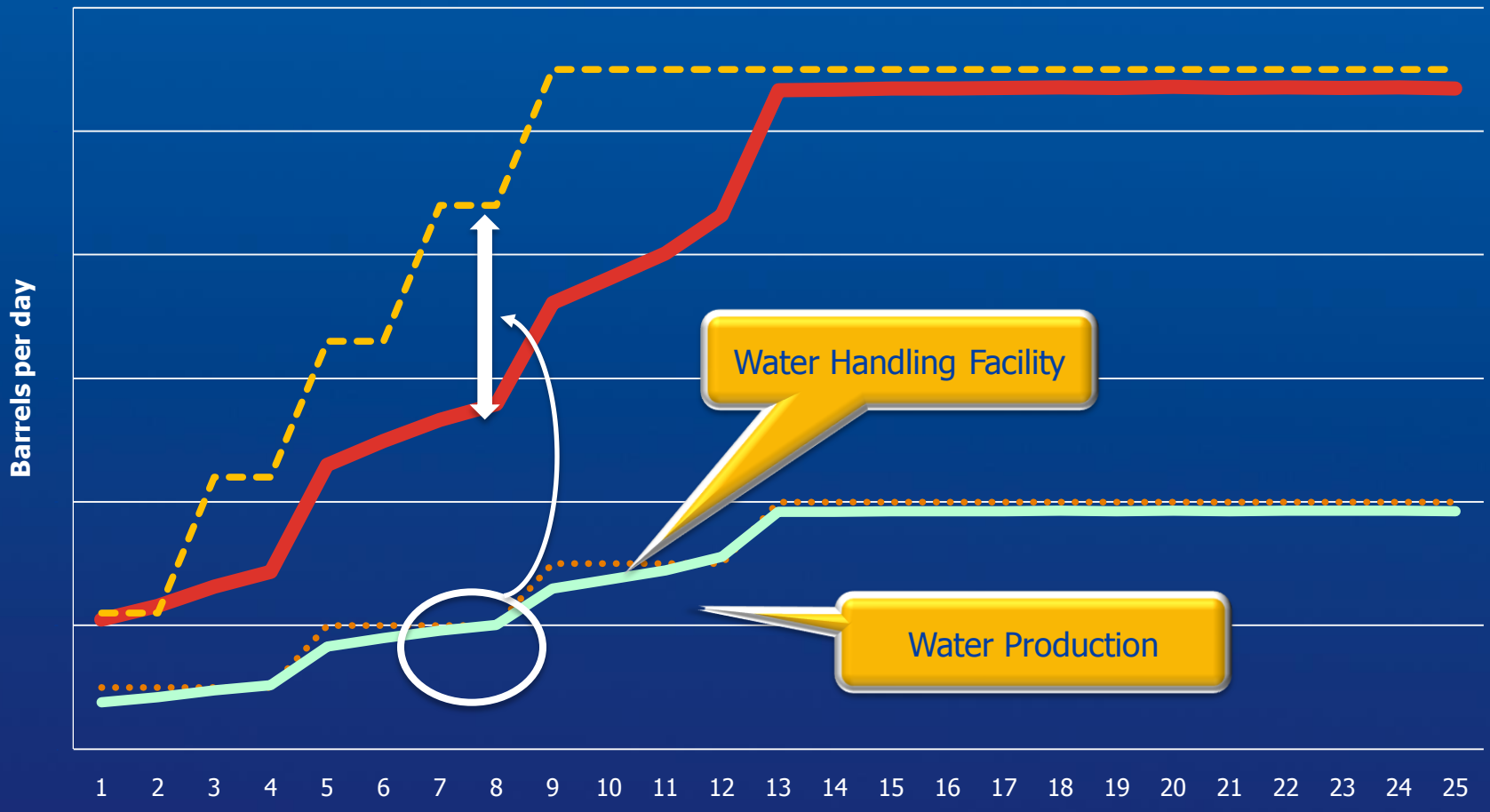


Source: GCA, HPDI

Production Constraints



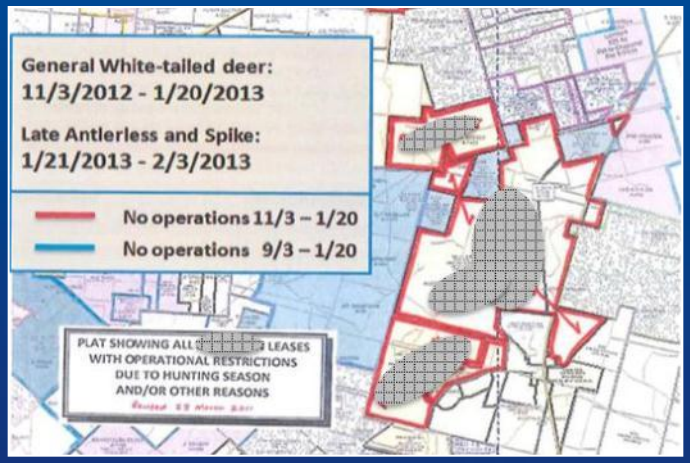
Production Constraints



Other Production Variables

Prod.

- Timing
  - Logistics and third party delays, including regulatory
  - Downtime (planned and unplanned)



- Volumes
  - Debottlenecking upside
  - Accounting for fuel gas usage, etc.

COSTS

Learning Curve

Exploration & Appraisal

Development & Production

Learning curve starts again when moving to another area

Batch/Pad Drilling

Well Design Tailoring

Technology Application e.g. drilling motor

Field/Rig Crew Experience & Drilling Pace

Leveling Off – Until the next technology breakthrough

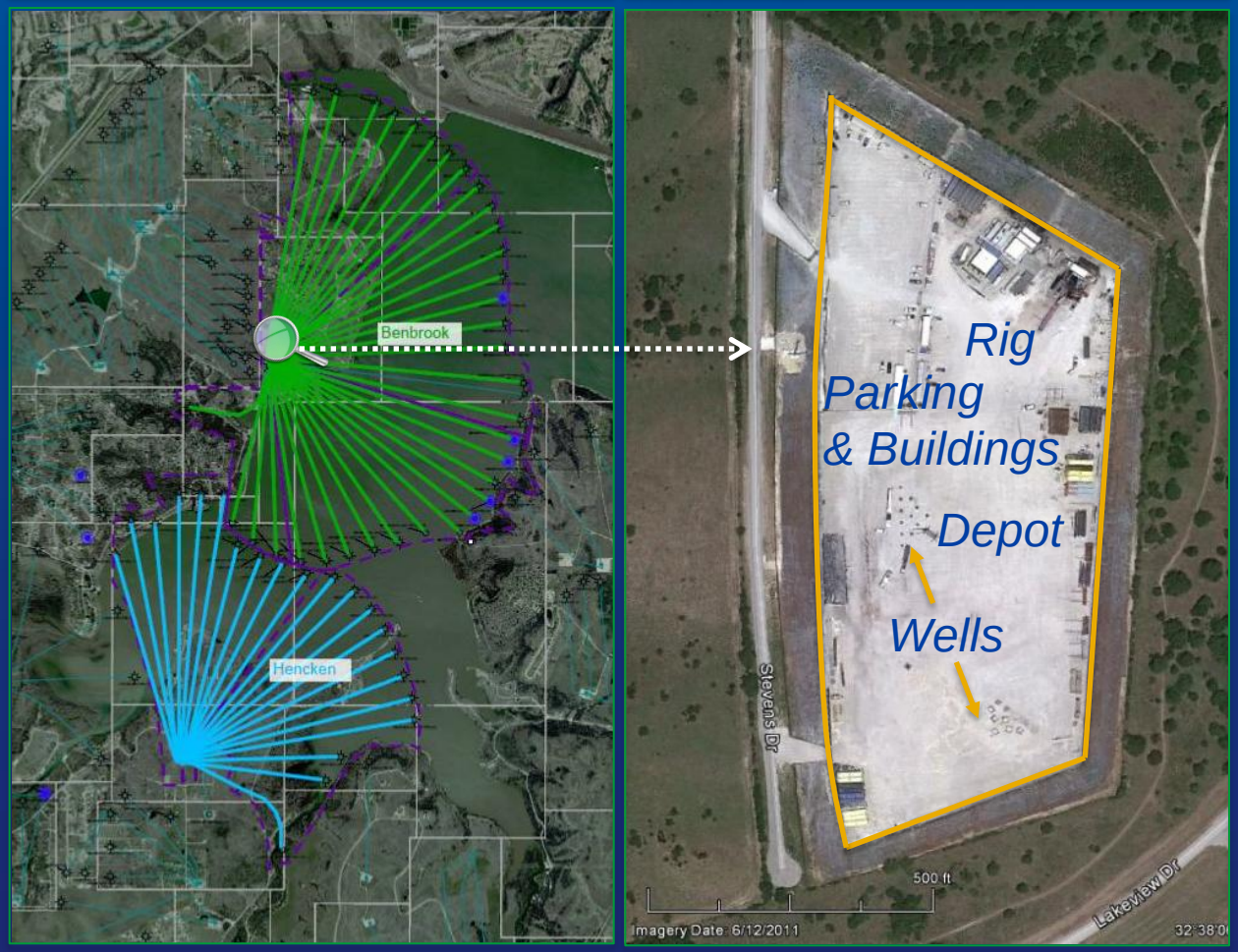
Days to drill a well

0 5 10 15 20 25 30 35 40

Number of wells drilled

Pad/Superpad Economies of Scale

Development Concept	Superpad Layout



- Common infrastructure and surface facilities
- Reduced footprint per well
- Minimized road traffic
- Permitting synergies
- HSE oversight

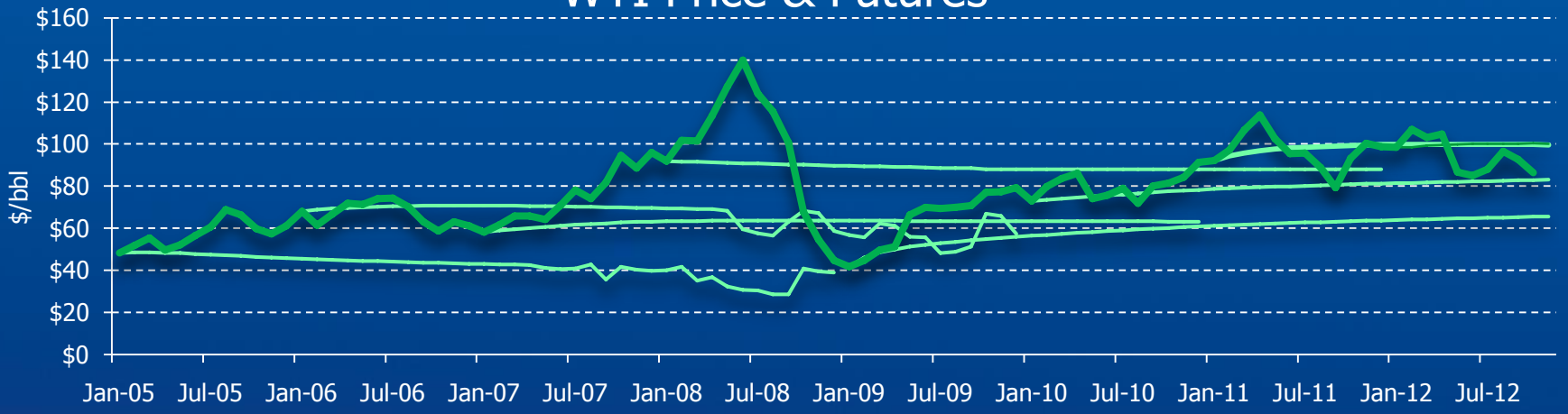
 Source: Devon Barnett Lake Benbrook - Google Earth June 2011

PRICE

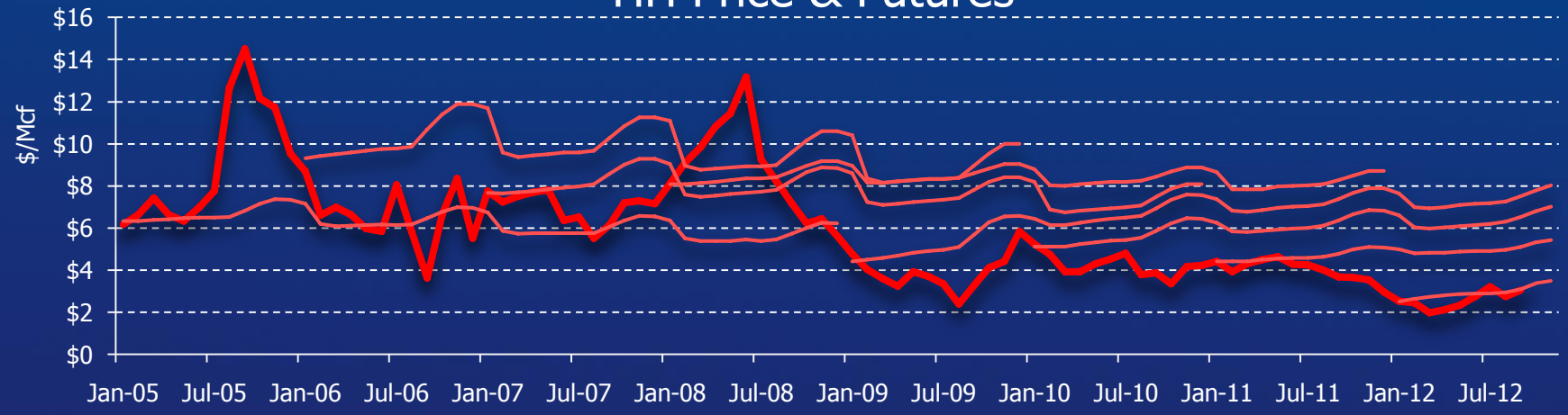
Oil & Gas Price Forecast Accuracy

Prices

WTI Price & Futures



HH Price & Futures



Source: Bloomberg

The Weather Analogy…

During World War II [Nobel Laureate] Ken Arrow was assigned to a team of statisticians to produce long-range weather forecasts.

After a time, Arrow and his team determined that their forecasts were not much better than pulling predictions out of a hat.

They wrote to their supervisors asking to be relieved of the duty and received the following reply:

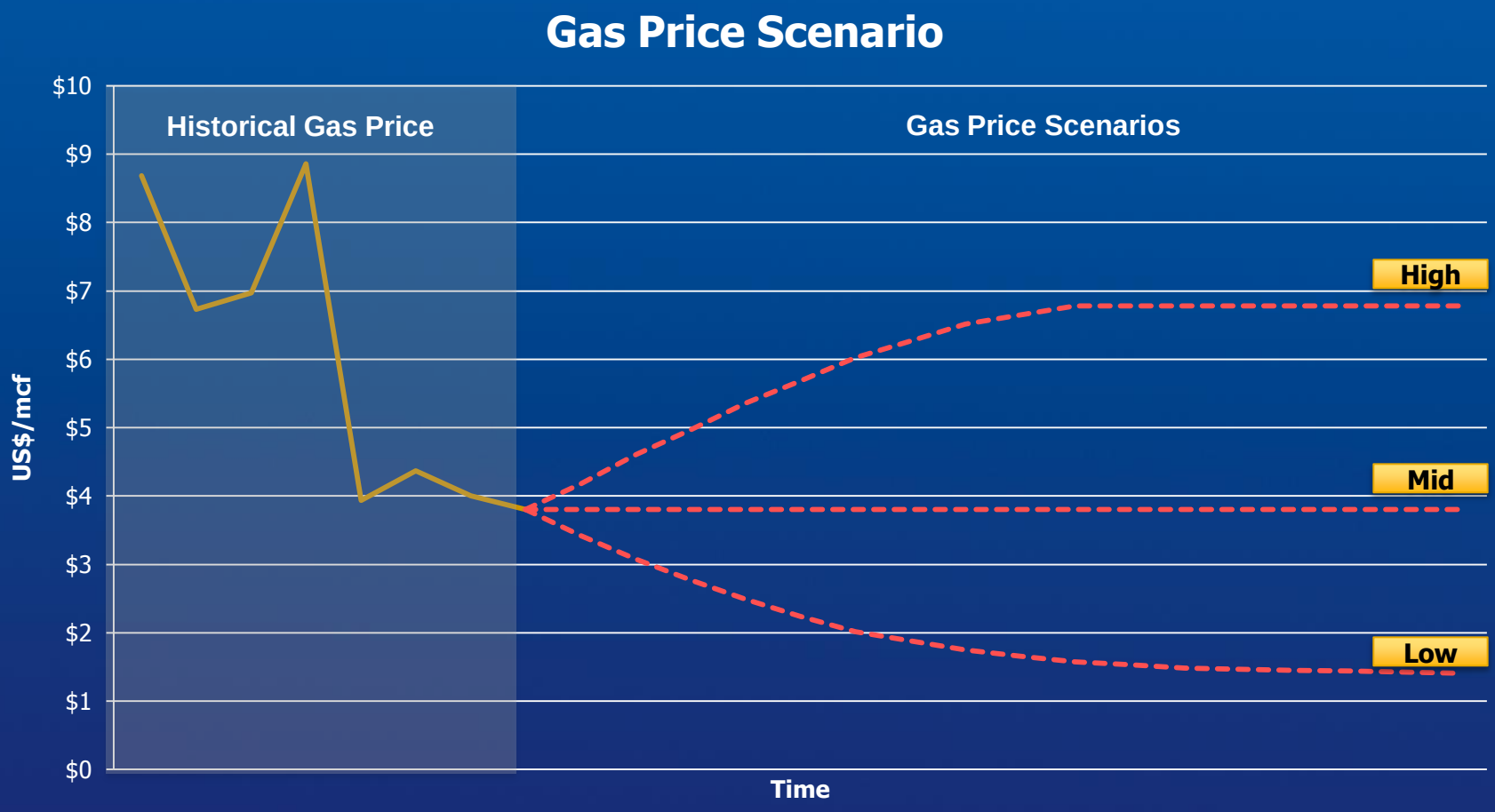
“The Commanding General is well aware that the forecasts are no good. However, he needs them for planning purposes.”

Source: Against the Gods: The Remarkable Story of Risk By Peter L. Bernstein

Price Sensitivity

ILLUSTRATIVE

Prices



Price Sensitivity

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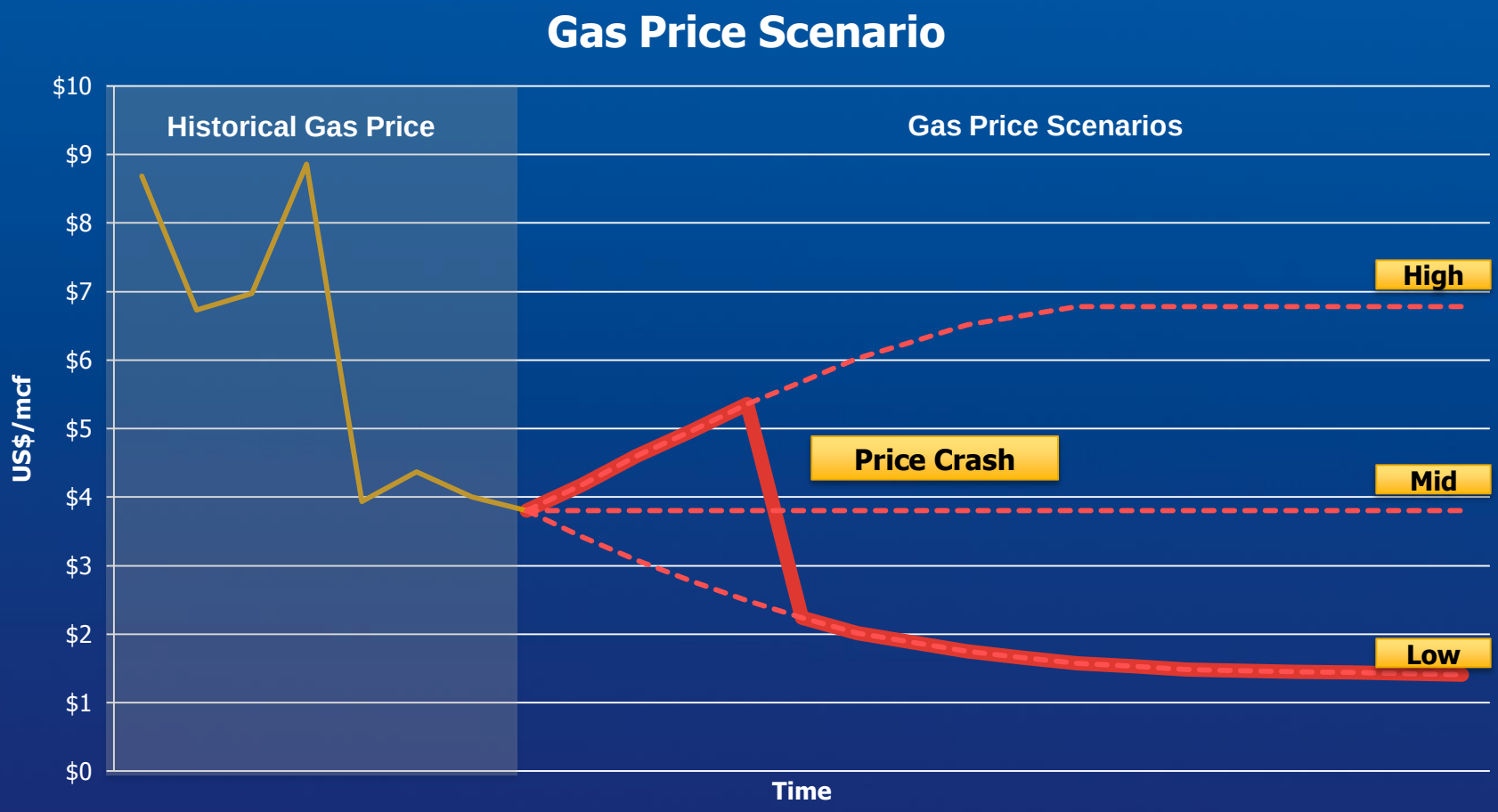
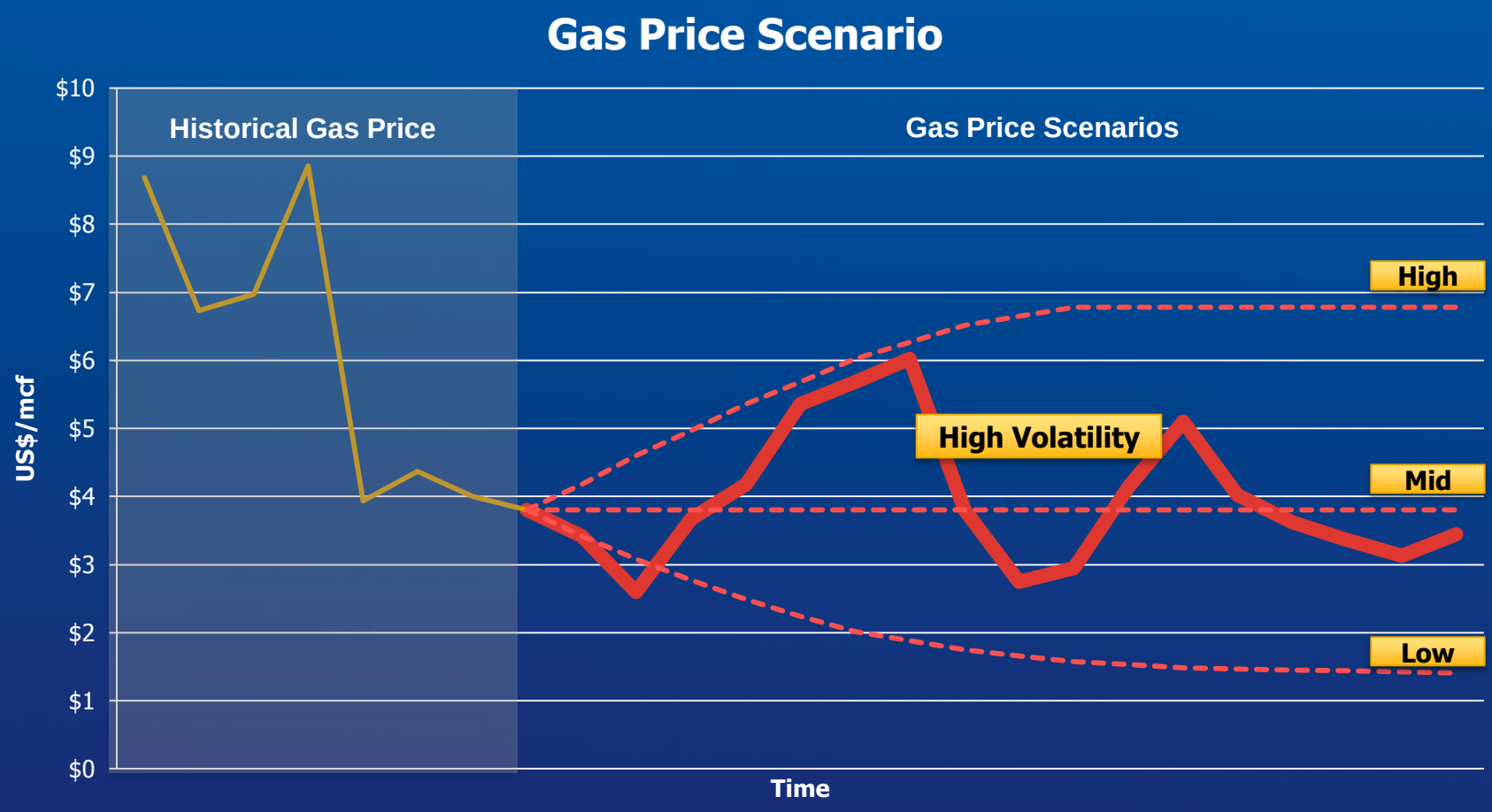
Prices



Price Sensitivity

ILLUSTRATIVE

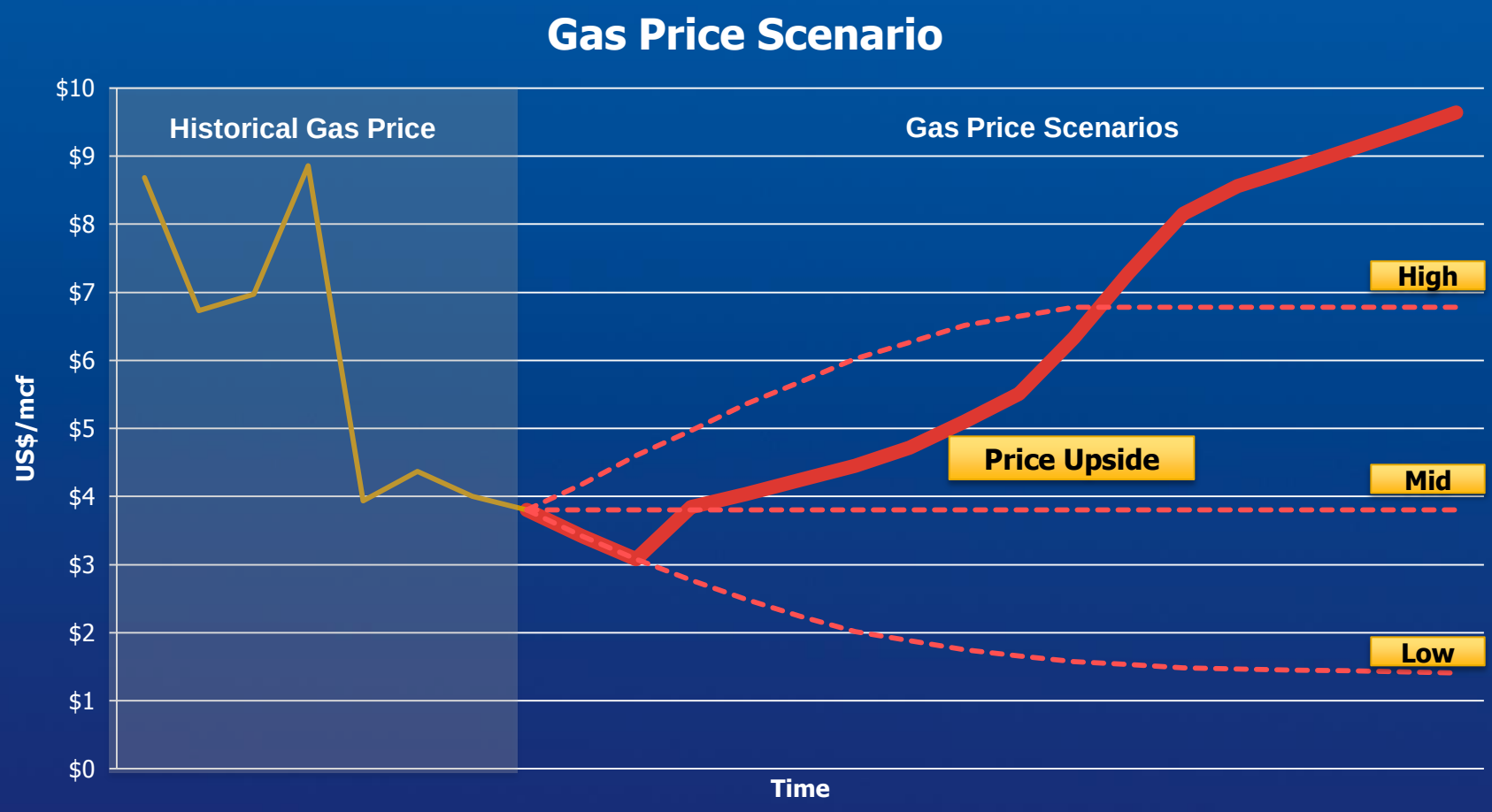
Prices



Price Sensitivity

ILLUSTRATIVE

Prices



Tailored Alternatives

Acreage Attractiveness	Temporary Dip	Prolonged Crash
Most Attractive	**Continue Operations**	**Scale Down Operations while Meeting Lease Obligations** *Drilling / Partial Hydraulic Fracturing*
Least Attractive	**Postpone or Discontinue Operations**	**Relinquish**

Price Expectation

 Source: GCA

Closing Remarks

Production

- ☑ Well spacing attributes
- ☑ Type curve distribution
- ☑ Production constraints
- ☑ Technology application

Costs

- ☑ Learning curve
- ☑ Economies of scale

Price

- ☑ Price scenarios
- ☑ Project resilience

THANK YOU