Presentation

Upstream Technology and Innovation (UTAI)

New Directions for Oil & Gas Technology

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JOGMEC Techno Forum — International Technology Innovation Panel

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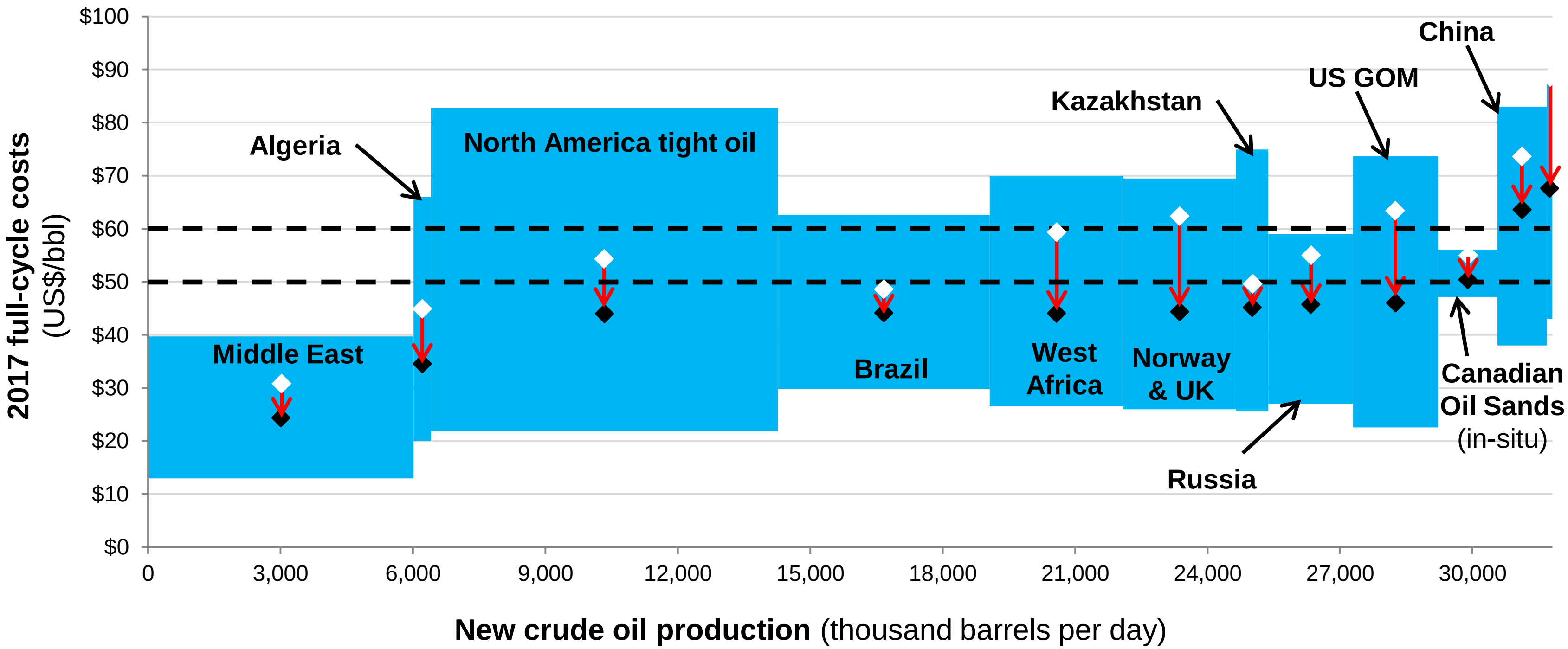
IHS Markit™

The upstream sector has re-set its cost structure through a combination of cyclical and structural factors

Indicative cost curve of global crude oil supply from new projects in select areas to 2030

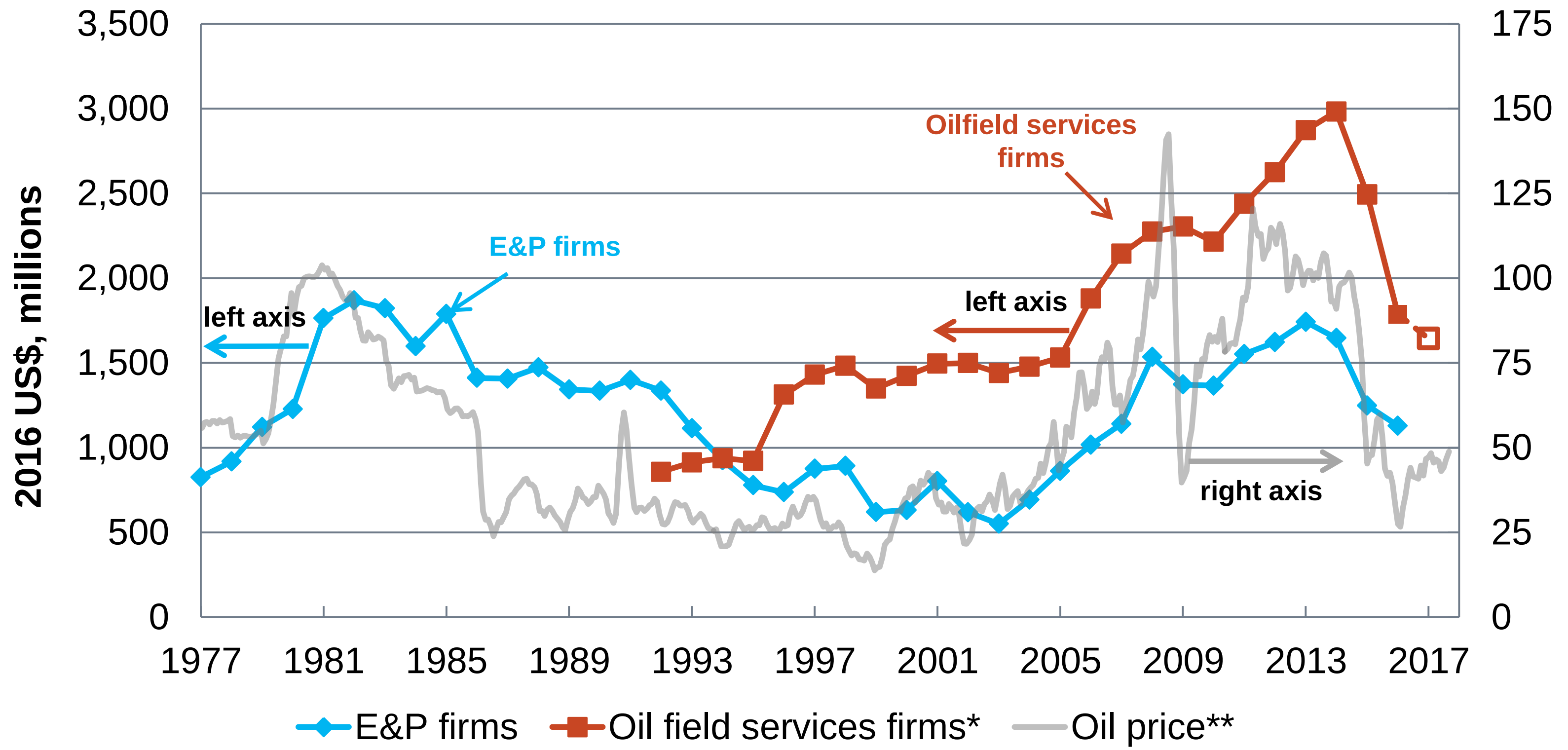


Notes: This cost of oil is expressed by the Dated Brent price necessary for projects to break even, assuming a 10% internal rate of return. The average, low, and high values for each supply source are estimated by analyzing the economics new projects in the IHS Markit Vantage database.

Source: IHS Markit

Substantial technology investment cuts are beginning to moderate as E&P organizations look in new directions

Upstream R&D spending of select E&P and oilfield services firms



Source: IHS Markit

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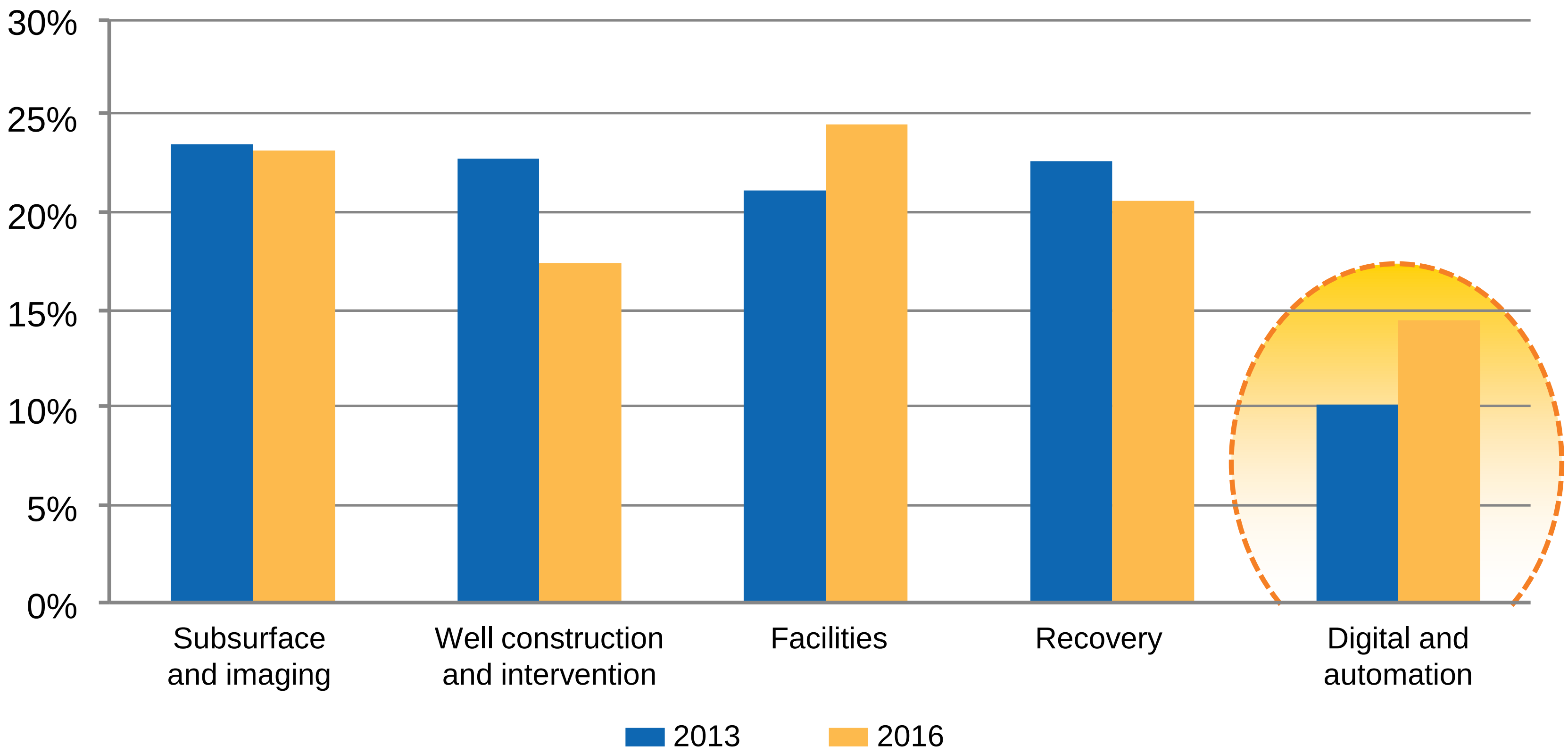
Notes: *US-based public oil and gas companies and the US-based subsidiaries of public foreign oil and gas companies that had at least 1% of US oil or gas production or reserves; sources: Department of Energy, EIA, IHS Markit analysis
** Leading oilfield equipment and service firms (24 firms examined); sources: Annual Reports, IHS Markit analysis

E&P players are adjusting technology priorities to compete in a low price environment—digital and automation technologies are rising

Upstream technology development focus areas*

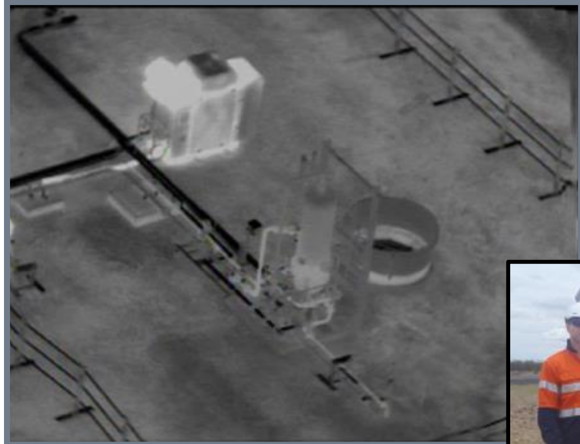


Notes: *806 technology focus areas of 29 E&P firms and OFS/EPC firms for 2013 and 891 technology focus areas of 34 E&P firms and OFS/EPC firms for 2016.
Source: IHS Markit

Digitalization is delivering real business value

Robots, drones, autonomous vehicles

Night images from 1,500 ft



1.4 million fewer km/month driven

Day images from 1,500 ft

Mobility

6% production uplift

The downturn has encouraged E&P organizations to pursue more diverse technology sourcing strategies—how best to balance them?

Expanding sources of upstream innovation

Open innovation

- **Partnerships and alliances** with and between industrial suppliers
- JIPs (e.g., OGCI, COSIA, Project 20K)
- Crowd sourcing (e.g., Robotics Challenge)

Formal, research center-based R&D

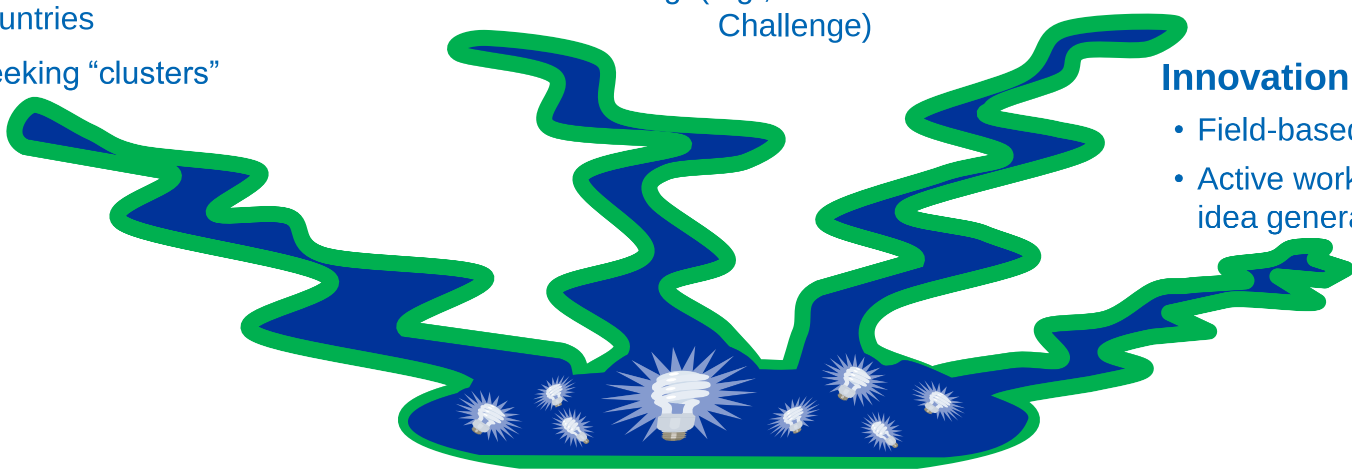
- Shift toward resource holder countries
- Seeking "clusters"

Corporate venture groups

- Access early stage technology outside core focus areas

Innovation at the edges

- Field-based experimenting
- Active workforce innovation idea generation



Source: IHS Markit

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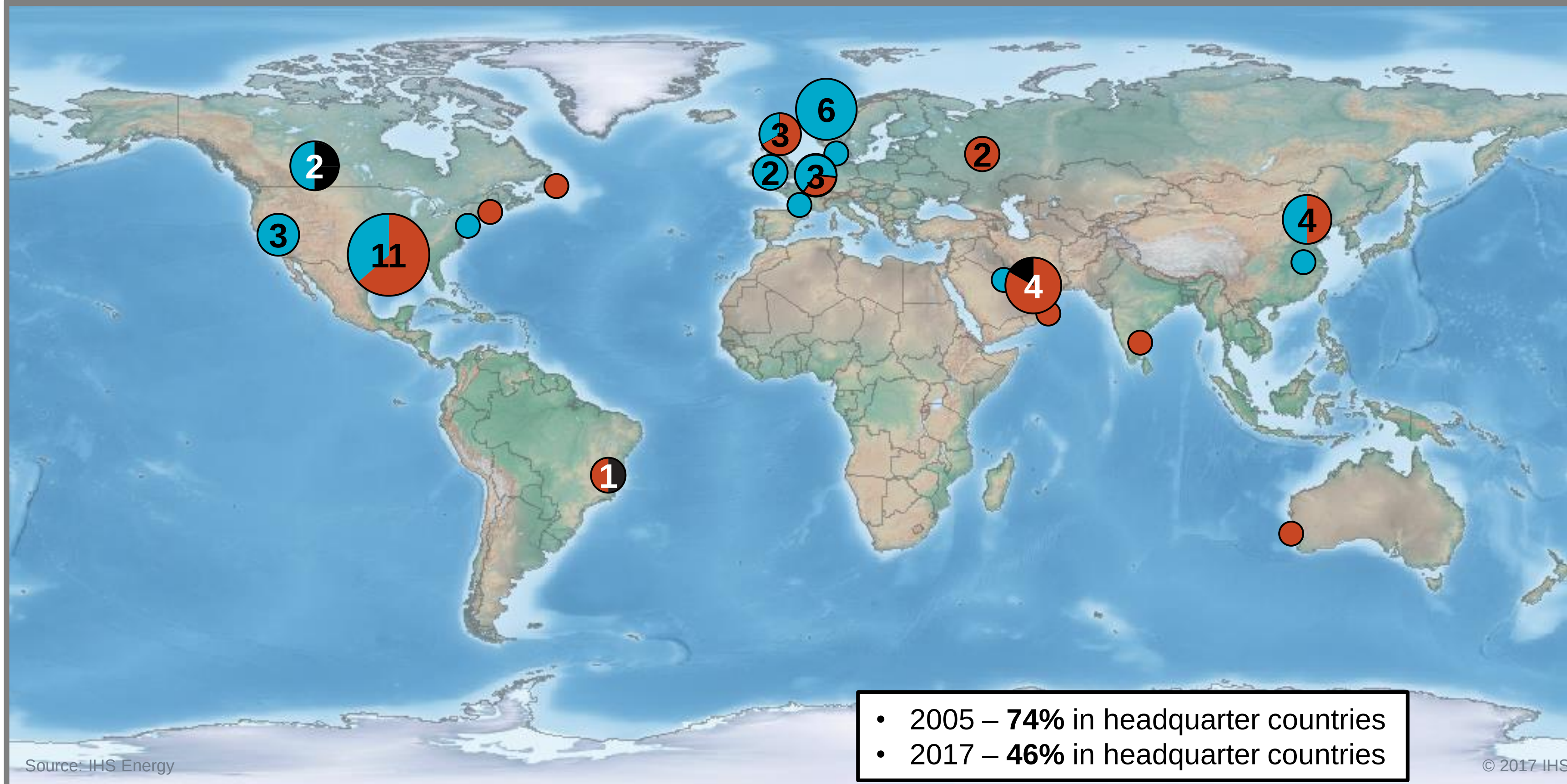
The Globalization of Innovation

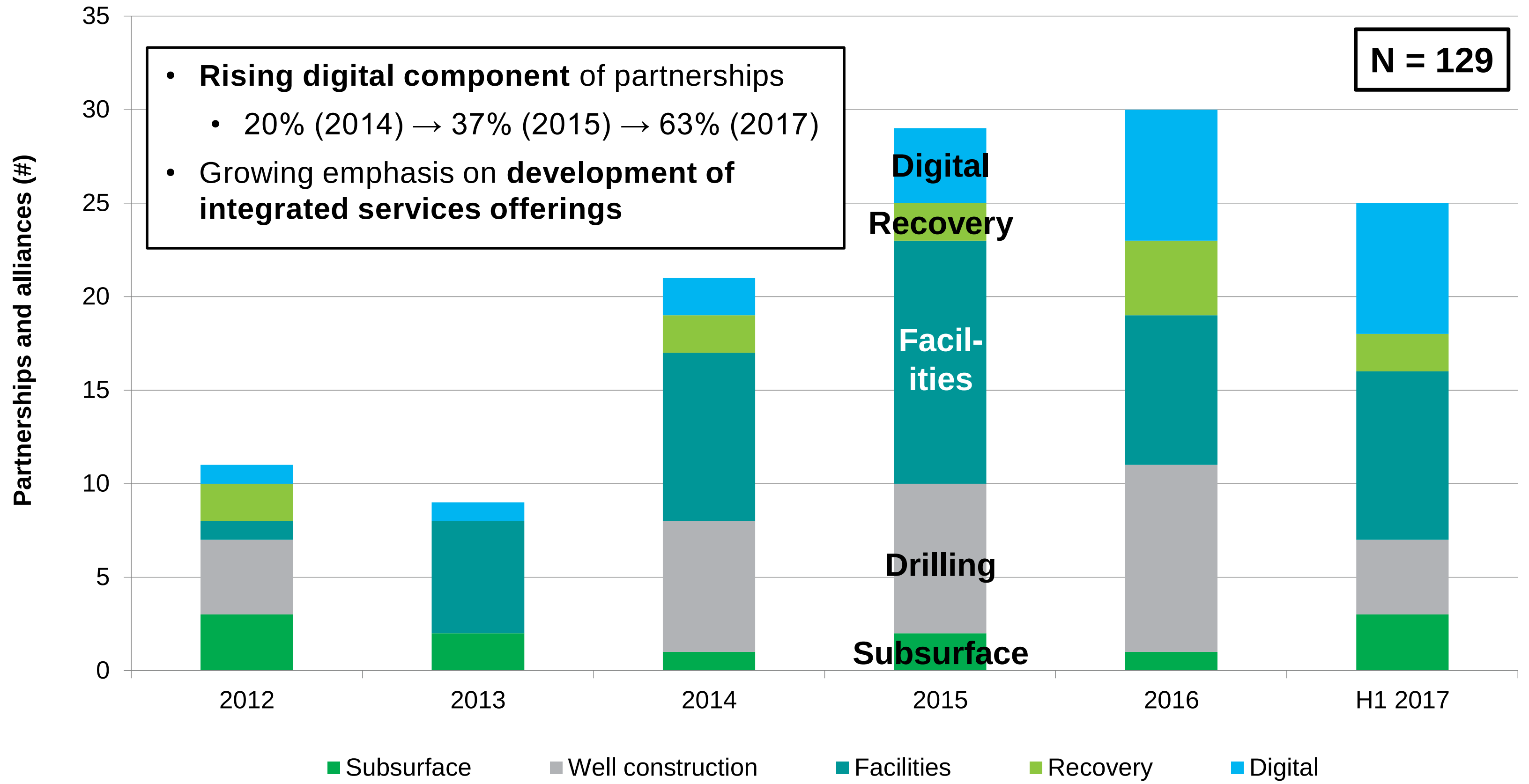
Upstream Technology & Research Centers of 12 large, representative E&P firms (IOCs and NOCs)



In place in 2005 **Constructed since 2006** **Closed since 2014**

The growth and evolution of technology development partnerships reflects expanding innovation portfolios

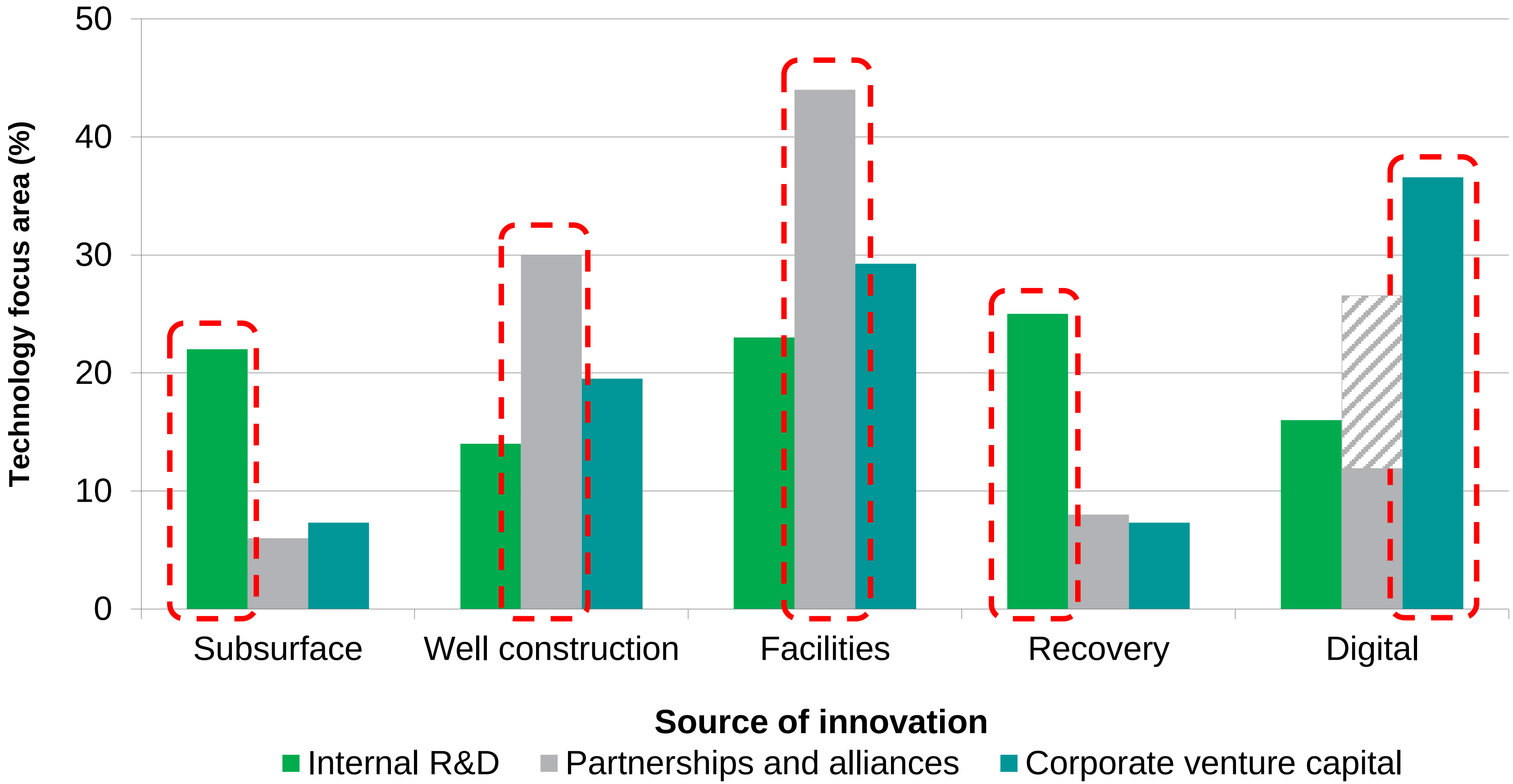
E&P technology development partnerships and alliances, by technology class



Source: IHS Markit

E&P organizations are pursuing increasingly portfolio-based approaches to technology development

Technology development focus, by innovation source, 2016



Source: IHS Markit

Upstream Technology and Innovation

Valuable insights into the technology trends and developments taking place across the exploration and production value chain, including how best to source, manage, and advance them

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