The Drilling Engineer of the Future – a changed profile

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Where did we come from?

- Uncomplicated well profiles and designs
- Costs not a high priority
- Siloed organizations
- Operators driving drilling technology development
- Paper and pdf files
- Poor quality data, inadequate measurements
- Basic technologies established for many years
- Manual operations

Where are we now?

- Complicated well profiles and challenging designs
- Cost reduction a first order objective
- Organization linkages
- Suppliers driving technology development
- Independent digital systems
- Data quality clarification, improved measurements
- Significant development of technologies 1990 - 2015
- Advanced control systems and automation

Where are we going?

- Broader repertoire of well designs and materials
- Managing costs while driving value
- Interconnectedness with geoscientists and production control
- Life cycle of wells accountability – value / integrity
- Fully integrated digitalized life cycle system
- Significant data attribute enhancement
- Highly automized systems with human agent connectivity
- Operator / supplier collaboration on technology development

“The Times They are a Changing” – Bob Dylan

The 3 C’s and Well Construction

COMPETE

Separate Products

- Motors
- Rotary Steerable
- Top Drive
- Cement Unit

COMPLEMENT

Interconnected Services

- Remote Directional Svc
- GeoSteering
- Vibration mitigation
- Cement Services

COLLABORATE

New Solutions

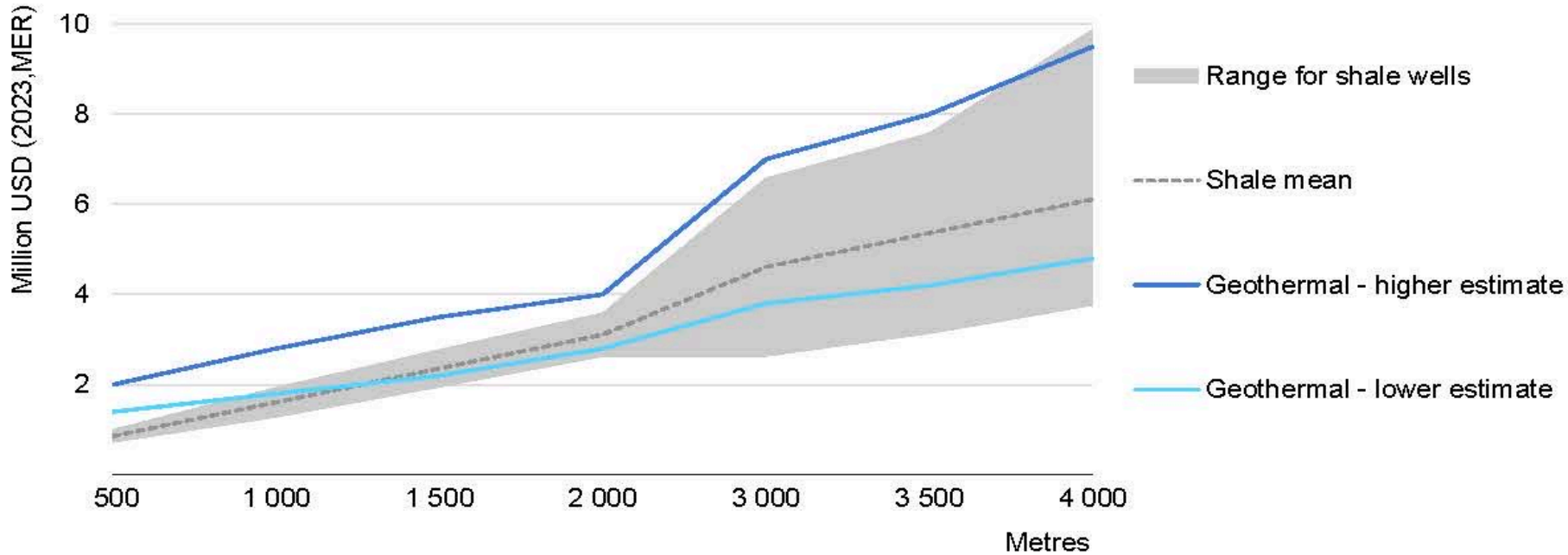
- Automation Agents
- Open-Source Models
- Connected Well Plan
- Connected Field Dev

Well design spectrum broadening

- Design for life cycle – blow down, abandon, re-use, ……
- Geothermal – from thermal to EGS and AGS

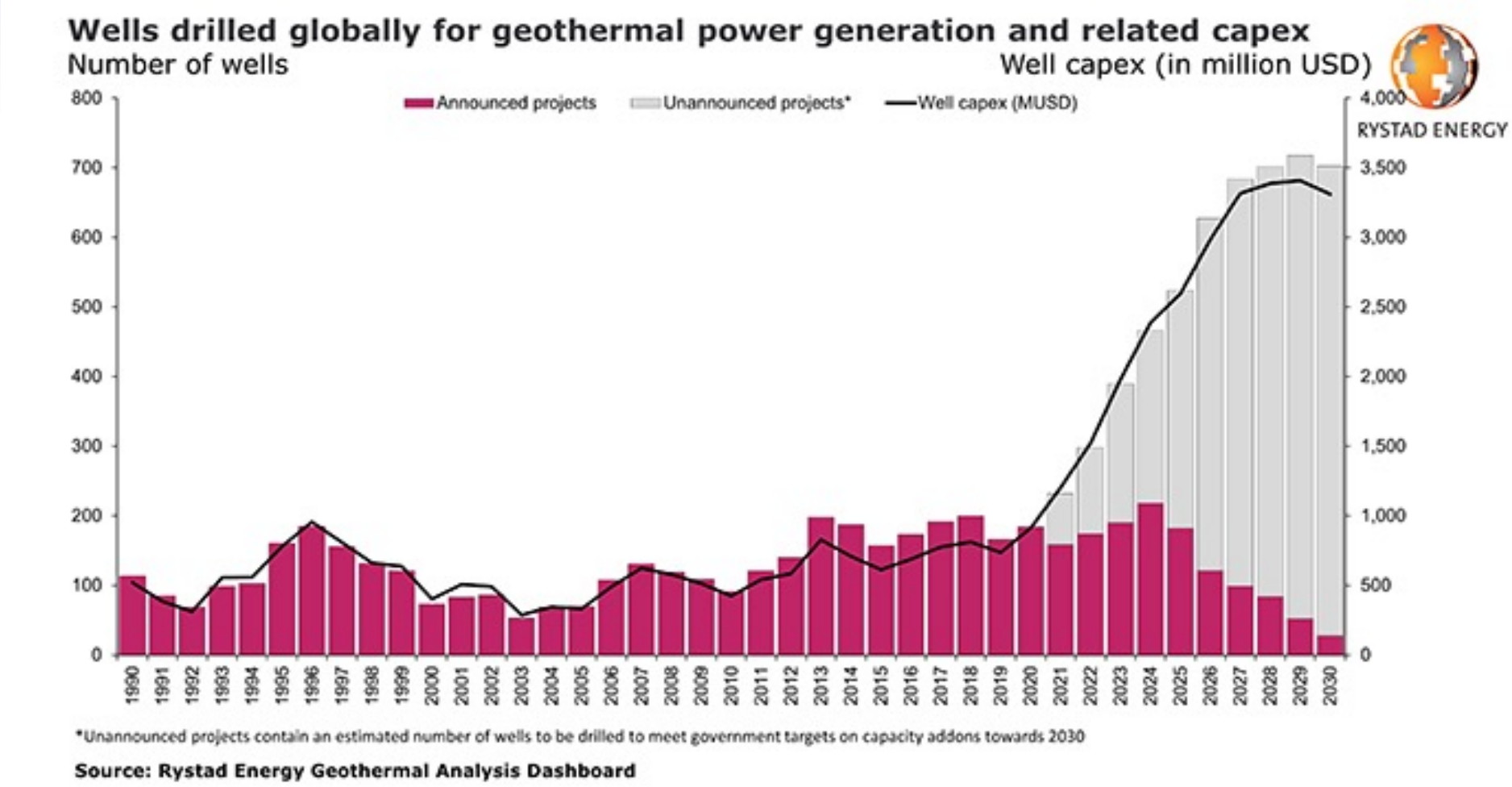
Belief Geothermal well costs match Shale

Well drilling and completion costs by drilling depth, enhanced geothermal vs shale gas in the United States



Sources: IEA analysis based on data from Rystad and NREL.

Projected growth is low but .....



Well design spectrum broadening

- Design for life cycle – blow down, abandon, re-use, ……
- Geothermal – from thermal to EGS and AGS
- CCUS – new and re-use
- Well life cycle integrity – QRA, …

Life cycle wells accountability

- Integrate workflow - concept, design, program, construct, intervention (heavy), abandonment
- Multiple data bases interconnected
- Drilling program cut from 3 months to under 2 weeks – "plan a well in a day". No more "Xerox Engineering"
- Integration of wells construction into field development / management

Managing costs while driving value

- Probabilistic through tracked detailed costs – Class 5 thro 1
- Schedule development – Level 1 thro 5
- Risk management
- Knowledgeable buyer of broad range of services / technologies
- Knowledgeable communicator to geoscientists and production
- Access to internal and external SME's

Data attribute enhancements

- Attributes include – frequency, precision, accuracy, latency, validity
- Traditional rig sensors – poor, out-of-date
- Improving sensors – mud density
- Adding sensors – real time mud systems
- Higher frequency data – dynamics requires very high frequency

Growth of data analytics

- Significant increased in real time data processing capability
- Bigger volumes - higher frequency and less latency
- Drilling engineers need Data Analysts / Data Analysts need Drilling Engineers
- SaaS – Software as a Service – select and use
- AI adoption growing but be wary of what it is actually doing

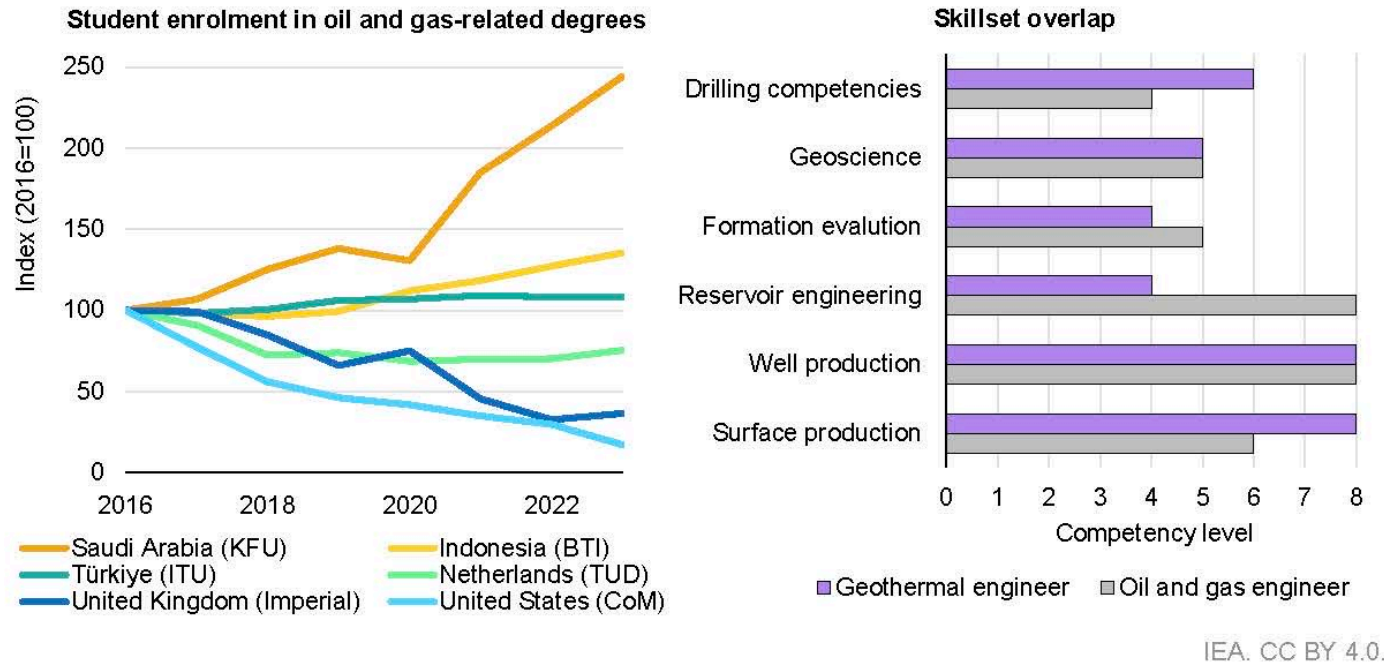
Operator / supplier collaboration

- Growth of IPM / LSTK, benefits, alliances, …..
- Hardware / software development / deployment by suppliers

Sourcing drilling engineers

- Negative view of oil and gas due to media
- Significant reduction in Petroleum Engineer intake in Western Univ
- Asian Univ continue to produce industry-oriented Petroleum Engineers and other engineers willing to enter oil and gas
- Source Mechanical, Industrial and similar engineering graduates and add industry-oriented courses

Enrolment in degree programmes that provide essential geothermal sector skills, 2016-2023, and skillset overlaps between geothermal and oil and gas engineers



Notes: KFU = King Faid University. BTI = Bandung Technology Institute. ITU = Istanbul Technical University. DUT = Delft University of Technology. Imperial = Imperial College London. CoM = Colorado School of Mines.

Sources: **Left:** IEA analysis based on university enrolment data and survey data collected by Lloyd Heinze for Petroleum Engineering and similar degree programmes. **Right:** IEA analysis based on SPE competency matrices; Okoroafor, E.R., C.P. Offor and E.I. Prince (2022), Mapping Relevant Petroleum Engineering Skillsets for the Transition to Renewable Energy and Sustainable Energy. Competency level: 2 = Awareness; 4 = Knowledge; 6 = Skill; 8 = Expertise.

Characteristics of DE in Future

- Knowledgeable buyer broad range services & technology
- Knowledgeable communicator multiple disciplines
- Well Life Cycle Value Delivery – cost (Capex & Opex), revenue (production flow rate and well uptime), speed of delivery
- High utilization of digitalization – fast cycle design, plan, execute
- Engineering graduates with added industry courses

Your comments and questions

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