



DATA ANALYTICS, AI, MACHINE LEARNING



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- General Manager – Power & Renewables for Enverus
- Energy career spanning 15 with focus in advisory services, and predictive software used broadly by thousands of market participants spanning O&G and power. Currently leading the Power & Renewables business for Enverus.
- Broad experience predicting commodity market price and supply/demand, valuing assets, and advising market participants in the upstream, midstream, and downstream space.
- O&G Journal 40 under 40, and advisory or board member for several industry organizations.
- BSc Economics, Colorado School of Mines, Master International Political Economy of Resources, Colorado School of Mines



Reservoir Management...



“Management is doing things right; leadership is doing the right things” – Drucker

- We’re here to talk about management...not leadership.
- Reservoir management is generally done through systematic application of integrated, multidisciplinary technologies. Most of these tools were discussed in previous sections, so we’re going to talk about ...
 - Data analytics, artificial intelligence, machine learning
 - Reserves
 - Project Economics



Data Analytics, AI and ML



Physics-based methods are insufficient when:

- Underlying phenomena are not well understood or cannot be modeled
- Inputs are inadequate for model characterization
- Computational time scale exceeds decision time scale

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| <p>Present</p> <p>Challenges</p> <p>Progress</p> | <p>Growing applications of data analytics and modeling strategies in reservoir engineering</p> <ul style="list-style-type: none"> - Unconventionals, field development, production optimization, forecasting, fluid/rock property estimation - Enabled by business intelligence, cloud, modern AI/ML algorithms |
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Recognition of importance of data-driven, decision-making

Data Analytics, AI and ML



Present
Challenges
Progress



- Lack of data management framework limiting progress
- Need proven reproducible methods for decision-making
- Address model fidelity for “small” data
 - Limited measurements, realizations, events of interest
- Interpretability and physical insights of AI/ML models
- Need to elevate AI/ML competency across organization

Elevate from finding structure in data to interpreting data

Data Analytics, AI and ML

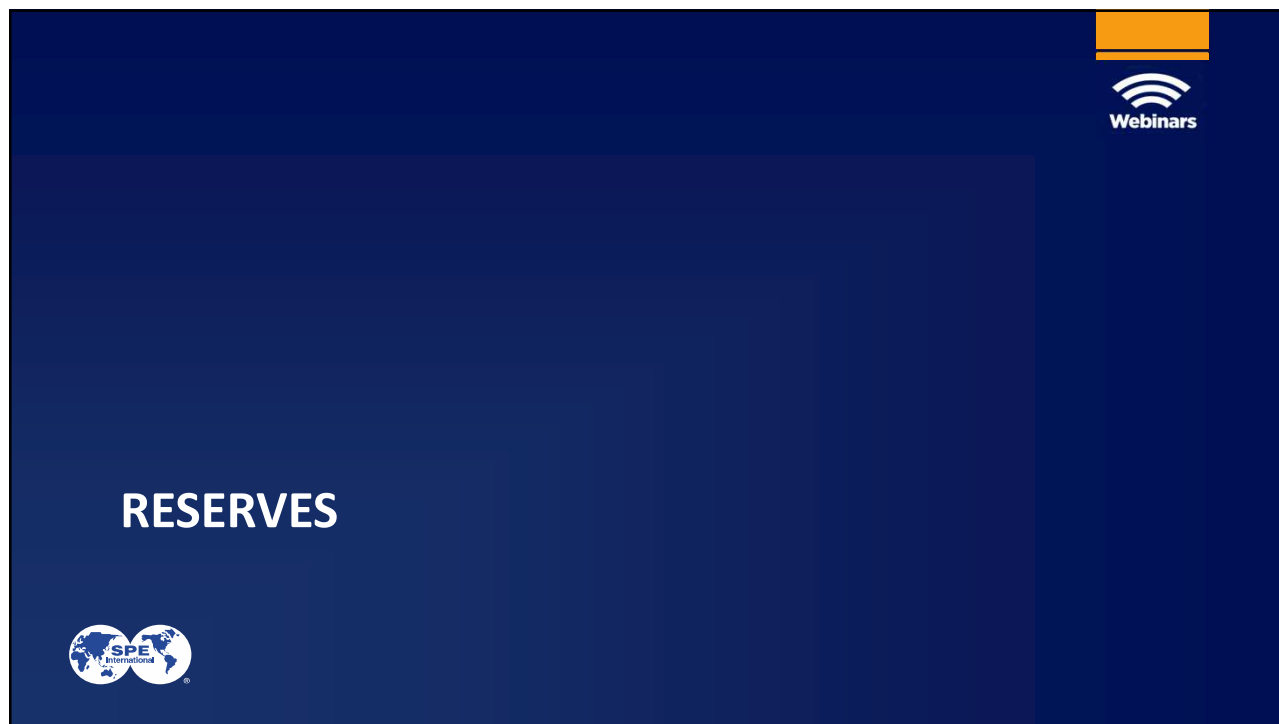


Present
Challenges
Progress



- Open-source data management initiatives (e.g. OSDU)
- Merge physics and data-driven methods to ensure physical consistency with limited data
 - AI in physics and Physics in AI
- Explainable AI/ML methods
- Education programs in universities and companies

Understand strengths and weaknesses of data-driven vs physics methods



Reserves


“Production forecasting, which provides the basis for reserves estimation, comprises a group of technologies almost as old as the petroleum industry itself, yet new technologies and approaches continue to add to the tool kit estimators can deploy.”

However, Much Work Remains to be Done

Present

Challenges

Progress



- Key Areas of Advancement
 - Rate-Transient Techniques Reflecting High-Density Data Collection
 - Reservoir Simulation and Its Broader Application
 - PRMS 2018 Revision
- Knowledge Transfer is at the Forefront
 - Training by Society Groups Including SPE on a Global Scale
 - Retaining and Transitioning Accumulated Knowledge of a Retiring Generation

Reserves



Evolving Needs and Changing Expectations are Drivers That are Creating Myriad Challenges for Reserves Estimation.

Present
Challenges
Progress



- While the Principles of the PRMS are Solid, the Applications Thereof are Ever Changing
- External Reliability and Integrity are Still a Challenge
- Estimation Technology Must Progress Along with Field Technology
- A Significant Amount of the Workforce Will Retire in the Next Decade

Reserves



Specific and Priority Areas of Focus

Present
Challenges
Progress



- Reputational Issues Stemming from a Perceived Overstatement of Expectations for Recovery in Low-Permeability Reservoirs
- Methods of Data Analysis Must Progress to Keep Pace with the Sheer Volume of Collected Data
- Future Granulation to a Full-Physics Simulation Model Down to Nanopores is among Cutting Edge Methods that Exemplify Where We May be Led
- Transferring Knowledge from Experienced Professionals

Reserves



Education and Knowledge Transfer are Areas of Progress

- Training by SPE and Its Partner Societies Has Been Able to Expand Globally with the Clear Purpose of Knowledge Transfer
- Programs are Being Encouraged to Create Mentors and Knowledge Sharing Sessions between Experienced Professionals to Younger Entrants to the Industry

Present

Challenges

Progress



Development of Processes and Methodologies for Evaluation of Low-Permeability Reservoirs Continues to Progress with Real Solutions for the Industry

- Guidelines Companion Document to PRMS is Near Completion, Including an Improved Chapter on Unconventionals
- Adoption and Instruction on Application of SPEE Monographs



PROJECT ECONOMICS



Previous, Current, Future



History: Running out of Hydrocarbon Resources

- Running out of hydrocarbon resources; peak oil was believed to be imminent
- Global energy market largely controlled by OPEC and NOCs
- Global supply discoveries by major oil companies or NOCs, instead of small operators or independents
- Renewable energy sources were a very small percent of overall global energy sources and were growing slowly
- Commodity prices were strong and believed to trend up over



Last ~15 Years: Era of Abundance

- With US unconventional revolution, US liquid production grew from 5.0 to over 12.8 MMBbl/d in less than 15 years
- US became a net exporter of natural gas, liquid, and NGL in significant volume
- 100s of small operators
- Significant conventional resources around the world were discovered
- Investors believe in production growth
- Operators outspent cash flow and focus on long-term inventory life
- Low prices – 10+ years for natural gas and 5+ years for crude/condensate

Today: Unprecedented Demand Destruction & Recovery, Supply Shortfall

- COVID-19 pandemic, OPEC price war/ cuts, shut-ins
- Investors demanding a return on capital
- Operators must demonstrate capital discipline and generate free cash flow
- Bankruptcy and consolidations
- Majors pivoting from IOC to Integrated Energy Company
- Reduced investor appetite for oil & gas with growing concerns about climate change and increased interest in renewable energy
- Significant near-term volatility in commodity prices

Future: Energy Transition

- Longevity of US unconventional resources is in question
- Geopolitics, trade wars, currency wars
- Lower prices for longer
- Investors looking for a diverse energy investment
- Competition of capital with renewable energy projects
- EV Market share and its impact on long term hydrocarbon demand

Challenges & Opportunities



WHAT HAS NOT CHANGED?

Asset Valuation

- Fundamental valuation methodologies for both conventional and unconventional have not changed
 - Discounted cash flow analysis
 - Market-based approach
 - Comparable (Selected) Company Analysis
 - Precedent Transactions Analysis

Primary Objectives of Valuation

- Corporate asset valuation
- Reserve estimation
- Operational decision
- Budget cycle
- Acquisition
- Divestiture
- Funding decision

WHAT NEEDS TO IMPROVE?

Technical Approach for Valuation

- Conventional
 - Multi-year reservoir characterization, subsurface and surface modeling, history-matching, and simulation studies
 - Exploration to production
- Unconventional
 - Assets vary more geologically, even within a basin or play, and therefore vary in terms of volume predictability and economics
 - Optimizing field development is an extremely complex issue
 - Delineation to development

Key Considerations for Valuation

- Political and business risk within a specific area or country
- Workforce and labor accessibility in a specific area or country
- Land and regulation
- ESG factors
- Critical technical drivers
- Operating and capital costs
- Midstream and marketing
- Capital and corporate structure
- Commodity prices



Evolving and Future Needs



- The valuation methodologies and technical approach in project economics have not changed but the global market dynamics continuously evolve impacting financial goals and critical drivers of risk and return
 - Macroeconomics, energy transition, energy investment, black swan events, asset valuation between unconventional versus conventional and portfolio construction
- Project economics to be part of technical valuation process
 - Tools and workflows which allow petro-techs to use fully integrated financial model (technical + commercial)
- Recognizing that financial modeling is similar to reservoir modeling – Defining uncertainty in input parameters are critical for valuation
- Today's petroleum engineers to take the lead in the energy transition and be able to compare economics of an oil & gas project against a renewable project

