

EIA Energy Conference

June, 2015

Shale Gas Plays

Inevitable Updates

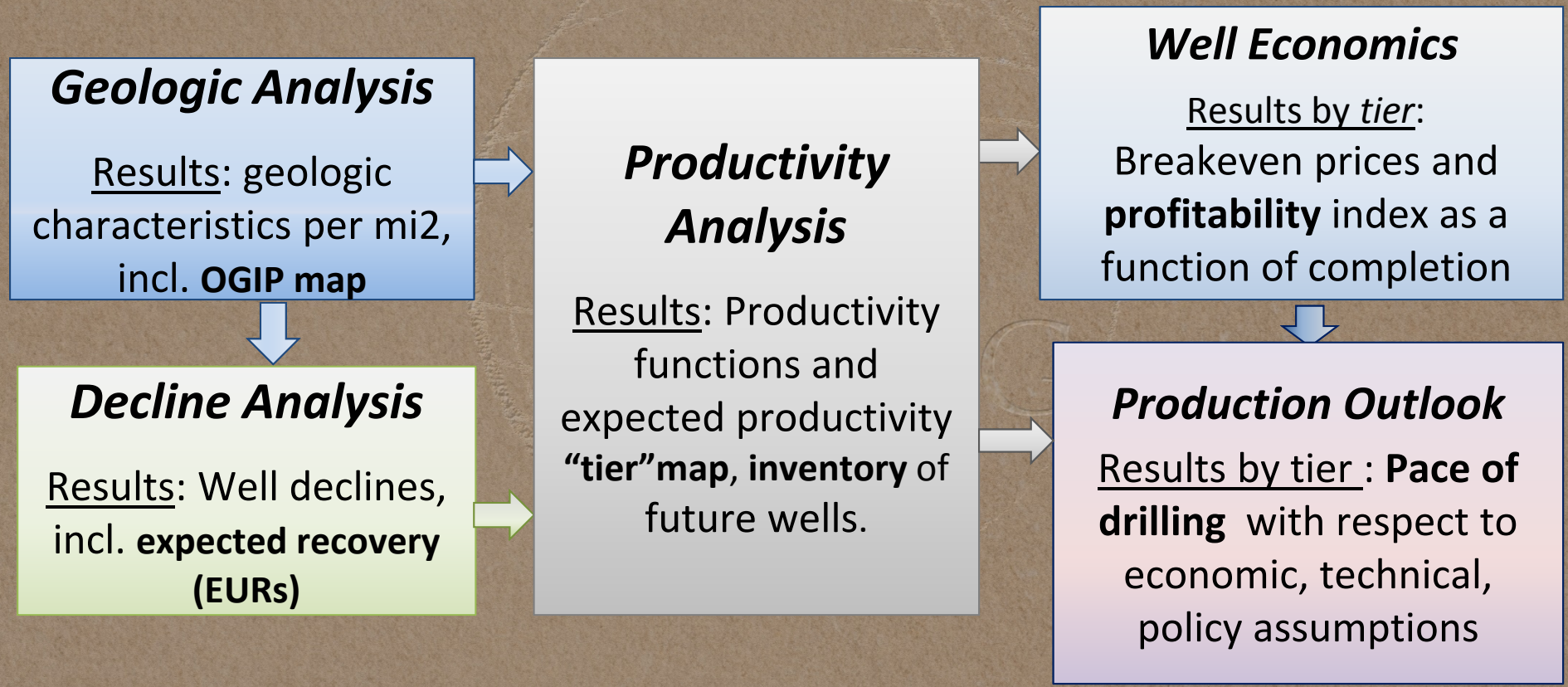
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University of Texas at Austin**

Acknowledgements and Disclosures

- Alfred P. Sloan Foundation
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- EIA
- BHP, ExxonMobil, Southwestern Energy, Devon, Range Resources, Cimarex, Carrizo for discussions

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- Potential conflicts of interest have been fully disclosed: see BEG website
 - Publications and Press:
 - Several peer-reviewed journal articles – see BEG website
 - Oil and Gas Journal Articles – Barnett and Fayetteville
 - Mainstream Media including NPR, WSJ and many others

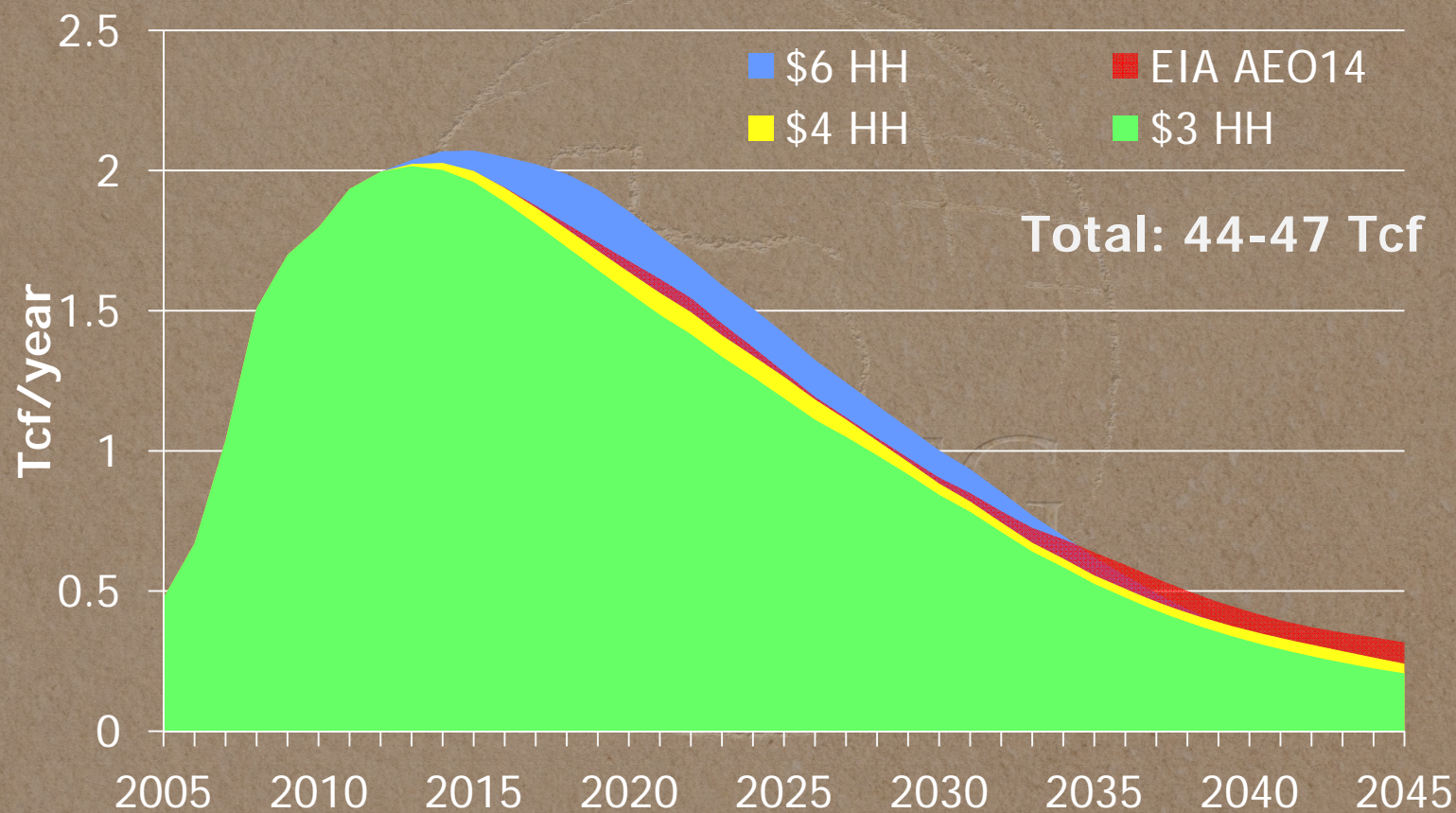
Interdisciplinary approach



State-of-art

- BEG outlooks have done well so far
- But some of the observe changes in producer behavior are not covered by the models
- We get access to more data
- We keep learning from every new play
- => Need to enhance our approaches

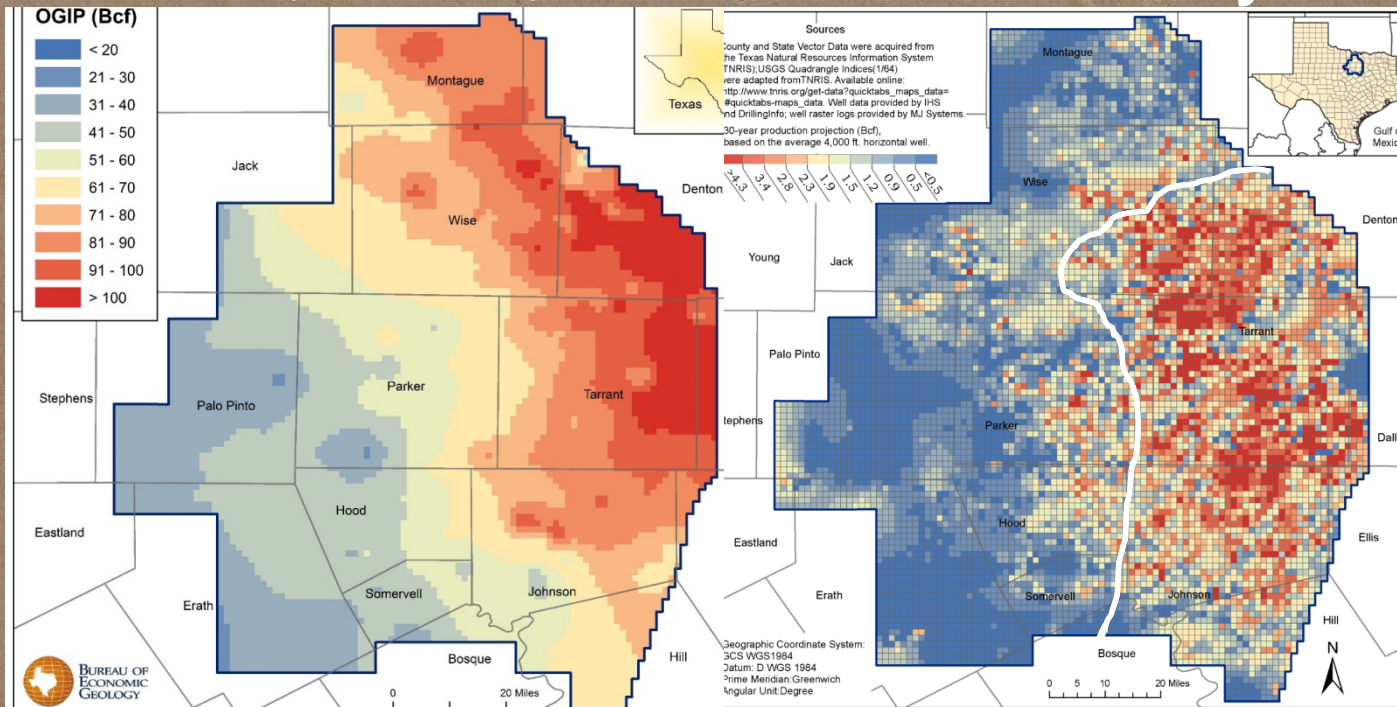
Barnett Shale: Price sensitivity



Barnett Shale

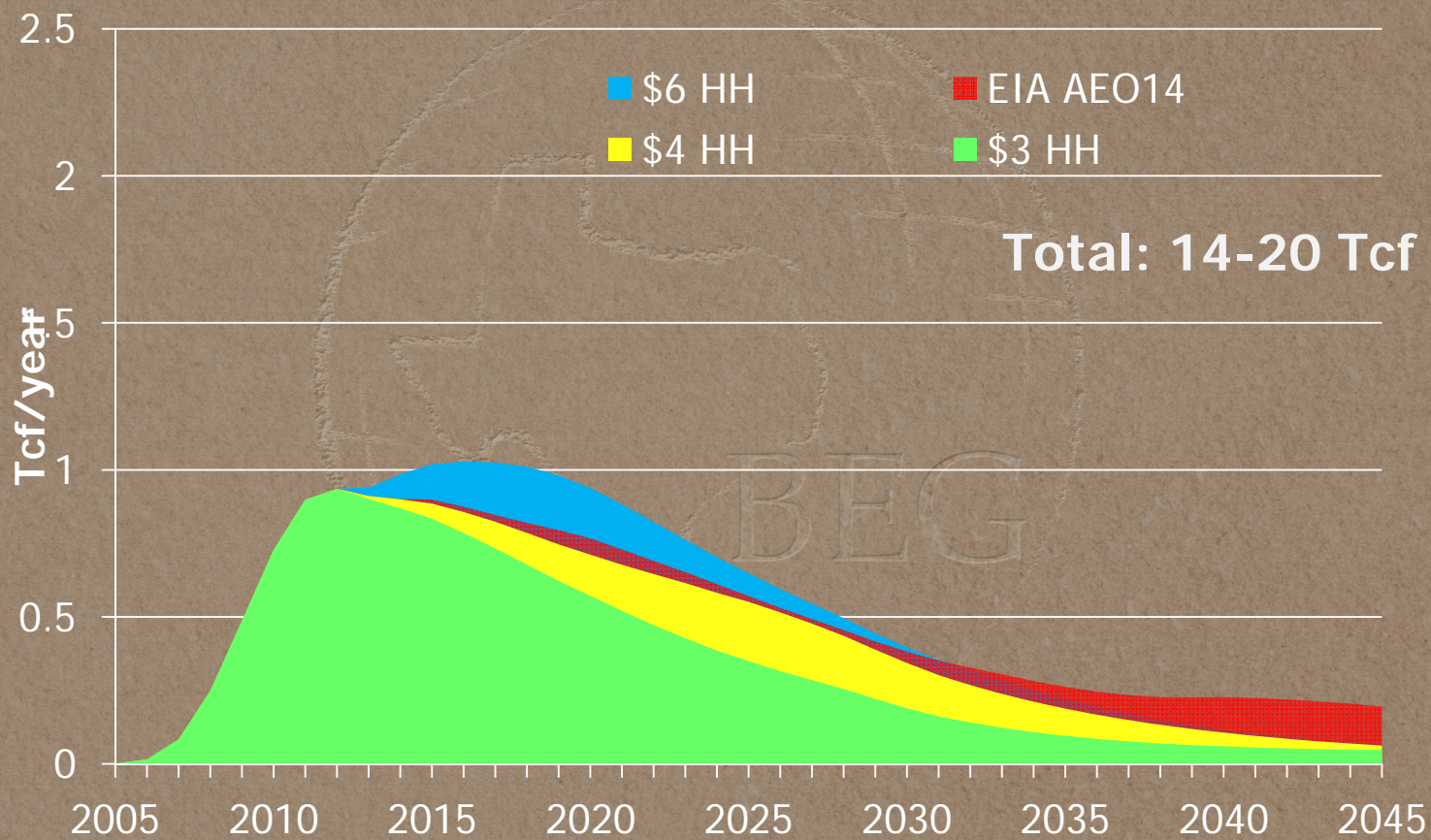
OGIP^{free} (productivity limit)

Productivity

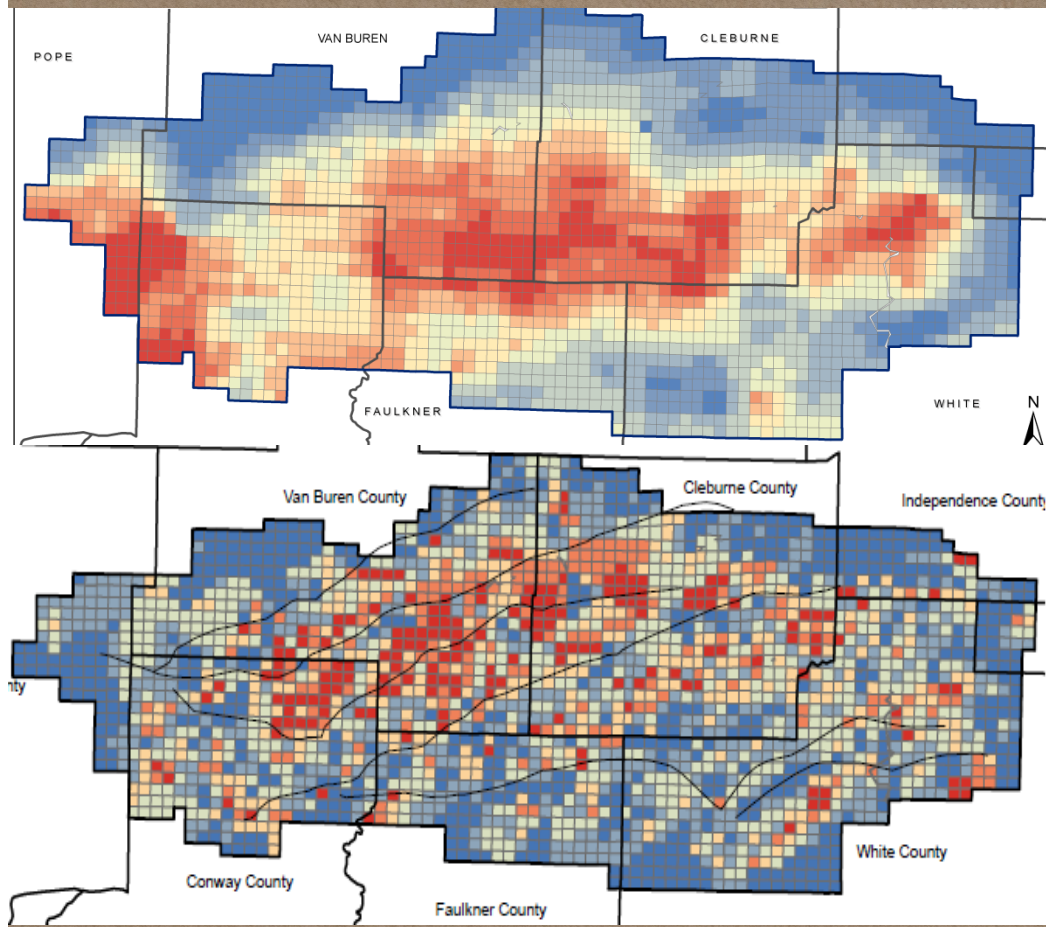


How to treat
Resource composition
that affects economics

Fayetteville: Price sensitivity



Fayetteville Shale



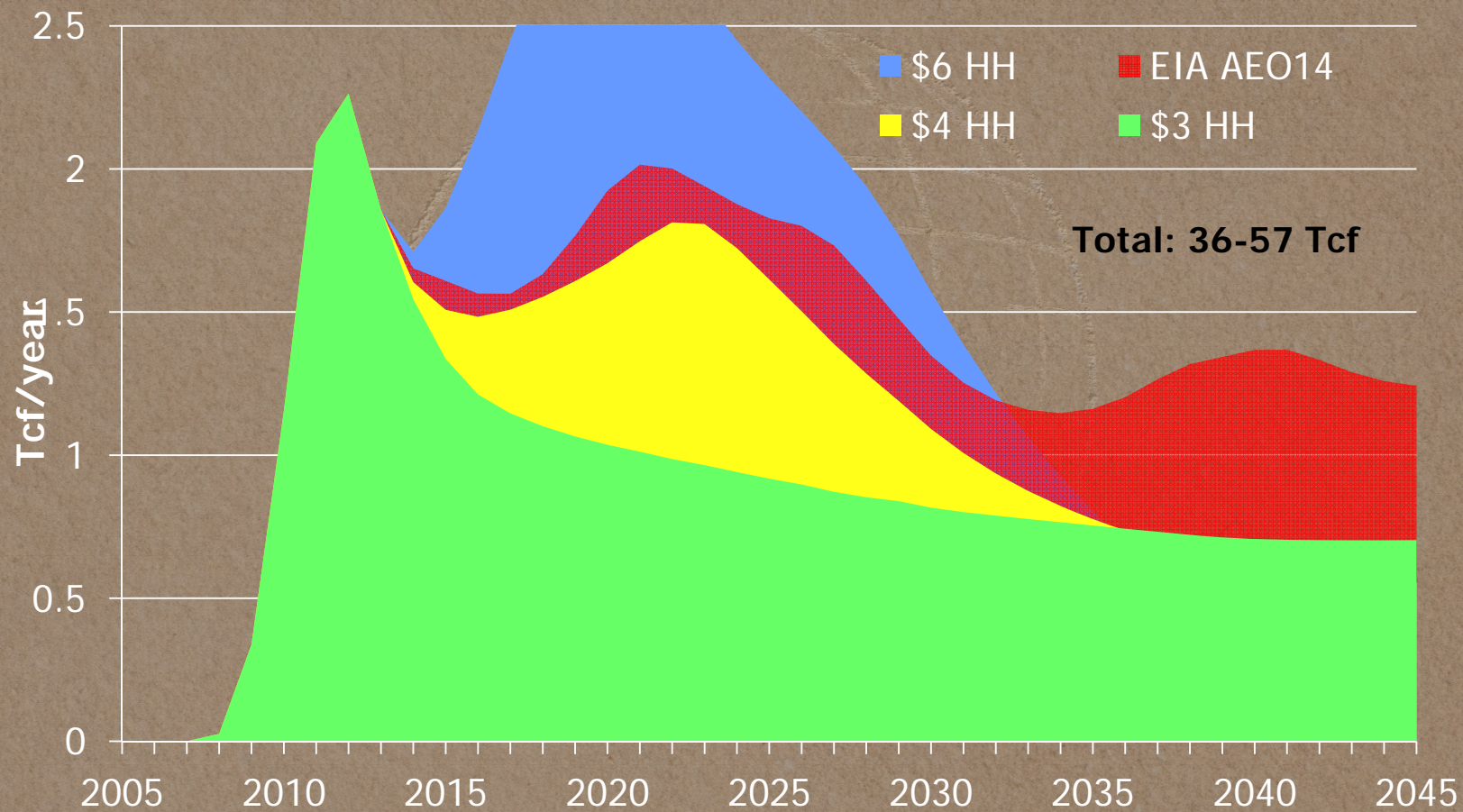
OGIP^{free}

How to account for

- Desorbed gas that matters for resource and future production
- Natural fractures and faults determining recoverable resource

Productivity

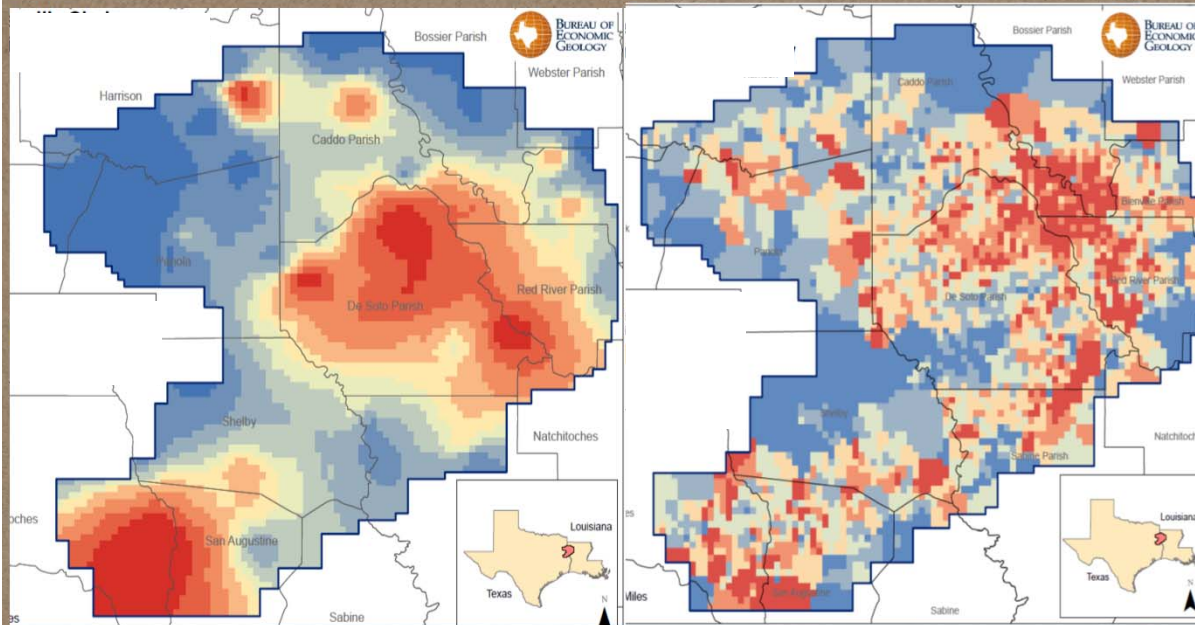
Haynesville Shale: Most expensive



Haynesville Shale

OGIP^{free}

Productivity



How to capture

- Pressure gradient (extreme values lead to dynamic permeability)
- Clay effect
- Potential contributions from adjacent formations

Need for Updates

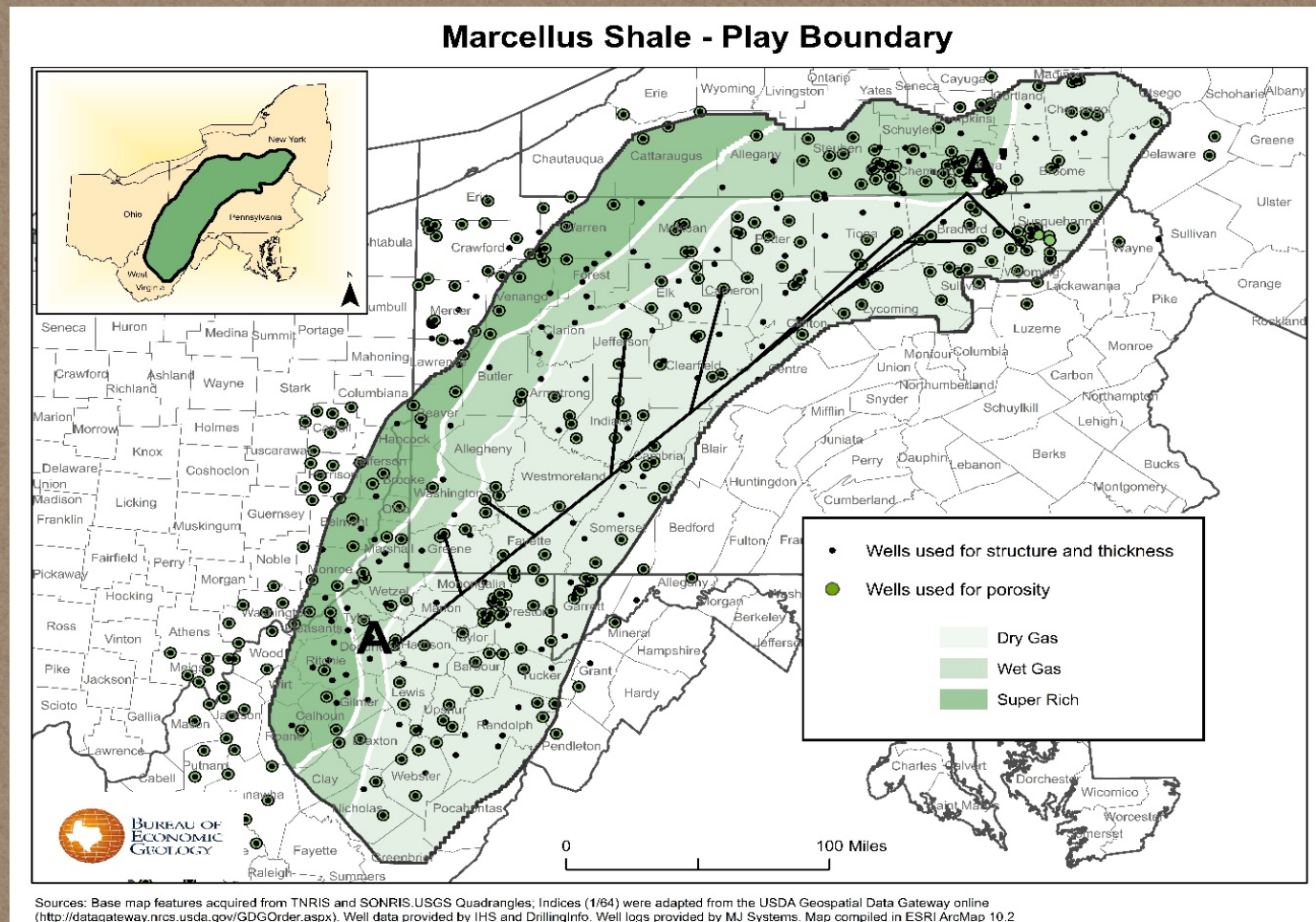
- Improved geologic knowledge
- Updates in decline analysis
- Revised analysis of productivity drivers (structural changes)
- Changes in well economics: cost structure and finances
- Production incentives w.r.t. new constraints

GEOLOGIC UPDATES:

1. Improved granularity (on characterization)
2. Better understanding (of data and features)
3. Knowledge expansion (reinterpretation of existing and usage of new data)

Marcellus Play Boundary

- ~46,000 square miles
- Minimum depth 2000'
- Minimum thickness 30'
- Outcrop +5 miles
- Maximum thermal maturity 3.5% Ro



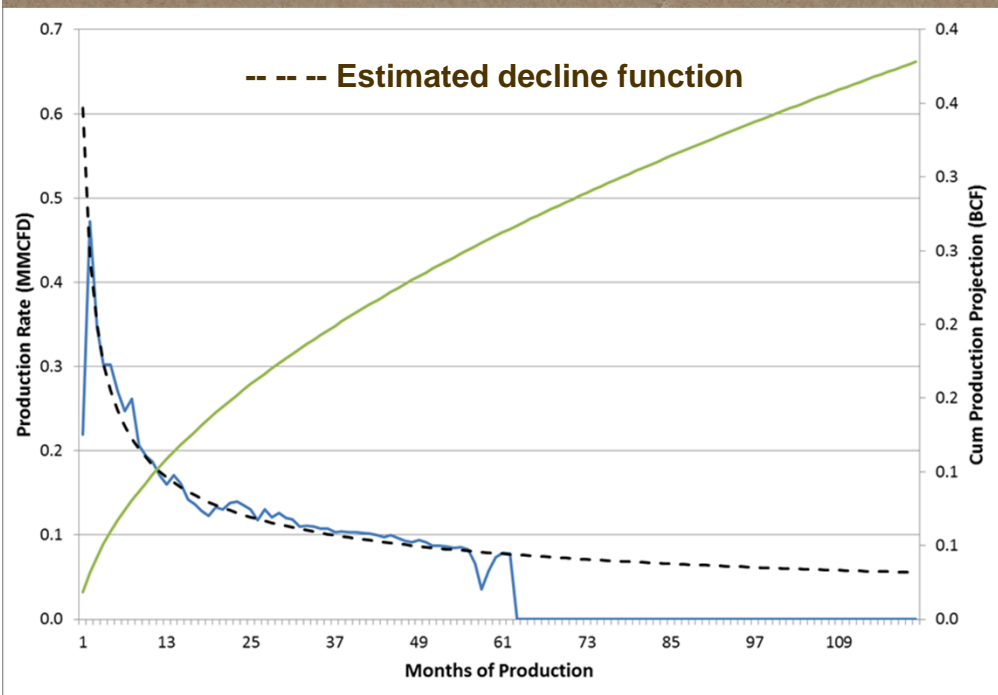
Summary

- Heterogeneity across plays makes us learn more about shale geology
- New data and technological advances lead to continuous updates
- Expansion of drilling activity changes uncertainties
- Changes in economic environment translate into improved granularity

WELL PRODUCTIVITY, RECOVERY, TECHNOLOGY, AND STRATEGY:

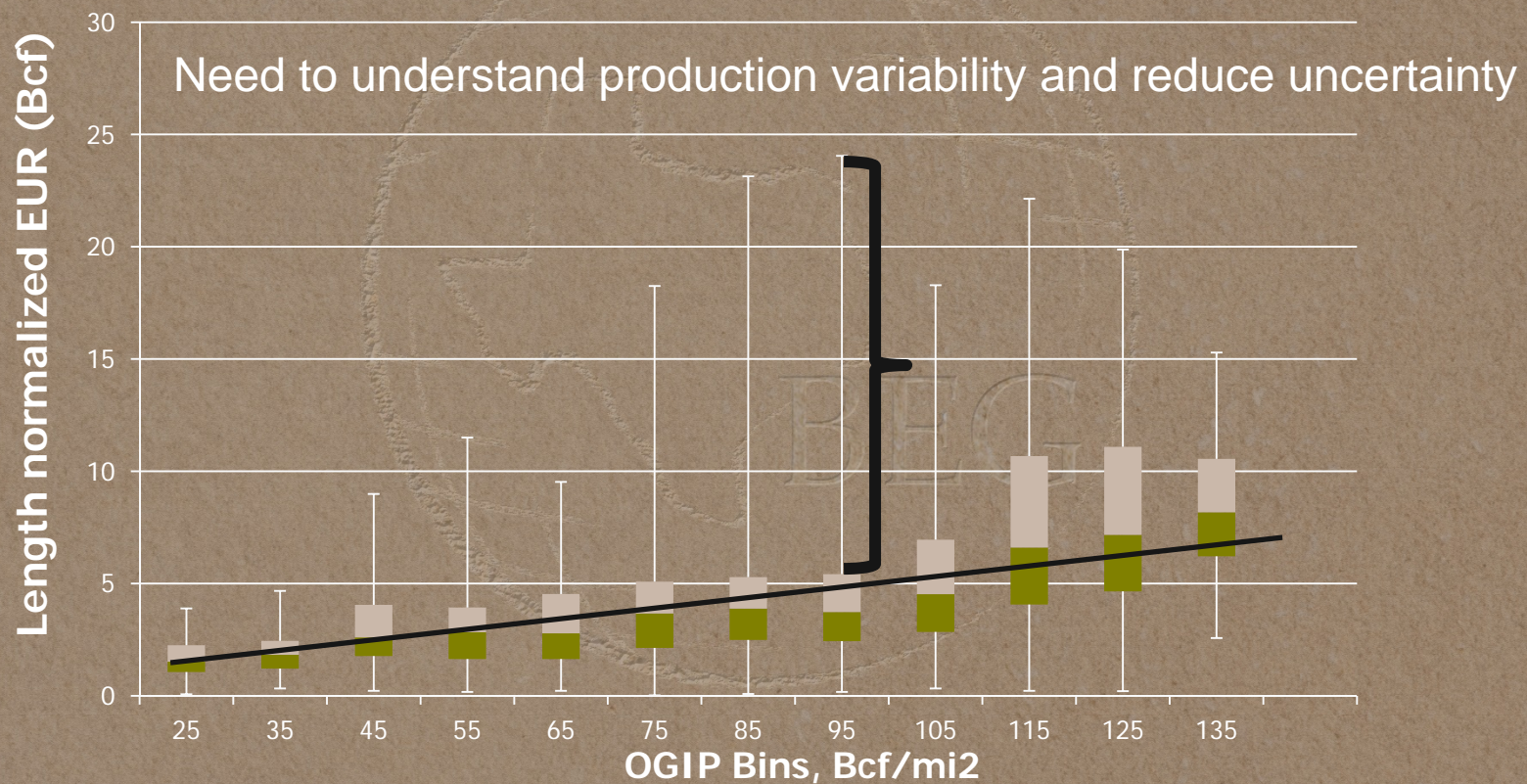
1. Improved granularity (on characterization)
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Decline Analysis



- Production decline is a function of geological rock properties;
 - Expected production, however, is a function of completion design, geologic and company parameters.
- => Standard well approach, or well normalization, cannot be used
- => Technology and economics determine the productivity along with geology

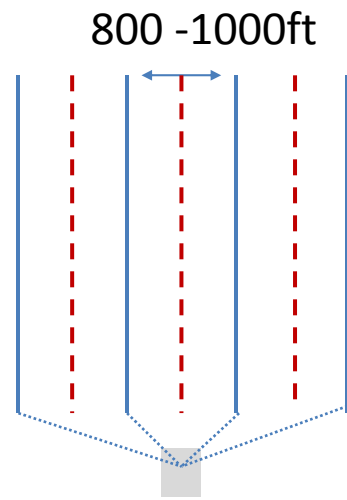
OGIP vs. EUR Correlation



New Strategies

Infill drilling:

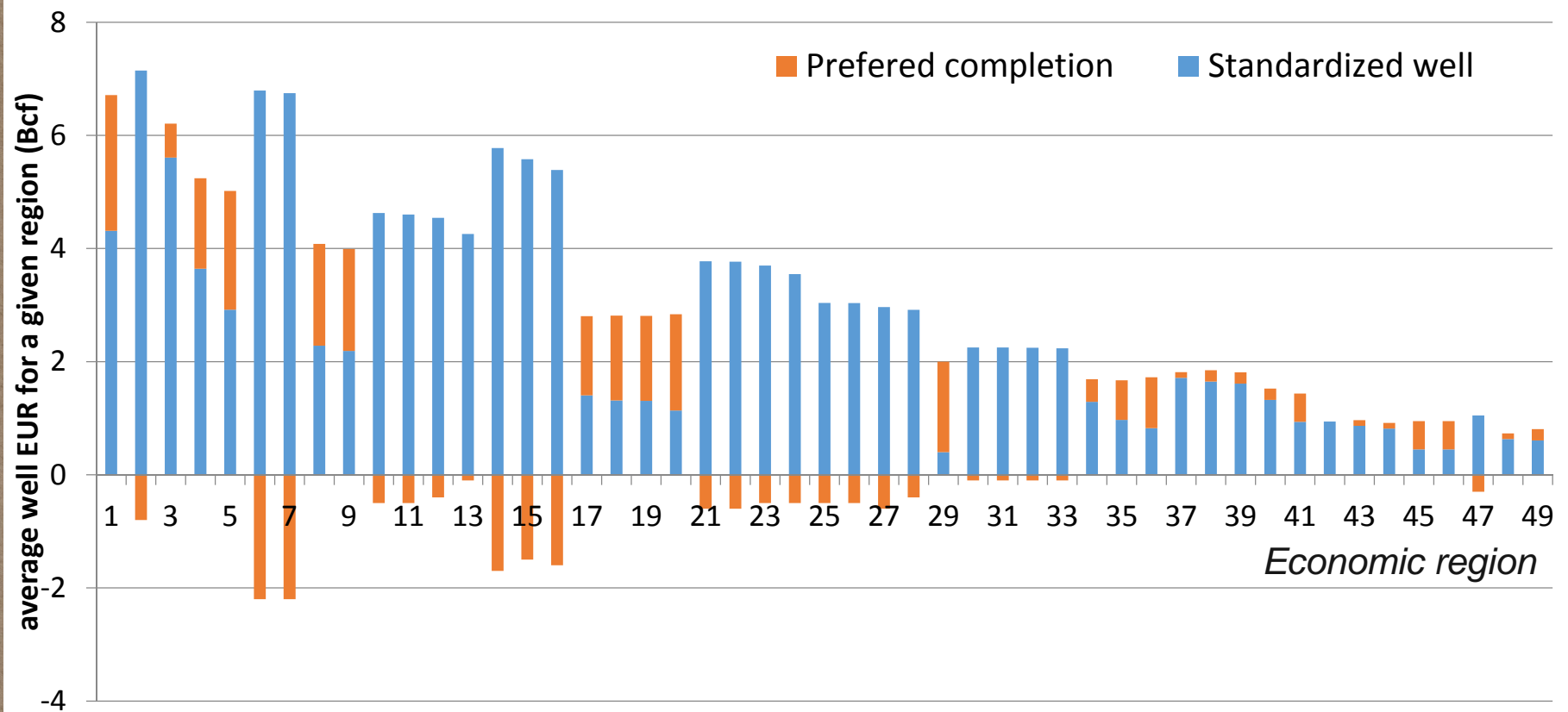
- adds locations
- reduced costs
- Increase EUR



- Drilling and completion strategies determine number of future well locations
- Knowledge accumulation, resource exhaustion, and unfavorable economic result in diversity drilling and completion techniques

Infill drilling and cluster drilling can results in a substantial increase in future individual well and play recovery!

Completions and Experience matter



WELL ECONOMICS AND PLAY OUTLOOK:

1. Models expand to account for new trends and practices
2. Outlooks improve when tested parameters are well defined and mutually consistent

Inventory w.r.t. Producers' Decisions

- Number of locations & productivity depend on completions (HF water, spacing)
- Completion choice depends on the market environment and technology

Conclusion

- Changes in any aspect of play description leads to a review of all the parts of the analysis
- The outlooks results keep changing with:
 - Price (NG/NGL/WTI) ,
 - Basis differential/Infrastructure,
 - Costs & Technology improvement;
 - Regulatory framework.
- But resource in place may not be fully known yet.